



Operating Instructions

Diesel engine
12V/16V2000Mx6
12V/16V2000M96L
12V2000M96X

MS150119/05E




A Rolls-Royce
solution

Engine model	kW/cyl.	Application group
12V2000M86	106 kW/cyl.	1D, continuous operation, variable, medium load
12V2000M96	112 kW/cyl.	1DS, continuous operation, variable, low load
12V2000M96L	119 kW/cyl.	1DS, continuous operation, variable, low load
12V2000M96X	123 kW/cyl.	1DS, continuous operation, variable, low load
16V2000M86	102 kW/cyl.	1D, continuous operation, variable, medium load
16V2000M96	112 kW/cyl.	1DS, continuous operation, variable, low load
16V2000M96L	121 kW/cyl.	1DS, continuous operation, variable, low load

Table 1: Applicability

California Proposition 65

This warning applies only to the State of California, USA, in compliance with Title 27 California Code of Regulations, Article 6, Clear and Reasonable Warnings.

 **WARNING:** Breathing diesel engine exhaust exposes you to chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

- Always start and operate the engine in a well-ventilated area.
- If in an enclosed area, vent the exhaust to the outside.
- Do not modify or tamper with the exhaust system.
- Do not idle the engine except as necessary.

For more information go to www.P65warnings.ca.gov/diesel.

(→ www.P65warnings.ca.gov/diesel)

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1 Preface

1.1 Preface

These Operating Instructions contain general instructions for the proper and safe operation of your product from the manufacturer MTU.

Definition of MTU

MTU refers to Rolls-Royce Power Systems AG and MTU Friedrichshafen GmbH or an affiliated company pursuant to Section § 15 AktG (German Stock Corporation Act) or a controlled company (joint venture).

2 Safety

2.1 Important provisions for all products

General

This product may pose a risk of injury or damage in the following cases:

- Incorrect use
- Operation, maintenance and repair by unqualified personnel
- Changes or modifications which are neither made nor authorized by the manufacturer
- Noncompliance with the safety instructions and warning notices

Nameplates

The product is identified by nameplate, model designation or serial number. This data must match the specifications in these instructions.

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

All EU-certified engines delivered by MTU come with a second nameplate. This second nameplate is delivered "loosely" with the engine. If the nameplate secured to the engine after installation in the vehicle/system is not visible without the removal of components, the system integrator must install the second nameplate in a clearly visible area on the vehicle/system.

Emissions regulations and emissions label

Responsibility for compliance with emissions regulations

Modification or removal of any mechanical/electronic components or the installation of additional components including the execution of calibration processes that might affect the emissions characteristics of the product are prohibited by emissions regulations. Emissions-related components must only be serviced, exchanged or repaired if the components used for this purpose are approved by the manufacturer.

Noncompliance with these specifications will invalidate the design type approval or certification issued by the emissions regulation authorities. The manufacturer does not accept any liability for violations of the emissions regulations.

The product must be operated over its entire life cycle according to the conditions defined as "Intended use" (→ Page 10).

Emissions certification applicable to engines with EPA Nonroad Tier 4 emissions certification in accordance with 40 CFR 1039 and with EPA Locomotive emissions certification in accordance with 40 CFR 1033

Extract from the standard:

Failing to follow these instructions when installing a certified engine in a piece of nonroad equipment violates federal law (40 CFR 1068.105(b)), subject to fines or other penalties as described in the Clean Air Act.

Extract from the standard:

If you install the engine in a way that makes the engine's emission control information label hard to read during normal engine maintenance, you must place a duplicate label on the equipment, as described in 40 CFR 1068.105.

When fitting the second label, the requirements of 40 CFR 1068.105(c) must be followed and observed. This paragraph describes the process for requesting and fitting the label, the documentation obligations and storage obligations for the required documents.

Replacing components with emissions labels

On all engines from MTU fitted with emissions labels, these labels must remain on the engine throughout its operational life.

Exception: Engines used exclusively in land-based, military applications other than by US government agencies.

Please note the following when replacing components with emissions labels:

- The relevant emissions labels must be affixed to the spare part.
- Emissions labels shall not be transferred from the replaced part to the spare part.
- The emissions labels must be removed from the replaced part and destroyed.

2.2 Intended use of all products

Intended use

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

Intended use entails operation:

- Within the permissible operating parameters in accordance with the (→ Technical data)
- With fluids and lubricants approved by the manufacturer in accordance with the (→ Fluids and Lubricants Specifications of the manufacturer)
- With preservation approved by the manufacturer in accordance with the (→ Preservation and Represervation Specifications of the manufacturer)
- With spare parts approved by the manufacturer in accordance with the (→ Spare Parts Catalog/MTU contact/Service partner)
- In the original as-delivered configuration or in a configuration approved by the manufacturer in writing (also applies to engine control/parameters)
- In compliance with all safety regulations and in adherence with all safety and warning notices in this manual
- In compliance with the maintenance work and intervals specified in the (→ Maintenance Schedule) throughout the useful life of the product
- Work which requires communication with the control units must only be carried out with a diagnosis software or with tools approved by the manufacturer.
- In compliance with the maintenance and repair instructions contained in this manual, in particular with regard to the specified tightening torques
- With the exclusive use of technical personnel trained in commissioning, operation, maintenance and repair

The product must not be operated in explosive atmospheres unless the engine fulfills the conditions for such use and approval has been granted.

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

The specifications of the manufacturer will be amended or supplemented as necessary. Prior to operation, make sure that the latest version is used. The latest version can be found at:

- <http://www.mtu-solutions.com>

Modifications or conversions

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

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

2.3 Personnel and organizational requirements

Organizational measures of the user/manufacturer

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

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

Personnel must receive instruction on product handling and repair based on this manual. In particular, personnel must have read and understood the safety requirements and warnings before starting work.

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

Personnel requirements

All work on the product must be carried out by trained, instructed and qualified personnel only:

- Training at the Training Center of the manufacturer
- Qualified personnel from the areas mechanical engineering, plant construction, and electrical engineering and also for work with live parts

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

Personnel shall not report for duty under the influence of alcohol, drugs or strong medication.

Clothing and personal protective equipment

Always wear appropriate personal protective equipment, e.g. safety shoes, ear protectors, protective gloves, goggles, breathing mask. Follow the instructions concerning personal protective equipment in the respective descriptions of the individual activities or the manufacturer's documentation included in the delivery.

When working on live components, in particular on electrical switchgear or on high-voltage component, wear special protective clothing according to IEC 61482.

Safe handling of Substances of Very High Concern pursuant to the REACH regulation (Registration, Evaluation, Authorization and restriction of CHemicals): We recommend wearing protective gloves at all times in order to reduce risk when working.

2.4 Safety regulations for commissioning and operation

Safety regulations for commissioning

Install the product correctly and carry out acceptance in accordance with the manufacturer's specifications before putting the product into service. All necessary approvals must be granted by the relevant authorities and all requirements for initial startup must be fulfilled.

Whenever the product is subsequently taken into operation ensure that:

- All personnel is clear of the danger zone surrounding moving parts of the machine.
Electrically-actuated linkages may be set in motion when the Engine Control Unit (governor) is switched on.
- All maintenance and repair work has been completed.
- All loose parts have been removed from rotating machine components.
- All protective devices are in place.
- All lines bearing media are ready for operation.
- All components are properly grounded. Ground separately by means of a grounding stake as necessary.
- No persons wearing pacemakers or any other technical body aids are present.
- Adequate ventilation of the operating room must be ensured for any operating status.
- In the first few hours of operation, the product emits gases as a result of smoldering e.g. lacquers or oil. These gases may be hazardous to health. Always wear respiratory protection in the operating room during this period.
- The exhaust system is leak-tight and that the gases are vented to atmosphere.
- The product must be free of any damage, this applies in particular to lines and cabling.
- Protect battery terminals, generator terminals or cables against accidental contact.
- Check that all connections have been correctly allocated e.g. +/- polarity, fuel line/reduction agent line, supply/return.

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

Smoking is prohibited in the area of the product.

Safety regulations during operation

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

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

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

Malfunctions and emergency stop

Practice emergency procedures, especially emergency stopping, at regular intervals.

Take the following steps if any system malfunctions are detected or signaled by the system:

- Inform supervisor(s) in charge.
- Analyze the message.
- Respond by taking any necessary emergency action, e.g. emergency stop.

After a safety shutdown, the engine may only be started after the cause of the shutdown has been eliminated.

Contact Service if the root cause of the malfunction cannot be clearly identified.

Operation

Do not remain in the operating room when the product is running unless absolutely necessary. Keep your stay as short as possible.

Keep a safe distance away from the product if possible. Do not touch the product unless expressly instructed to do so following a written procedure.

Do not inhale the exhaust gases of the product.

The following requirements must be fulfilled before the product is started:

- Wear hearing protection.
- Mop up any leaked or spilled fluids and lubricants immediately or soak up with a suitable binding agent.

Operation of electrical equipment

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

Follow the applicable operating and safety instructions when operating the devices and heed warnings at all times.

2.5 Safety regulations for assembly, maintenance, and repair work

Safety regulations for work prior to assembly, maintenance, and repair

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

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

Relieve pressure in fluid and lubricant systems and compressed-air lines which are to be opened. Use suitable containers of adequate capacity to catch fluids and lubricants.

Release residual pressure before removing or replacing a component in the supply line. To depressurize pressurized lines, shut off the lines first, then release the residual pressure.

Work may only be carried out on lines when they are free of fluids and lubricants.

Ensure adequate ventilation of the operating room when conducting an oil change, working on the gaseous/liquid fuel system or working with process materials (e.g. adhesive, cleaner).

Never carry out assembly, maintenance, or repair work with the product in operation, unless:

- It is expressly permitted to do so following a written procedure.

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

- Start interlock
- Key switch
- Close supply line for hydraulic starting.
- Close the main valve on the compressed-air system and vent the compressed-air line when air starters are fitted.

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

Disconnect the battery cables or actuate the battery isolator switch, if fitted. Lock circuit breakers.

Before starting work on CaPoS, if used:

- Switch off the charging system (DC/DC converter).
- Discharge the UltraCap modules using the appropriate discharger.
- Short-circuit the UltraCap modules with a suitable wire jumper.

Before working on the exhaust gas aftertreatment system, close the shutoff valve on the reducing agent tank. Note that the reducing agent pumps continue to run for a certain period when the engine is stopped.

Disconnect the control equipment from the product.

Use the recommended special tools or suitable equivalents when instructed to do so.

Safety regulations when performing assembly, maintenance, and repair work

Special tools and lifting equipment

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

Setting down, lifting and climbing

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

Use appropriate lifting equipment for all components. Use all specified attachment points and observe the center of gravity.

Never stand beneath a suspended load.

Never work on engines or components when they are held in place by lifting equipment.

Make sure components or assemblies are placed on stable surfaces and secured against tilting over or rolling away. Adopt suitable measures to prevent components/tools from falling down.

Assume a safe standing position when performing assembly work.

Never use the product as a climbing aid.

When working high on the equipment, always use suitable ladders and work platforms. Special instructions for outdoor areas: There must be no risk of slipping e.g. due to icing.

Removing, installing and cleanliness

Pay particular attention to cleanliness at all times.

Completely wipe up escaped fluids and lubricants due to the risk of slipping.

Take special care when removing ventilation or plug screws from the product.

Ensure that O-rings are not installed in a slanted/twisted condition.

Carry out appropriate cleaning procedures to clean and inspect components requiring special cleanliness (e.g. components carrying oil, fuel, or air).

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

Ensure that all mounts and dampers are installed correctly.

Remove any accumulation of condensate after assembling chilled components. Coat the components with a suitable corrosion inhibitor as necessary.

Lines

Ensure that lines for all fluids and lubricants and their connections are clean.

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

Fit new seals when re-installing lines.

Never bend lines and avoid damaging lines, particularly the fuel lines.

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.

Miscellaneous

Sufficient ventilation must be guaranteed during the work.

Wear a breathing mask offering protection against soot, dust, and mineral fibers (filter class P3) when working on exhaust components. Clean the work area with a dust extraction machine of class H. Wear protective gloves and goggles for protection against acidic condensate.

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

Elastomer components (e.g. engine mounts, damping elements, couplings and V-belts) must not be painted. Only install them after painting the engine or mask them prior to painting.

The following applies to starters with copper-beryllium alloy pinions:

- Wear a respirator mask (filter class P3). Do not blow out the interior of the flywheel housing or the starter with compressed air. Clean the flywheel housing inside with a class H dust extraction device.
- Observe the safety data sheet.

Safety regulations after performing assembly, maintenance, and repair work

Before cranking the engine, make sure no one is in the danger zone of the engine.

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

All protective devices must be installed and all tools and loose parts must be removed (especially the barring tool).

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

Ensure that the grounding system is properly connected.

Welding work

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

Before starting welding work:

- Switch off the power supply master switch.
- Disconnect the battery cables or actuate the battery isolator switch.
- Separate the electrical ground of electronic equipment from the ground of the unit.

No other assembly, maintenance, or repair work may be carried out in the vicinity of the product while welding is in progress. There is a risk of explosion or fire due to oil vapors or highly flammable fluids and lubricants.

Do not use product as ground terminal.

Never position the welding power supply cable adjacent to, or crossing wiring harnesses of the product. The welding current can induce interfering voltages in the wiring harnesses which may damage the electrical system.

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

Hydraulic installation and removal

Check the function and safe operating condition of tools and fixtures to be used. Use only the specified jigs for the 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 which are under pressure.

Before starting work, pay attention to the following:

- Vent the installation/removal jig, the pumps and the pipework at the relevant designated points.
- For hydraulic installation, screw on the jig with the piston retracted.
- For hydraulic removal, screw on the jig with the piston extended.

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

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

Working with batteries

Observe the safety instructions of the manufacturer when working on batteries.

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

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

Wear protective clothing, goggles and protective gloves.

Do not place objects on the battery.

Before connecting the cable to the battery, check the battery polarity. The battery may explode and spray acid if the battery terminals are connected incorrectly.

Working on electrical and electronic assemblies

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

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

ESD (Electrostatic Discharge): Work on components which could be damaged by electrostatic discharge must always be carried out with appropriate equipment. Appropriate equipment is e.g. electrically conductive work surfaces or antistatic wristbands.

Do not damage cabling during removal work. When reconnecting, ensure that cabling cannot be damaged during operation by:

- Contact with sharp edges
- Chafing on components
- Contact with hot surfaces.

Do not secure cables on lines carrying fluids.

Do not use cable ties to secure lines.

Always use connector pliers to tighten union nuts on connectors.

Subject the device as well as the product to functional testing on completion of all repair work. The emergency stop function must be tested in particular. The functional check of the emergency stop, during which the voltage supply of the engine governor is switched off, must only be carried out when the product is cold.

Store spare parts properly prior to replacement, i.e. protect them against moisture in particular. Package faulty electronic components or assemblies properly before dispatching for repair:

- Moisture-proof
- Shock-proof
- Wrapped in antistatic foil (as necessary)

Working with laser equipment

Work with laser devices shall be carried out by trained and qualified personnel only. Follow the safety instructions in the manufacturer's user manual when working with laser equipment.

Wear special laser safety glasses when working with laser equipment (danger of concentrated radiation).

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

Measuring component dimensions

Workpieces, components and measuring equipment lie in the specified tolerance range at a reference temperature of 20 °C.

2.6 Fire and environmental protection, indirect materials

Fire prevention and fire

Flames, naked light and smoking are prohibited.

In the event of a fire, stop the fuel supply if this is possible without endangering personnel.

Manually-actuated equipment must be easily accessible to authorized personnel to facilitate stopping the fuel supply in the event of fire.

The product has hot surfaces that can ignite combustible gases and other substances in the surrounding area. The operating company must ensure that the product is installed and operated a sufficient distance away from danger sources and any existing safety instructions or recommendations must be observed. Products that comply with the SOLAS convention do not constitute such a danger.

Depending on the operating and ambient conditions, fuel temperatures above the flash point temperature are possible in the tank. This can lead to the creation of a dangerous potentially explosive atmosphere in the tank and makes suitable explosion protection measures necessary.

After working with combustible indirect materials (e.g. cleaning agents), ensure that the area is well ventilated. The resultant steam/air mixture must be sufficiently diluted to prevent a potentially explosive atmosphere.

Immediately eliminate any fluid or lubricant leakage. Fluids or lubricants splashing on hot components can cause fires, so keep the product clean at all times. Do not leave rags saturated with fluids and lubricants on the product. Do not store combustible materials near the product.

Incorrect refueling of the reducing agent system with fuel can lead to fires.

Before welding, clean the areas to be welded with a nonflammable fluid. Do not carry out welding work on pipes and components carrying oil or fuel.

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.

A risk of fire due to human error or a technical defect cannot be excluded completely. Always have suitable extinguishing agents (fire extinguishers) on hand and familiarize yourself fully with their handling.

For safety-critical environments, check whether further fire prevention measures are necessary.

Toxic substances may be created during a fire. Always wear protective gloves and any other personal protective equipment that may be necessary when touching any components.

Noise

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

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

Environmental protection and disposal

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

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

Indirect materials

Indirect materials may also be hazardous or toxic. When handling indirect materials as well as other chemical substances, observe the information contained in the associated safety data sheet. The safety data sheet may be obtained from the relevant manufacturer or from MTU.

Only fluids and lubricants approved by the manufacturer must be used in accordance with the Fluids and Lubricants Specifications. Request the most recent edition from the manufacturer.

Contamination of indirect materials with reducing agent (e.g. AdBlue®, DEF): Store indirect materials in separate containers and use separate drip trays. Even very slight contamination with reducing agent can lead to malfunctions in sensors and other components.

Used oil contains combustion residues that are harmful to health.

When handling used oil, protective gloves must be worn.

Wash affected areas after contact with used oil.

Registration, evaluation, authorization and restriction of chemicals (REACH ordinance)

Particularly hazardous substances in our products are compiled in a list:

- <http://www.mtu-solutions.com> → REACH Declaration

Compressed air

- Unauthorized use of compressed air, e.g. forcing flammable liquids (hazard rating A1, A11 and B) out of containers, risks causing an explosion.
- Wear goggles when blowing dirt off workpieces or blowing away swarf.
- Blowing compressed air into thin-walled containers (e.g. containers made of sheet metal, plastic or glass) for drying purposes or to check for leaks risks bursting them.
- Pay special attention to the pressure in the compressed air system or pressure vessel.
- Assemblies or products which are to be connected must be designed to withstand this pressure. Install pressure-reducing or safety valves set to the admissible pressure if this is not the case.
- Hose couplings and connections must be securely attached.
- Provide the snout of the air nozzle with a protective disk (e.g. rubber disk).
- Release residual pressure before removing a compressed air device from the supply line. To depressurize compressed-air lines, shut off the lines first, then release the residual pressure.
- Carrying out a leakage test as specified.

Paints

- Observe the relevant safety data sheet for all materials.
- 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 adversely affected.
- There must be no naked flames in the vicinity.
- No smoking.
- Observe fire-prevention regulations.
- Always wear a mask providing protection against paint and solvent vapors.





Liquid nitrogen

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

Acids/alkaline solutions/reducing agents (e.g. AdBlue[®], DEF)

- Observe the relevant safety data sheet for all materials.
 - When working with acids and alkaline solutions, wear goggles or face mask, gloves and protective clothing.
 - Do not inhale vapors.
 - If reducing agent is swallowed, rinse out mouth and drink plenty of water.
 - Remove any wet clothing immediately.
 - After skin contact, wash body areas with plenty of water.
 - Rinse eyes immediately with eye drops or clean tap water. Consult a doctor as soon as possible.
- Contamination of reducing agent with other indirect materials: Store reducing agent in separate containers and use separate drip trays. Even very slight contamination can result in malfunctions to the exhaust gas aftertreatment system.
- Incorrect refueling of the reducing agent system with fuel can cause leakages at the gaskets and in the hoses.

2.7 Standards for warning notices in the text and highlighted information

DANGER 	In the event of immediate danger. Consequences: Death, serious or permanent injury! <ul style="list-style-type: none">• Remedial action.
WARNING 	In the event of a situation involving potential danger. Consequences: Death, serious or permanent injury! <ul style="list-style-type: none">• Remedial action.
CAUTION 	In the event of a situation involving potential danger. Consequences: Minor or moderate injuries! <ul style="list-style-type: none">• Remedial action.
NOTICE 	In the event of a situation involving potentially adverse effects on the product. Consequences: Material damage! <ul style="list-style-type: none">• Remedial action.• Additional product information.

Warning notices

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

Highlighted information

Important

This field contains product information which is important or useful for the user.
This information must not refer to hazards related to personal injury or material damage.

3 Transport

3.1 Transport

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Crossbeam	T80091731	1

DANGER



Suspended load

Danger to life

- Never stand under suspended loads!
- Wear appropriate personal protective equipment.

Transport

1. Install transportation locks for engine mounts and transport locking device for engine prior to transport.
2. Always use the lifting eyes provided when transporting the engine. See installation drawings.
3. Use suitable transport and lifting gear only.
4. Take the engine's center of gravity into account. See installation drawings.
5. The engine must only be transported in installation position: maximum permissible diagonal pull 10°.
6. Remove any loose parts from the system, engine/generator.
7. Always raise/lower the engine slowly. Do not allow lifting ropes or chains to contact the engine or any of its component parts when lifting. Readjust lifting gear as necessary.
8. Special packaging with aluminum foil: Attach engine at lifting eyes of bearing pedestal or use a means of transport which is capable of bearing the load (forklift truck).
9. Secure the engine against tilting during transport. In particular when going up or down inclines or ramps, the engine must be secured against slipping and tilting.

Setting down following transport

1. Engine may only be set/transported on a horizontal surface and the engine mounts/transport supports provided for this purpose.
2. Make sure that the consistency and load-bearing capacity of the ground or support surface is adequate.
3. Never set the engine down on the oil pan unless this has been expressly authorized by MTU.

4 General Information

4.1 Tightening specifications for screws, nuts and bolts

Tightening torques for setscrew and stud connections as per MTN 5008 standard

The standard applies to setscrews that are not subject to dynamic load and the associated nuts according to the following standards:

- MMN 384
- ISO 4762 (DIN 912)
- ISO 4014 (DIN 931-1)
- ISO 4017 (DIN 933)
- DIN EN ISO 8765 (EN 28765; DIN 960)
- DIN EN ISO 8676 (EN 28676; DIN 961)
- DIN 6912

The standard applies to studs and associated nuts according to following standards:

- DIN 833
- DIN 835
- DIN EN ISO 5395 (DIN 836)
- DIN 938
- DIN 939

The standard applies to screws with hexalobular head according to the following standards:

- DIN 34800
- DIN 34801

It does not apply to heat-resistant and highly heat-resisting screws in the hot component section.

Tightening torques M_A are specified for screws of strength class 8.8 (surface condition bare, phosphatized or galvanized) and 10.9 (surface condition bare or phosphatized).

The values in the table are based on a friction coefficient $\mu_{\text{tot}} = 0.125$.

Threads and mating faces of screws and nuts must be coated in engine oil prior to assembly unless a different lubricant is expressly specified.

When hand-tightening (defined torque), an assembly tolerance of -5+15% of the figures in the table is permitted.

The admissible assembly tolerance is $\pm 15\%$ for machine tightening.

Important

Specific tightening torques are specified accordingly in the respective task descriptions; these must be observed!

Tightening torque for setscrews

Thread	Manual tightening		Machine-tightening	
	8.8 M_A (Nm)	10.9 M_A (Nm)	8.8 M_A (Nm)	10.9 M_A (Nm)
M6	9	12	8	11
M8	21	31	20	28
M8 x 1	23	32	21	30
M10	42	60	40	57
M10 x 1.25	45	63	42	60
M12	74	100	70	92

Thread	Manual tightening		Machine-tightening	
	8.8 M _A (Nm)	10.9 M _A (Nm)	8.8 M _A (Nm)	10.9 M _A (Nm)
M12 x 1.25	80	110	75	105
M12 x 1.5	76	105	72	100
M14	115	160	110	150
M14 x 1.5	125	180	120	170
M16	180	250	170	235
M16 x 1.5	190	270	180	255
M18	250	350	240	330
M18 x 1.5	280	400	270	380
M20	350	500	330	475
M20 x 1.5	390	550	350	520
M22	480	680	450	650
M22 x 1.5	520	730	490	700
M24	600	850	570	810
M24 x 1.5	680	950	640	900
M24 x 2	660	900	620	850
M27	900	1250	850	1175
M27 x 2	960	1350	900	1275
M30	1200	1700	1100	1600
M30 x 2	1350	1900	1250	1800
M _A = Tightening torques				

Tightening torques for studs

Thread	Screwed into		
	steel M _A (Nm)	gray cast iron M _A (Nm)	Al alloy M _A (Nm)
M6	9	6	6
M8	11	9	10
M10	17	13	13
M12	27	23	18
M14	37	33	33
M16	55	45	–
M _A = Tightening torques			

Tightening torques for setscrews and nuts made of stainless steels

The values in the table are based on a friction coefficient $\mu_{\text{tot}} = 0.12$, lubricated with Molykote on the thread and under the screw head.

Basic size	Strength class		Material
	70 M _A (Nm)	80 M _A (Nm)	
M5	3.7	4.9	A2 / A4
M6	6.4	8.5	A2 / A4

Basic size	Strength class		Material
	70 M_A (Nm)	80 M_A (Nm)	
M8	15.3	20.4	A2 / A4
M10	31	41	A2 / A4
M12	52	70	A2 / A4
M16	126	167	A2 / A4
M20	254	326	A2 / A4
M_A = Tightening torques			

Tightening torques for self-locking hex nuts

Thread	M_A (Nm)	Lubricant
M6	7.5 +1	-
M8	17 +2	-
M10	35 +4	-
M12	59 +6	-
M14	100 +10	-
M16	140 +14	-
M20	290 +29	-
M_A = Tightening torques		

Tightening torques for stress bolt connections as per MTN 5007 standard

This standard applies to stress pin bolts and stress bolts which are subjected to static and dynamic load of strength class 10.9 as well as to the associated nuts.

Shaft and transition dimensions as per MMN 209 standard and material and machining as per MMN 389 standard (bright surface or phosphatized).

The values in the table are based on a friction coefficient $\mu_{tot} = 0.125$.

Threads and mating faces of screws and nuts must be coated in engine oil prior to assembly.

For unavoidable deviations during the tightening procedure, an assembly tolerance of +10% of the table value is permissible.

The values in the tables are for manual tightening using a torque wrench.

Thread	Not torsion-protected M_A (Nm)	Torsion-protected* M_A (Nm)
M6	9	12
M8	21	28
M8 x 1	24	30
M10	42	55
M10 x 1.25	46	60
M12	75	93
M12 x 1.5	78	99
M14	120	150
M14 x 1.5	135	160
M16	180	225
M16 x 1.5	200	245

Thread	Not torsion-protected M_A (Nm)	Torsion-protected* M_A (Nm)
M18	250	315
M18 x 1.5	300	360
M20	350	450
M20 x 1.5	430	495
M22	500	620
M22 x 1.5	560	675
M24	640	790
M24 x 2	700	850
M27	900	1170
M27 x 2	1000	1230
M30	1250	1575

*Protect screw shank from torsion when tightening.

M_A =tightening torques.

Tightening torques for plug screws as per MTN 5183-1 standard

This standard applies to plug screws as per DIN 908, DIN 910 and DIN 7604 with screwed plug DIN 3852, model A (sealed by sealing ring DIN 7603-Cu).





Tightening torques M_A are given for plug screws made of steel (St) with surface protected by a phosphate coating and oiled or galvanized.

Threads and mating faces beneath heads must be coated in engine oil prior to assembly.

For unavoidable deviations during the tightening procedure, an assembly tolerance of +10% of the table value is permissible.

Tightening torques for plug screws DIN 908, DIN 910 and DIN 7604A (with short screwed plug)

Thread	Screwed into	
	Steel/gray cast iron M_A (Nm)	Al alloy M_A (Nm)
M10 x 1	15	15
M12 x 1.5	25	25
M14 x 1.5	35	30
M16 x 1.5	40	35
M18 x 1.5	50	40
M20 x 1.5	60	50

Thread	Screwed into	
	Steel/gray cast iron M_A (Nm)	Al alloy M_A (Nm)
M22 x 1.5	70	70
M24 x 1.5	85	80
M26 x 1.5	100	100
M27 x 2	100	100
M30 x 1.5	110	110
M30 x 2	120	120
M33 x 2	160	160
M36 x 1.5	190	180
M38 x 1.5	220	200
M42 x 1.5	260	240
M45 x 1.5	290	270
M48 x 1.5	310	300
M52 x 1.5	325	320
M56 x 2	380	360
M64 x 2	400	400
M_A = Tightening torques		

Tightening torque for plug screws DIN 7604C (with long spigot union)

Thread	Screwed into	
	Steel/gray cast iron M_A (Nm)	Al alloy M_A (Nm)
M8 x 1	10	10
M22 x 1.5	80	65
M26 x 1.5	105	90
M30 x 1.5	130	130
M38 x 1.5	140	120
M45 x 1.5	160	140
M_A = Tightening torques		

Tightening torque for banjo screws as per MTN 5183-2 standard

This standard applies to banjo screws as per MMN 223 and N 15011 sealed with sealing ring DIN 7603-Cu.



The stated tightening torques M_A apply to steel (St) banjo screws with a phosphatized surface and oiled or galvanized and for copper-aluminum alloy.

Threads and mating faces beneath heads must be coated in engine oil prior to assembly.

For unavoidable deviations during the tightening procedure, an assembly tolerance of +10% of the table value is permissible.

Tightening torques for steel banjo screws

Thread	Screwed in steel/gray cast iron/aluminum alloy M_A (Nm)
M8 x 1	10
M10 x 1	15
M12 x 1.5	20
M14 x 1.5	25
M16 x 1.5	25
M18 x 1.5	30

Thread	Screwed in steel/gray cast iron/aluminum alloy M_A (Nm)
M22 x 1.5	60
M26 x 1.5	90
M30 x 1.5	130
M38 x 1.5	140
M45 x 1.5	160
M_A = Tightening torques	

Tightening torques for copper-aluminum alloy banjo screws

Thread	Screwed in steel/gray cast iron/aluminum alloy M_A (Nm)
M10 x 1	15
M16 x 1.5	30
M_A = Tightening torques	

Tightening torques for male connectors as per MTN 5183-3 standard

This standard applies to male connectors DIN 2353, series L with screwed plug DIN 3852, model A (sealed by sealing ring DIN 7603-Cu).



Tightening torques M_A are given for male connectors made of steel (St) with surface protected by a phosphate coating and oiled or galvanized.

Threads and mating faces beneath heads must be coated in engine oil prior to assembly.

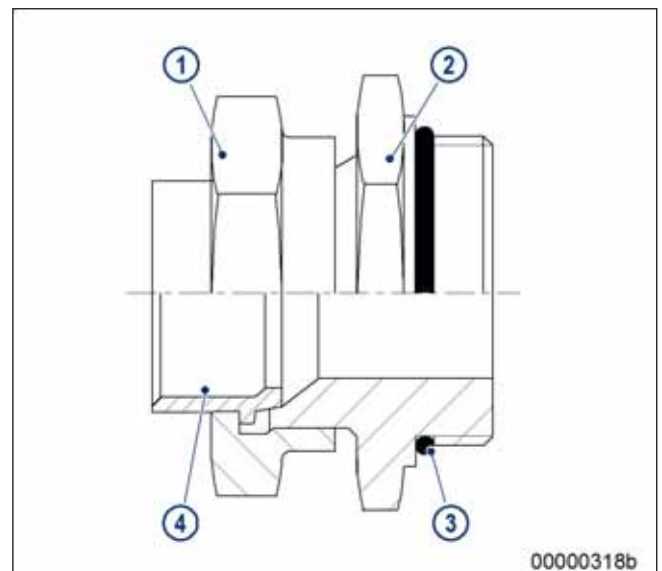
For unavoidable deviations during the tightening procedure, an assembly tolerance of +10% of the table value is permissible.

Thread	Screwed in steel/gray cast iron M_A (Nm)
M10 x 1	15
M12 x 1.5	20

Thread	Screwed in steel/gray cast iron M_A (Nm)
M14 x 1.5	35
M16 x 1.5	50
M18 x 1.5	60
M22 x 1.5	70
M26 x 1.5	100
M32 x 2	160
M42 x 2	260
M48 x 2	320
M_A = Tightening torques	

Tightening torques for union nuts as per DIN 3859-2

- 1 Union nut
- 2 Screw fixture
- 3 O-ring
- 4 Ball-type union



Union nut: On installing the ball-type union, after tightening the union nut firmly by hand (noticeable increase in force), it should be tightened another 1/4 turn (90°) past this point.

Tightening torques for spigot unions with O-ring as per ISO 6149-2



Thread	Torque (Nm) +10%
M8 x 1	10
M10 x 1	20
M12 x 1.5	35
M14 x 1.5	45
M16 x 1.5	55
M18 x 1.5	70
M20 x 1.5 ¹⁾	80
M22 x 1.5	100
M27 x 2	170
M33 x 2	310
M42 x 2	330
M48 x 2	420
M60 x 2	500
¹⁾ Only for closing off installation spaces for screw-in valves (see ISO 6149-47 and ISO 7789).	

Tightening torques for spigot unions with O-ring as per ISO 6149-3



Thread	Torque (Nm) +10%
M8 x 1	8
M10 x 1	15
M12 x 1.5	25
M14 x 1.5	35
M16 x 1.5	40
M18 x 1.5	45
M22 x 1.5	60
M27 x 2	100
M33 x 2	160
M42 x 2	210
M48 x 2	260
M60 x 2	315

Tightening torques for plug screws as per MTN 5183-6



Thread	Screwed into	
	Steel/gray cast iron M_A (Nm)	Al alloy M_A (Nm)
M10 x 1	20	10 +2
M12 x 1.5	35	14 +2
M14 x 1.5	45	15 +3
M16 x 1.5	55	18 +3
M18 x 1.5	70	23 +3
M22 x 1.5	100	33 +4
M27 x 2	170	57 +5
M33 x 2	310	103 +10
M42 x 2	330	110 +11
M48 x 2	420	140 +14
M60 x 2	–	200 +20
M_A = Tightening torques		

Assembly instructions and tightening torques for hose fittings with union nuts

The instructions do not apply to ORFS hose fittings. When connecting hose fittings with sealing heads and the associated adapters, assemble in contrast to the instructions for pipe unions in the following manner.

Hose fitting, metallic sealing with union nut: Tighten union nut by hand then tighten max. 1/4 turn with wrench.

Hose fitting with O-ring and union nut: Tighten union nut by hand then tighten max. 1/2 turn with wrench.

Align hoses accordingly prior to tightening the union nut.

Sealing head/sealing cone with metric union nut		
Metric thread	Pipe outer diameter	Torque (Nm)
M12 x 1.5	6	20
M14 x 1.5	8	38

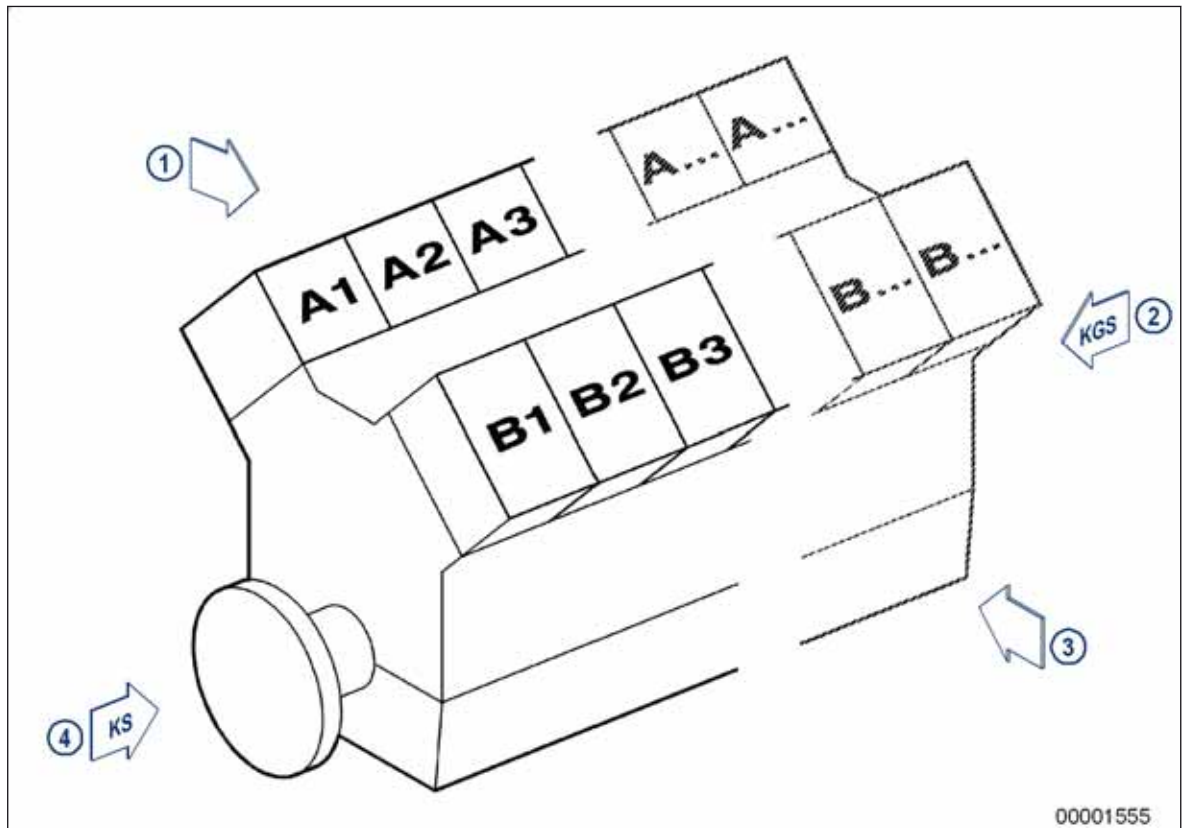
Sealing head/sealing cone with metric union nut		
Metric thread	Pipe outer diameter	Torque (Nm)
M16 x 1.5	8	45
	10	
M18 x 1.5	10	51
	12	
M20 x 1.5	12	58
M22 x 1.5	14	74
	15	
M24 x 1.5	16	74
M26 x 1.5	18	105
M30 x 2	20	135
	22	
M36 x 2	25	166
	28	
M42 x 2	30	240
M45 x 2	35	290
M52 x 2	38	330
	42	

Sealing head with BSP union nut	
BSP thread	Torque (Nm)
G1/4	20
G3/8	34
G1/2	60
G5/8	69
G3/4	115
G1	140
G1.1/4	210
G1.1/2	290
G2	400

SAE sealing cone with union nut JIC 37°		
UNF thread	Size	Torque (Nm)
7/16-20	-4	15
1/2-20	-5	20
9/16-18	-6	30
3/4-16	-8	50
7/8-14	-10	69
1.1/16-12	-12	98
1.3/16-12	-14	118
1.5/16-12	-16	140
1.5/8-12	-20	210
1.7/8-12	-24	290
2.1/2-12	-32	450

UNF thread	ORFS – flat sealing with union nut	
	Size	Torque (Nm)
9/16-18	-4	14 +2
11/16-16	-6	24 +3
13/16-16	-8	43 +4
1-14	-10	60 +8
1.3/16-12	-12	90 +5
1.3/16-12	-14	90 +5
1.7/16-12	-16	125 +10
1.11/16-12	-20	170 +20
2-12	-24	200 +25
2-1/2-20	-32	460 +30

4.2 Engine side and cylinder designations



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

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

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

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

4.3 Product description

Engine description

Engine

The engine is a liquid-cooled four-stroke diesel engine with c.c.w. direction of rotation, direct injection, sequential turbocharging and charge-air cooling.

An electronic management system provides engine control and monitoring.

Fuel system with common-rail injection

Controlled by the electronic engine management system, the common rail injection system determines injection pressure, injection timing and injection quantity to regulate engine speed and engine performance.

Injection pressures up to 2200 bar ensure optimum combustion conditions.

Turbocharging system

The charging system comprises charge-air system, exhaust system and sequential turbocharging.

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

The triple-walled design ensures

- low surface temperature,
- reduced thermal load,
- absolute gas-tightness.

Lube oil system

Wet-sump forced-feed lubrication system

Components supplied with oil:

- Bearings
- Piston cooling
- Crankcase breather suction jet pump
- Control and actuating elements of sequential turbocharging system

Cooling system

- Two separate circuits
 - Engine coolant
 - Raw water
- Coolant cooling by raw water-cooled plate-core heat exchanger
- Thermostat-controlled coolant system
- Coolant cooled / heated charge air (basic intercooler)
- Raw water-cooled charge air (additional switchable intercooler)
- Coolant-cooled in-engine fuel return

Electronic system

Electronic control and monitoring system with integrated security and test system with interfaces to remote control system (RCS) and to monitoring system (MCS)

Connection box EIM (Engine Interface Module)

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

Functions:

- Starter control and monitoring (for electric and pneumatic starters) (start repetition tooth on tooth, starter protection)
- Battery-charging generator monitoring
- Open bus interface to the plant (SAE J1939)
- Emergency stop function with open circuit monitoring
- Redundant power supply
- Optional control of emergency air-shutoff flaps
- Key switch logic
- Interface to ECU and EMU
- MCS5 dialog interface
- Control of an MTU lube-oil priming pump (power components in separate MTU PPC Box)
- Connection facility for an MTU Local Operating Station (LOS)

Serial RS422 interface for diagnosis

The engine interface is divided into two parts. The first part is integrated in the engine wiring harness via the 62-pole connector X52. The second part is formed by those signals involving a higher current. Such signals are routed out via M threaded pins and are also integrated in the engine wiring harness.

Functions

- ECU supply
- EMU supply
- Plant signals (ECU9 connector X1)
- Bus interface (2x MCS5 CAN)
- CAN dialog output (1x MCS5 CAN)
- ECU and EMU emergency stop
- Electric starter
- Terminal 45 starter A/B (engaged)
- Pneumatic starter
- Starting air pressure valve
- Starting air pressure sensor
- Barring tool (Barring Gear 1 and 2)
- Battery-charging generator (with exciter control)
- Optional emergency air-shutoff flaps
- Activation of emergency air-shutoff flaps 1+2
- Feedback from emergency air-shutoff flaps 1+2

Electronic engine control unit (ECU)

Closed-loop control:

- Engine speed
- High-pressure fuel

Open-loop control:

- Injection (fuel pressure, injection timing, injection duration, operating status)
- Sequential turbocharging (cutting-in and out) with secondary turbocharger
- Engine protection with multi-stage safety systems:
 - Power reduction
 - Power limitation
 - Emergency stop

Monitoring (basic sensor scope):

- Exhaust gas temperature, A side
- Exhaust temperature, B side
- Engine speed
- Oil pressure
- Differential oil pressure
- Coolant temperature
- Coolant level
- Exhaust turbocharger speed
- Oil temperature
- Coolant pressure
- Fuel pressure after filter

Monitoring in engine room

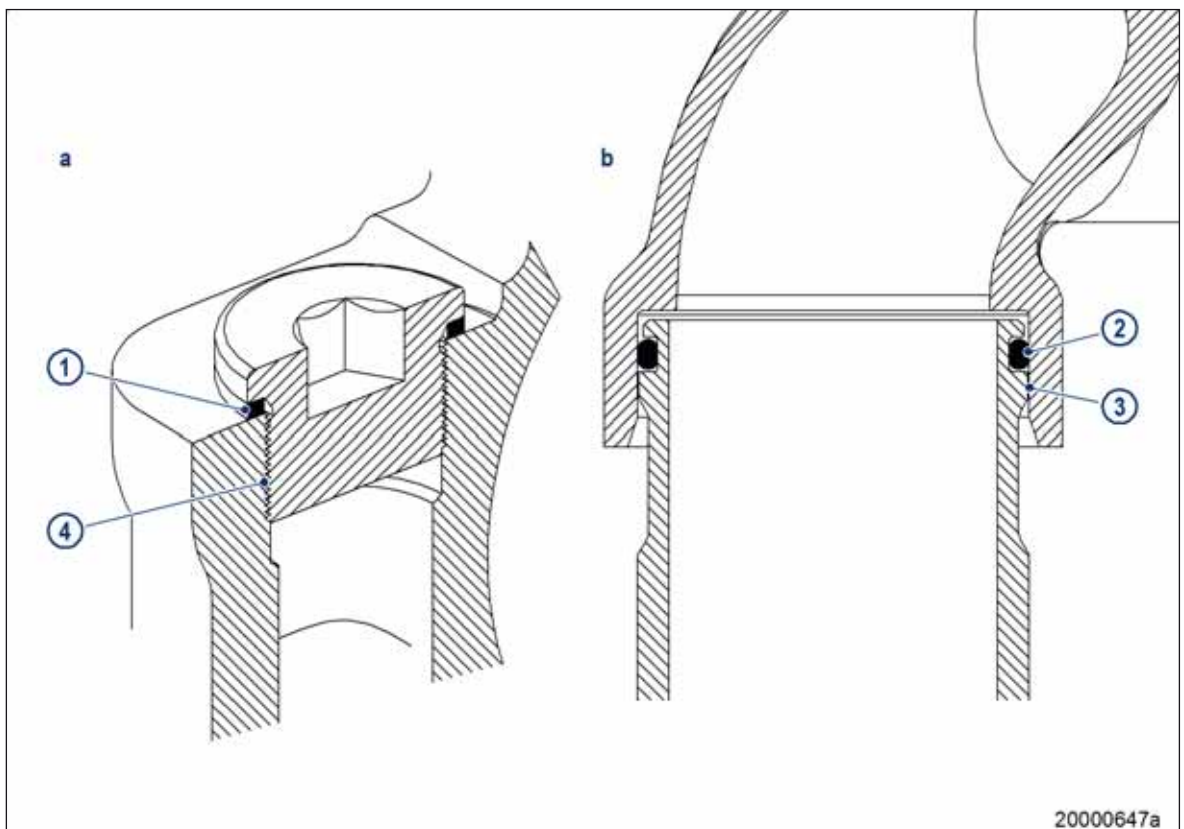
Engine control and monitoring unit (LOP)

Functions:

- Display of engine operating/limit values and alarms
- Integrated safety system
- Integrated test system
- Redundant CAN bus interface to governor and higher-level control and monitoring system
- 24 VDC supply

SOLAS – Fire safety requirements

Special connections



In case of leakage, the connection types shown above are spray-protected even without a cover and have been confirmed compliant with SOLAS by GL and DNV.

Plug-in pipe union

The sleeve (3) covers the joint to prevent lateral spray.

Only leak-off along the line is possible, the pressure decreases significantly if an O-ring (2) fault occurs.

The connection is confirmed as compliant with SOLAS by DNV and GL.

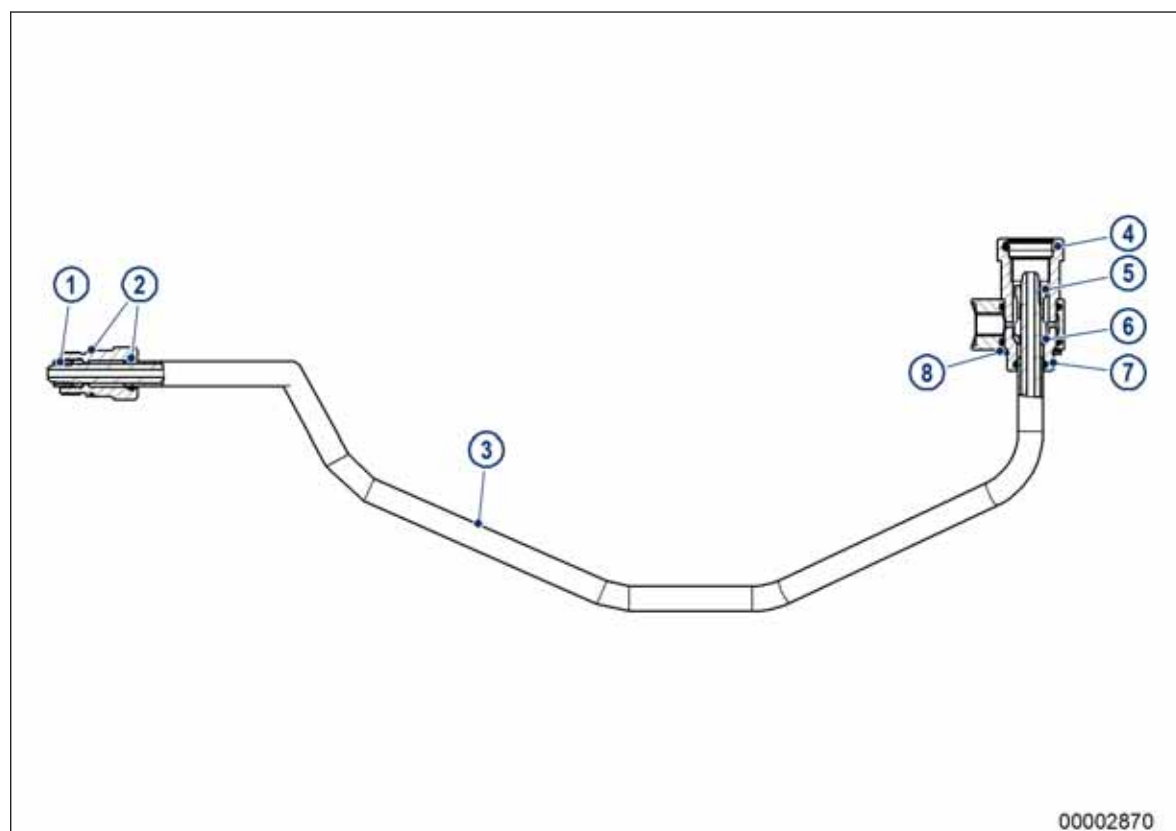
Plugs and sensors

Screw-in plugs (4) are sealed toward the outside either with a copper sealing ring (1), according to DIN, or an O-ring (ISO).

In case of a loose thread or a faulty sealing ring (1), the liquid first has to pass the thread.

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

HP line between injector and HP accumulator

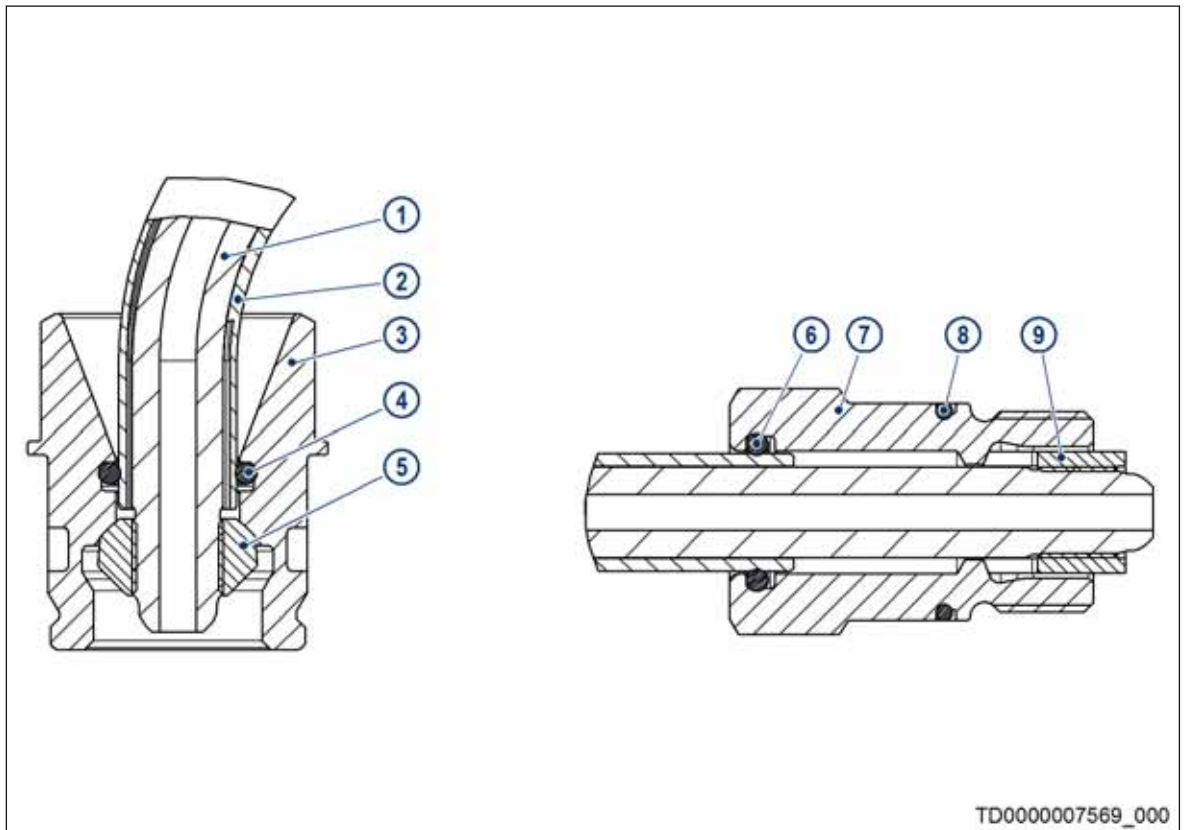


1 Thrust ring
2 O-ring
3 HP pipe

4 O-ring
5 Thrust ring
6 Spherical sliding disk

7 Thrust ring
8 Union nut
9 Compensating washer

HP line between distributor and HP accumulator

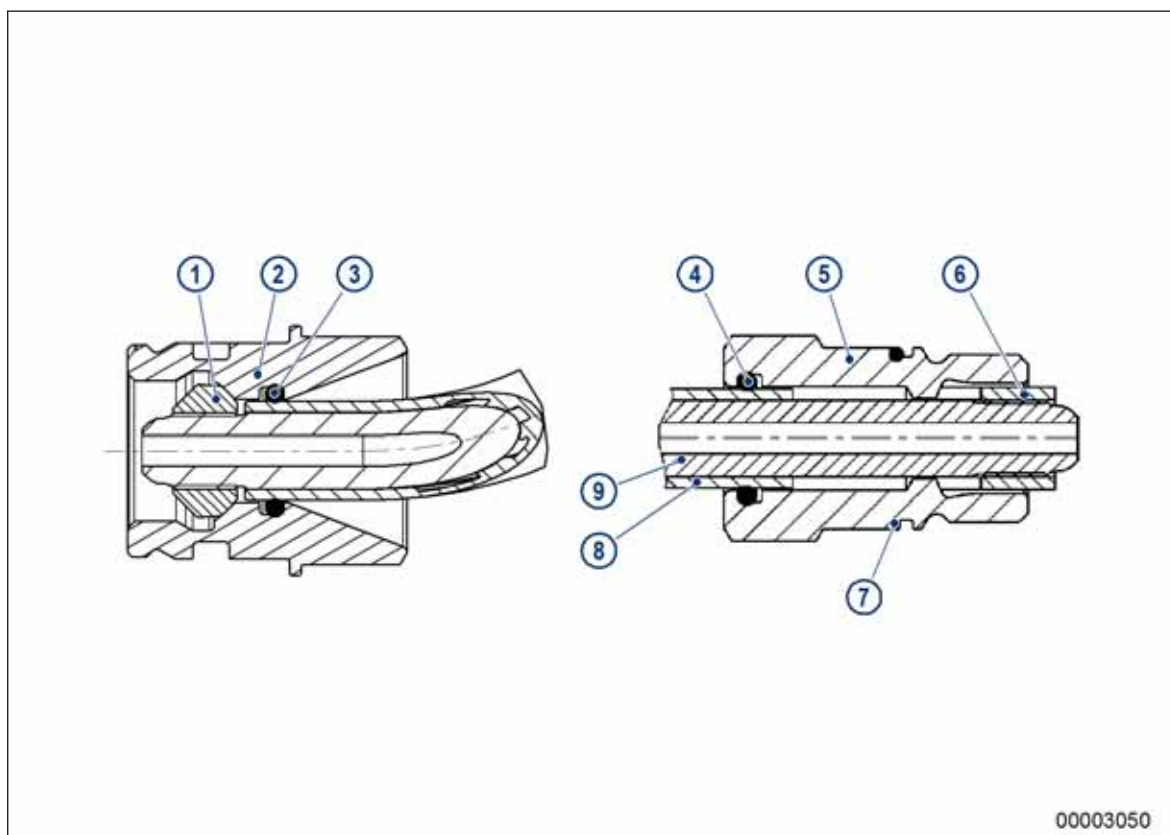


- 1 HP line
- 2 Jacket pipe
- 3 Union nut

- 4 O-ring
- 5 Thrust ring
- 6 O-ring

- 7 Thrust screw
- 8 O-ring
- 9 Thrust ring

HP line between distributor and HP accumulator



00003050

- 1 Thrust ring
- 2 Union nut
- 3 O-ring

- 4 Thrust ring
- 5 Thrust screw
- 6 Thrust ring

- 7 O-ring
- 8 Jacket pipe
- 9 HP line

Leak fuel originating from leakage at the sealing tapers or HP lines, is routed directly from the sealing taper into the leak-fuel tank. (The small leak-fuel tank is standard. The large leak-fuel tank is optional)

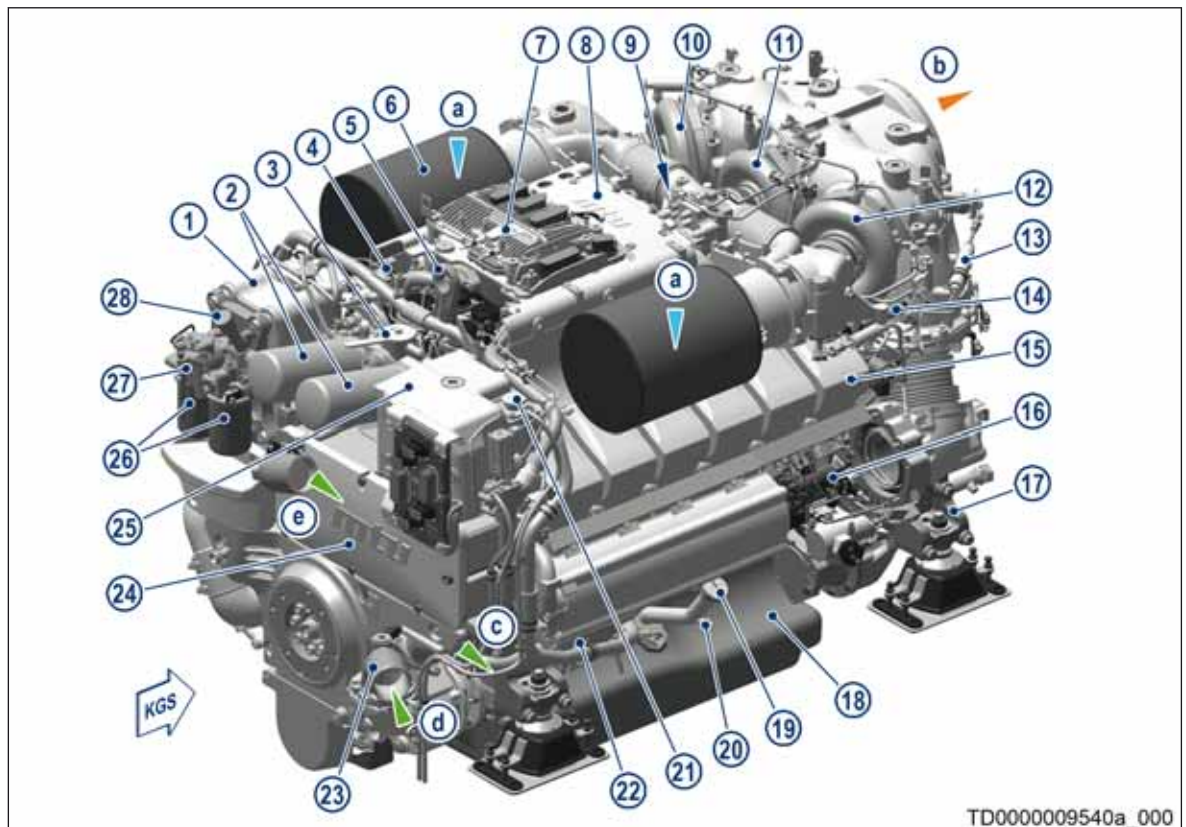
To facilitate leak search, leak-fuel pipework is divided into three sections:

- from high-pressure pump to rails
- rail A side and HP lines to injectors, A side
- rail B side and HP lines to injectors, B side

4.4 Engine - Overview

Engine overview 12V

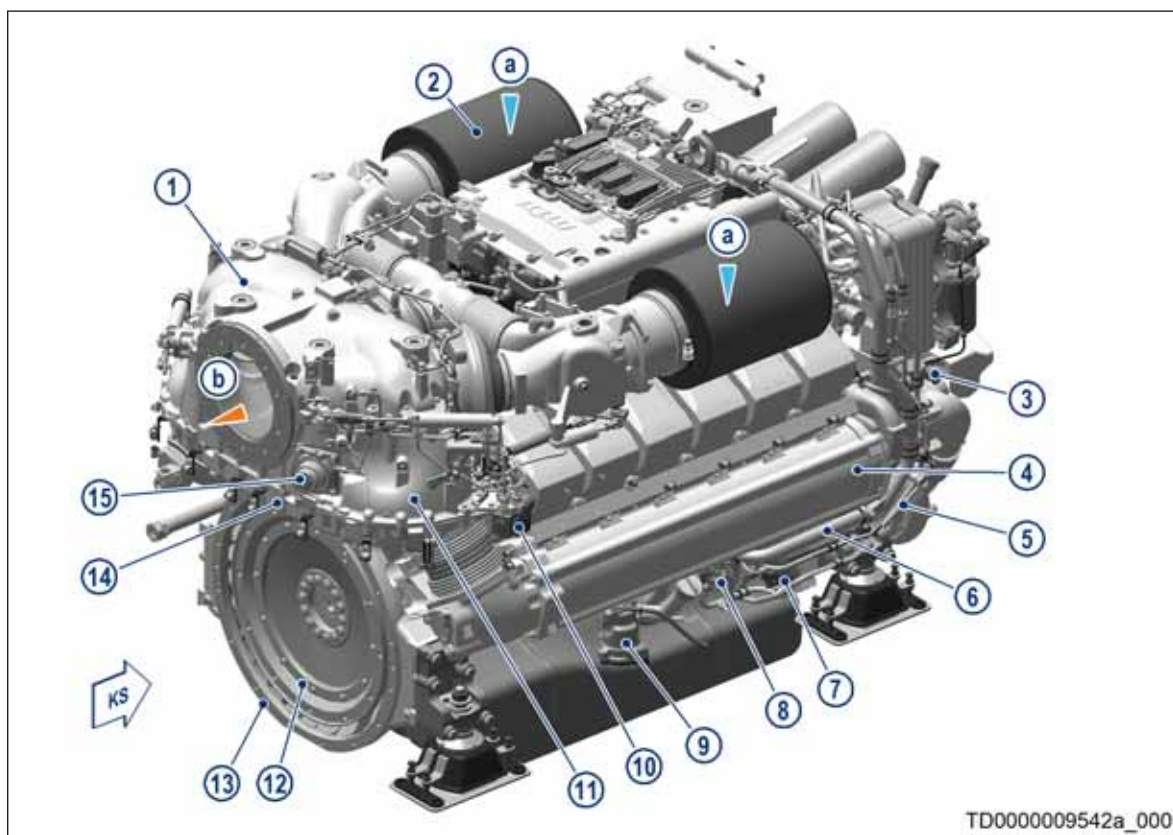
Overview - Free end



TD0000009540a_000

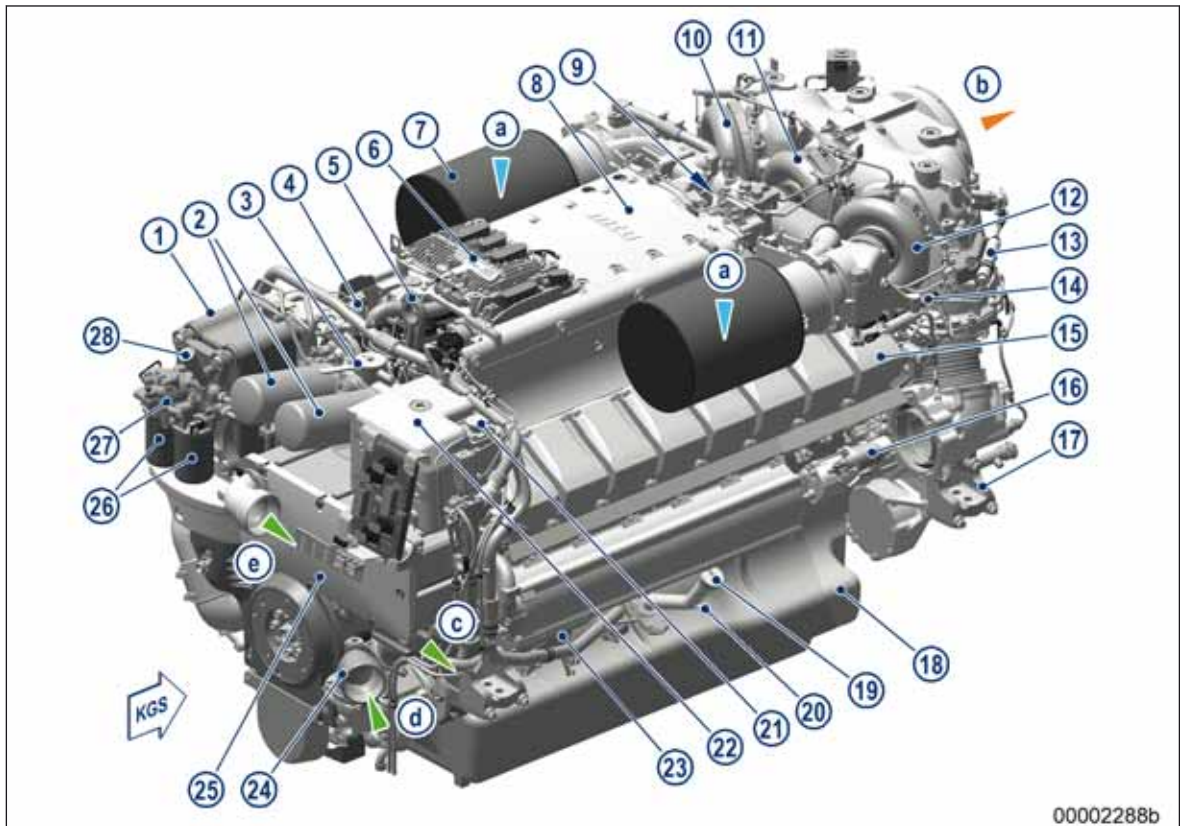
- | | | |
|-------------------------------|----------------------------------|-------------------------------|
| 1 Engine oil heat exchanger | 13 Actuating cylinder for ex- | 25 Coolant expansion tank |
| 2 Engine oil filter | haust flap | 26 Easy-change fuel filter |
| 3 Change-over housing for en- | 14 Actuating cylinder for air | 27 Change-over housing for |
| gine oil filter (optional) | flap | fuel filter (optional) |
| 4 Cable clamp | 15 Cylinder head cover | 28 Hand pump |
| 5 Cover for crankcase breath- | 16 Starter (position possible on | a Air intake |
| er (engine lifting equipment, | A or B side) | b Exhaust outlet (horizontal) |
| free end) | 17 Engine mounting bracket | c Raw water connection to |
| 6 Air filter (air intake) | 18 Oil pan | gearbox cooling system |
| 7 Engine Control Unit | 19 Oil filler neck | d Raw water connection from |
| 8 Air collector housing | 20 Oil dipstick | overboard |
| 9 Engine lifting eye (driving | 21 Coolant filler neck | e Raw water connection to |
| end) | 22 Protective cover for battery- | overboard |
| 10 Exhaust turbocharger | charging generator | KGS Free end |
| 11 Exhaust turbocharger | 23 Elbow | |
| 12 Exhaust turbocharger | 24 Plate-core heat exchanger | |

Overview – Driving end



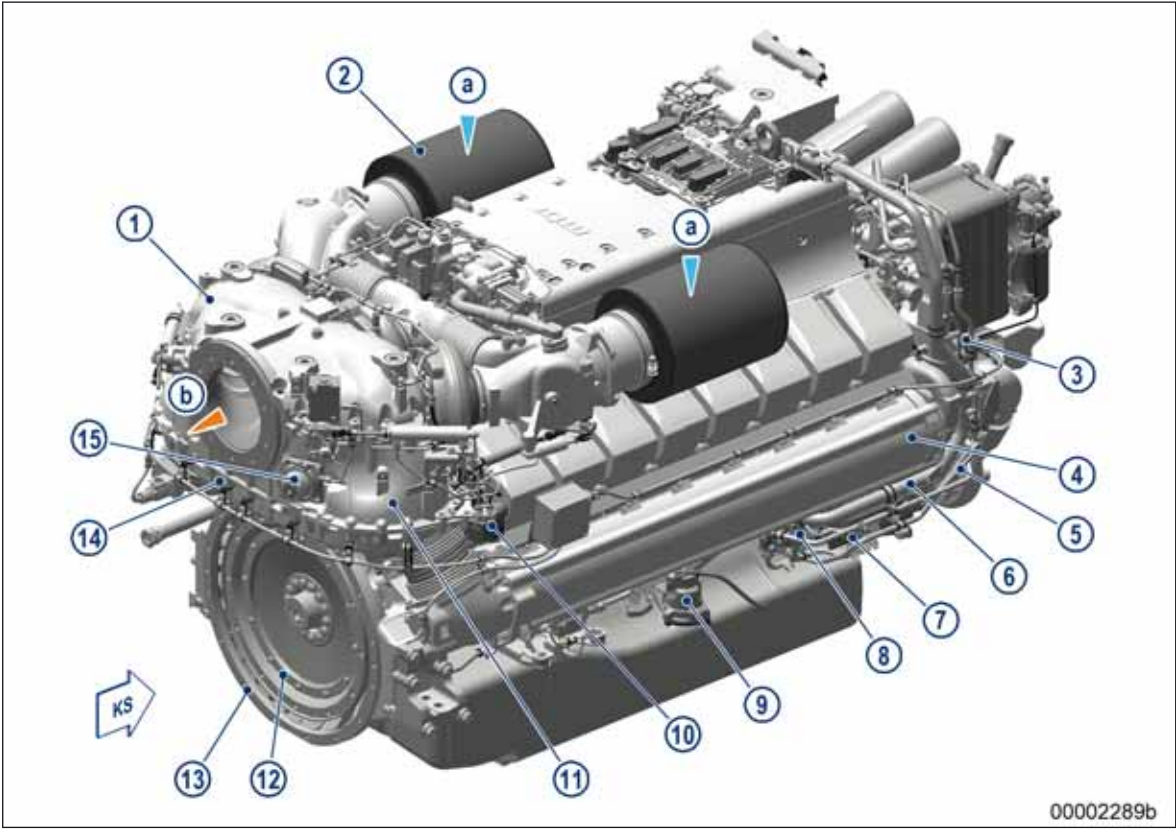
- | | | |
|-------------------------|----------------------------------|----------------------------------|
| 1 Carrier housing cover | 7 HP fuel pump | 13 Flywheel housing |
| 2 Air filter | 8 Fuel delivery pump | 14 Carrier housing lower section |
| 3 Thermostat housing | 9 Leak-fuel tank (optional) | 15 Bleeder valve |
| 4 Exhaust housing | 10 4/2-way solenoid valve | a Air intake |
| 5 Fuel return line | 11 Carrier housing upper section | b Exhaust outlet |
| 6 Crankcase vent line | 12 Flywheel | KS Driving end |

Overview – Free end



- | | | |
|---|--|---|
| 1 Engine oil heat exchanger | 13 Actuating cylinder for exhaust flap | 25 Plate-core heat exchanger |
| 2 Engine oil filter | 14 Actuating cylinder for air flap | 26 Fuel duplex filter |
| 3 Change-over housing for engine oil filter (optional) | 15 Cylinder head cover | 27 Change-over housing for fuel filter (optional) |
| 4 Fuel cooler | 16 Electric starter | 28 Hand pump |
| 5 Cover for crankcase breather (engine lifting equipment, free end) | 17 Engine mounting bracket | a Air intake |
| 6 Engine Control Unit | 18 Oil pan | b Exhaust outlet (horizontal) |
| 7 Air filter (air intake) | 19 Oil filler neck | c Raw water connection to gearbox cooling system |
| 8 Air collector housing | 20 Oil dipstick | d Raw water connection from overboard |
| 9 Engine lifting eye (driving end) | 21 Engine coolant filler neck | e Raw water connection to overboard |
| 10 Exhaust turbocharger, right (secondary turbocharger) | 22 Coolant distribution housing with integrated expansion tank | KGS Free end |
| 11 Exhaust turbocharger (primary turbocharger) | 23 Battery-charging generator | |
| 12 Exhaust turbocharger, left (secondary turbocharger) | 24 Raw water pump | |

Overview – Driving end



- 1 Carrier housing cover

2 Air filter

3 Thermostat housing

4 Exhaust housing

5 Fuel return line

6 Crankcase vent line
- 7 HP fuel pump

8 Fuel delivery pump

9 Leak-fuel tank (optional)

10 4/2-way solenoid valve

11 Carrier housing upper section

12 Flywheel
- 13 Flywheel housing

14 Carrier housing lower section

15 Bleeder valve

a Air intake

b Exhaust outlet

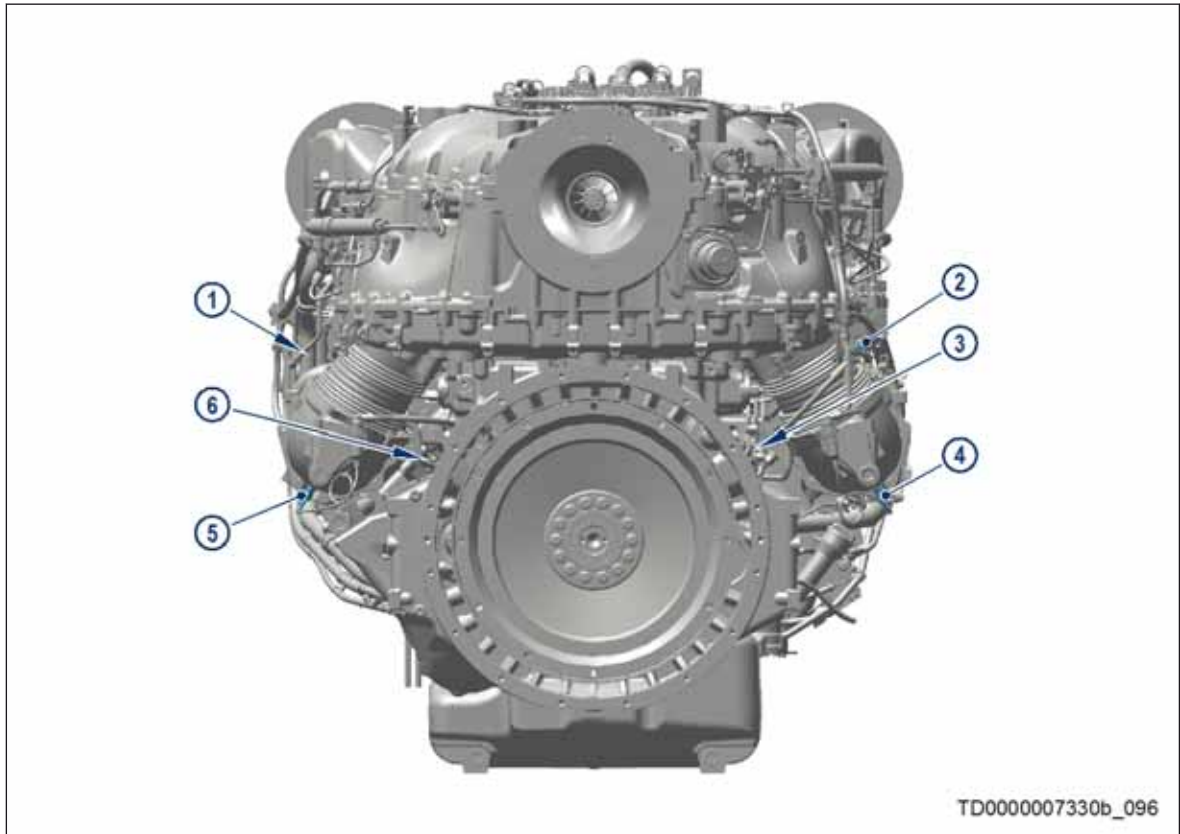
KS Driving end

Engine model designation

Explanation of engine model designation 12V/16V 2000 Mxyz	
12/16	Number of cylinders
V	Cylinder arrangement: V engine
2000	Series
M	Application
x	Application segment (4, 5, 6, 7, 8, 9)
y	Design index (0, 1, 2,...)
z	Special features

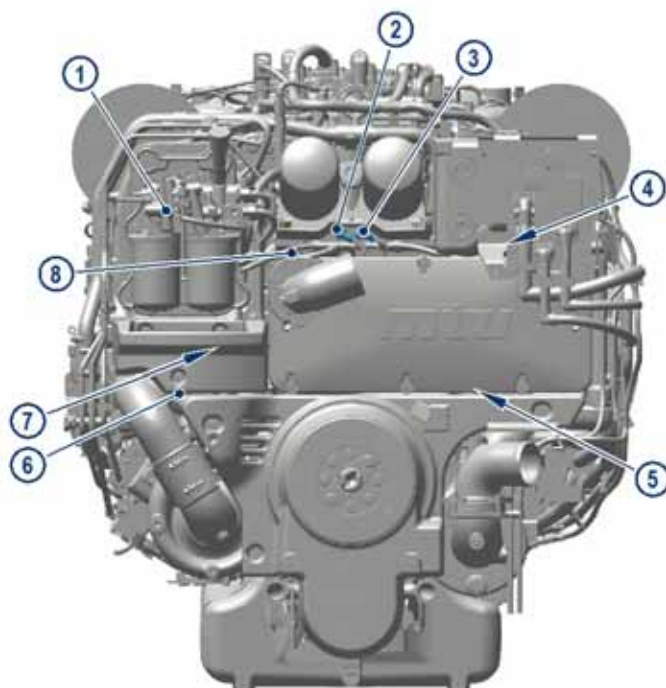
4.5 Sensors and actuators – Overview

Sensors and actuators 12V



Item	Designation	Monitoring of
1	Y27.1	Solenoid valve ETC cut-in, A side
2	Y27.2	Solenoid valve ETC cut-in, B side
3	B13.1	Crankshaft speed
4	B4.22	Exhaust gas temperature ETC, B side
5	B4.21	Exhaust gas temperature ETC, A side
6	B13.2	Crankshaft speed for EMU (optional)

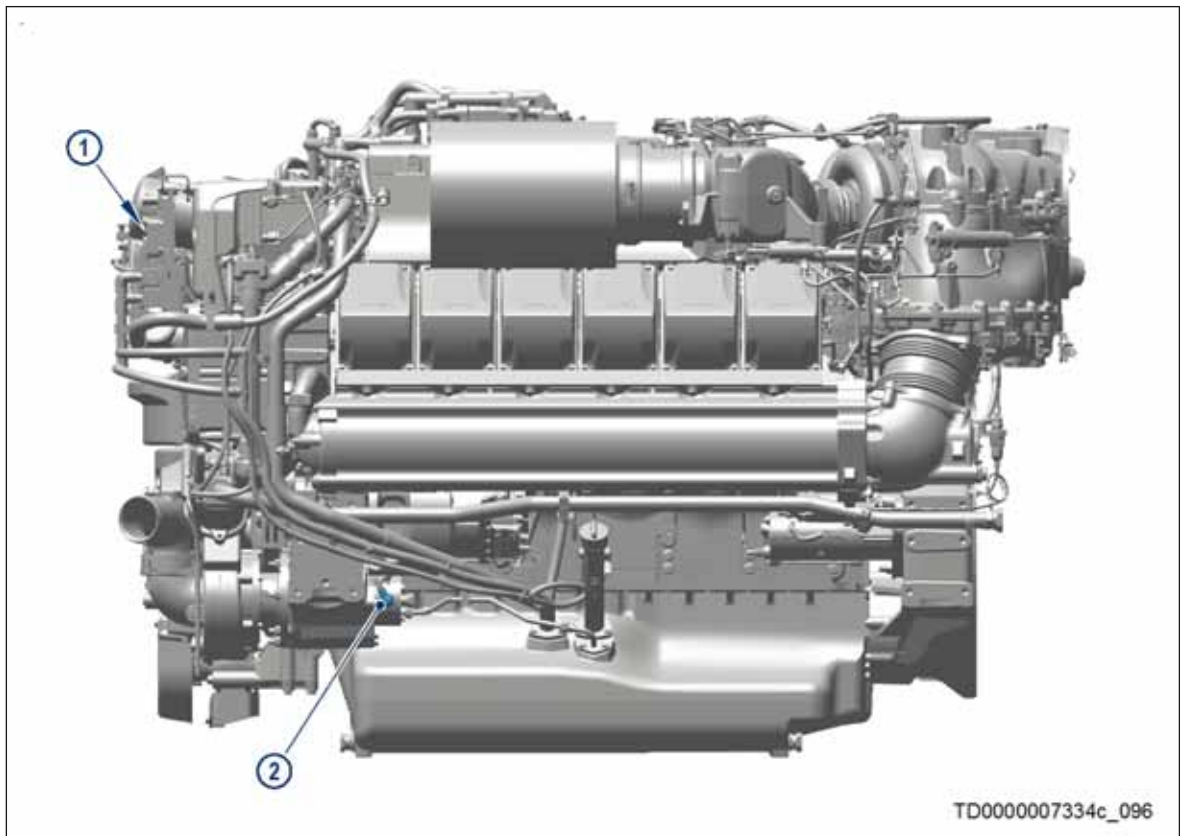
Table 2: Sensors and actuators, driving end



TD0000007332b_096

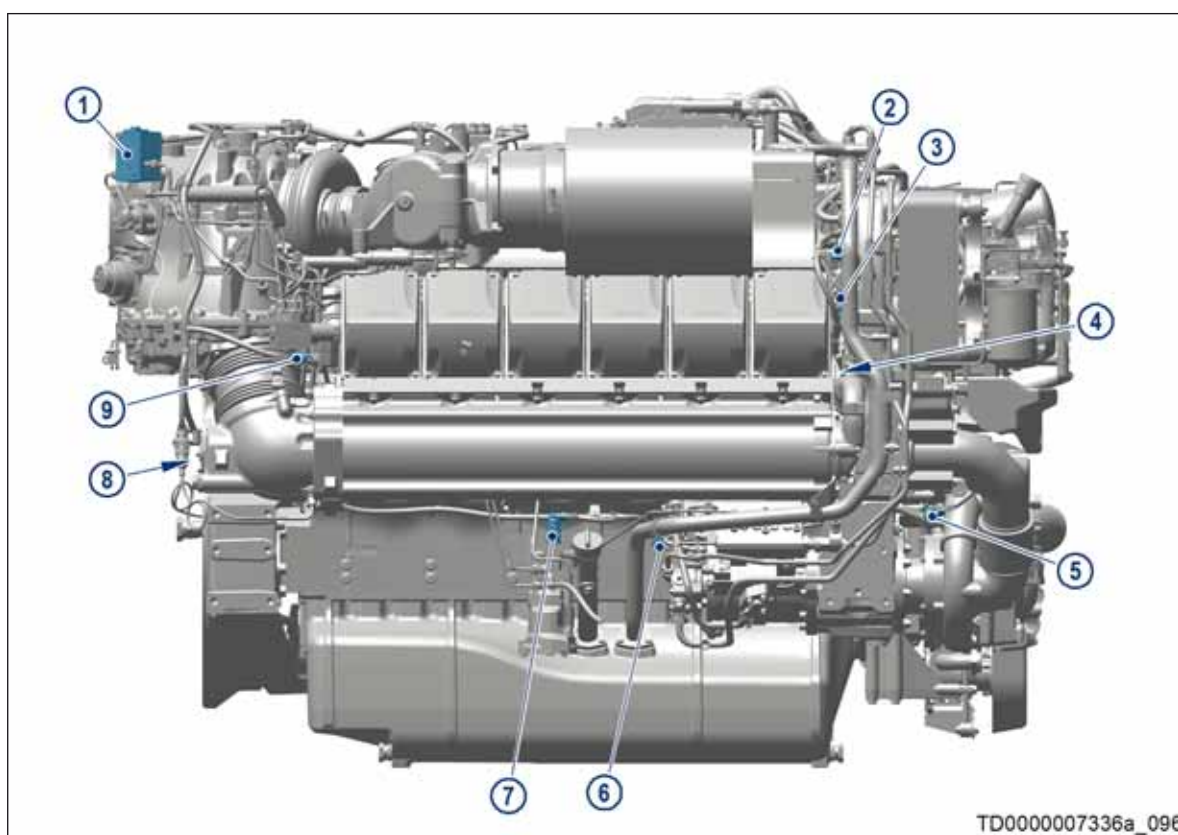
Item	Designation	Monitoring of
1	B34	Fuel pressure after filter
2	B5.2	Lube oil pressure after filter (optional)
3	B5.1	Lube oil pressure after filter
4	F33	Coolant level, expansion tank
5	B21	Seawater pressure (optional)
6	B6.2	Coolant temperature (optional)
7	B6.1	Engine coolant temperature
8	B5.3	Lube oil pressure before filter (optional)

Table 3: Sensors and actuators, free end



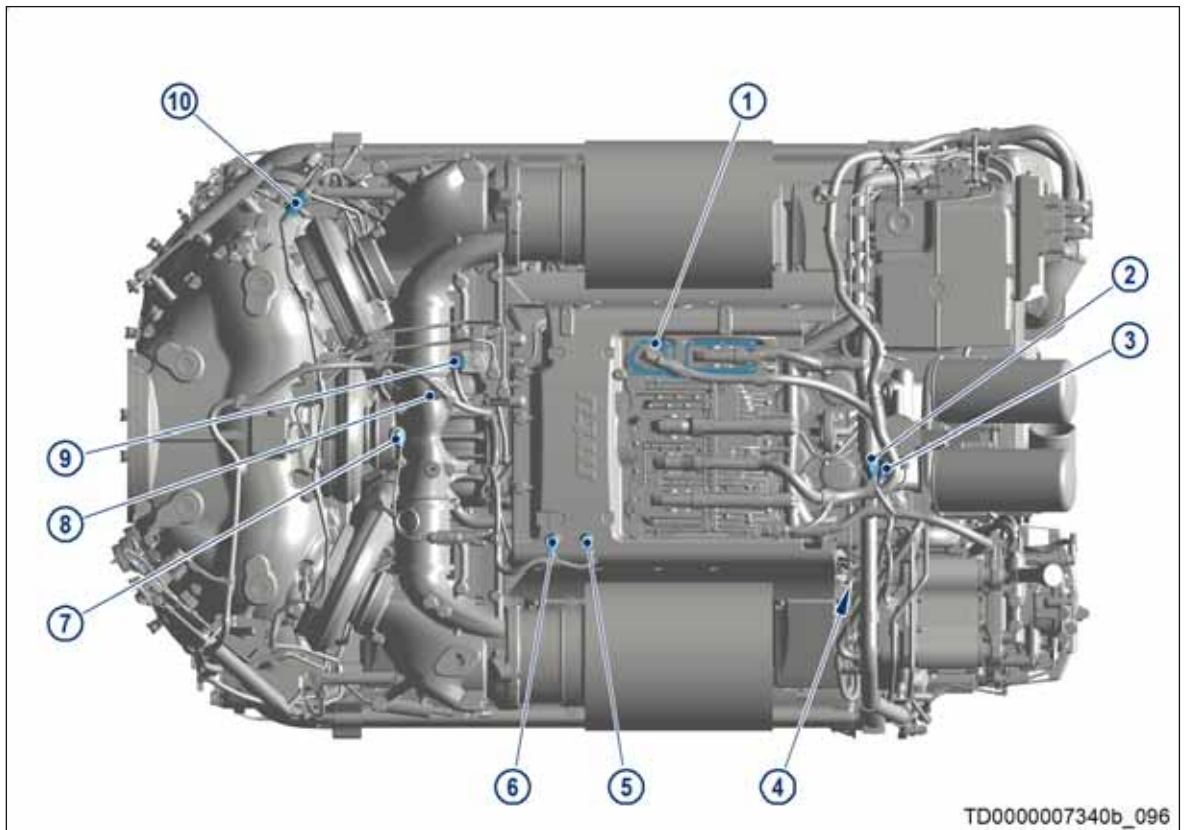
Item	Designation	Monitoring of
1	A18	EIM Engine Interface Module
2	B54	Lube oil pressure, oil replenishment pump

Table 4: Sensors and actuators, A side



Item	Designation	Monitoring of
1	M52	Pressure regulating valve for wastegate control
2	B33	Fuel temperature
3	Y45	Pressure regulating valve for HP fuel system
4	A19	EIL electronic label
5	B16	Coolant pressure (optional)
6	M8	HP pump control block
7	F46	Leak fuel level (optional)
8	B1	Camshaft speed
9	Y27.2	Solenoid valve ETC cut-in, B side

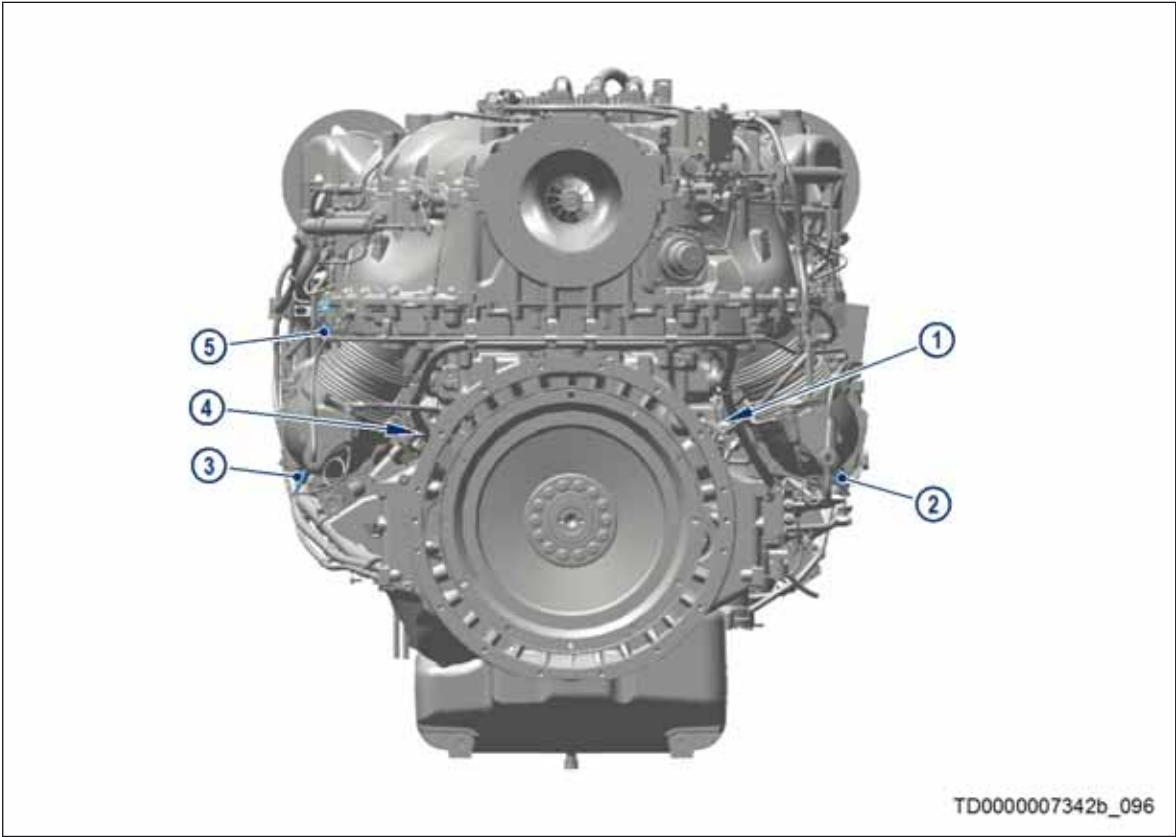
Table 5: Sensors and actuators, B side



Item	Designation	Monitoring of
1	A77	EMU Engine Monitoring Unit (optional)
2	B50	Crankcase pressure
3	B7	Lube oil temperature
4	B48	High-pressure fuel
5	B10	Charge-air pressure
6	B9	Charge-air temperature
7	B44	ETC speed
8	B3	Intake air temperature
9	Y35	Intercooler valve (seawater admission)
10	B5.8	Lube oil pressure before ETC

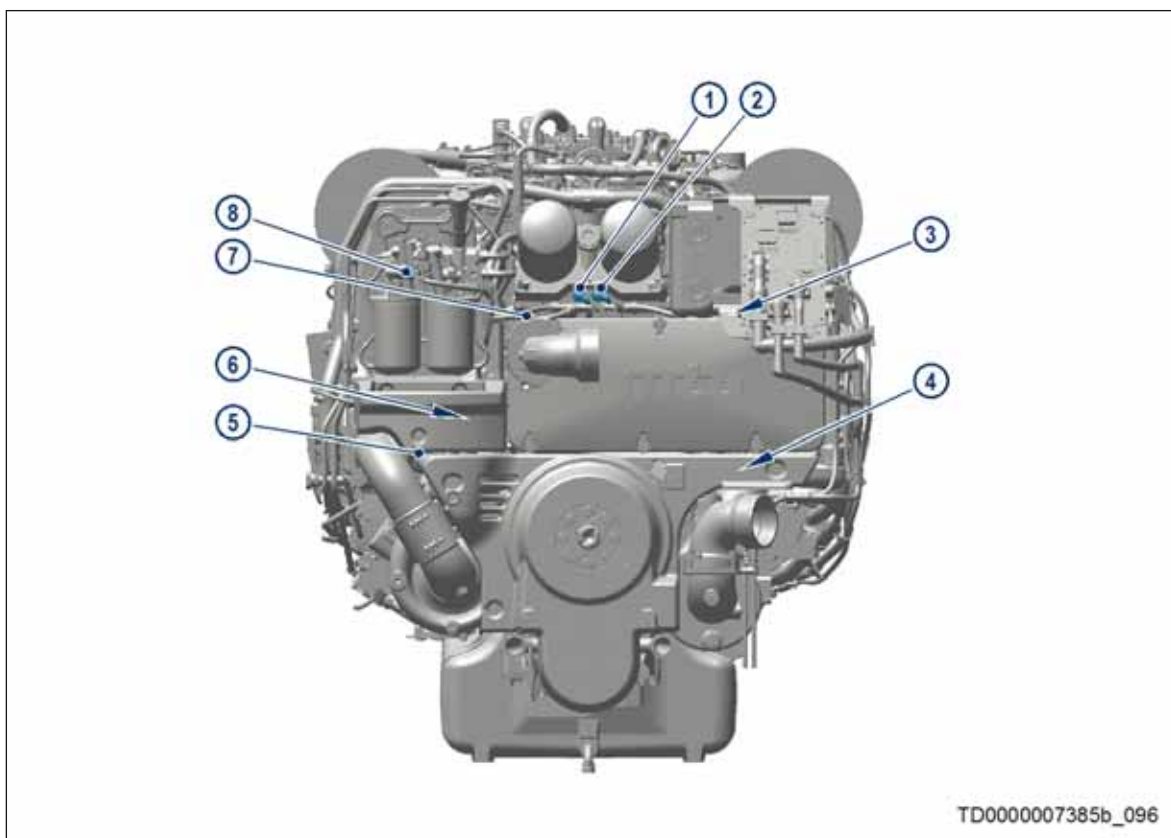
Table 6: Sensors and actuators, engine top

Sensors and actuators 16V



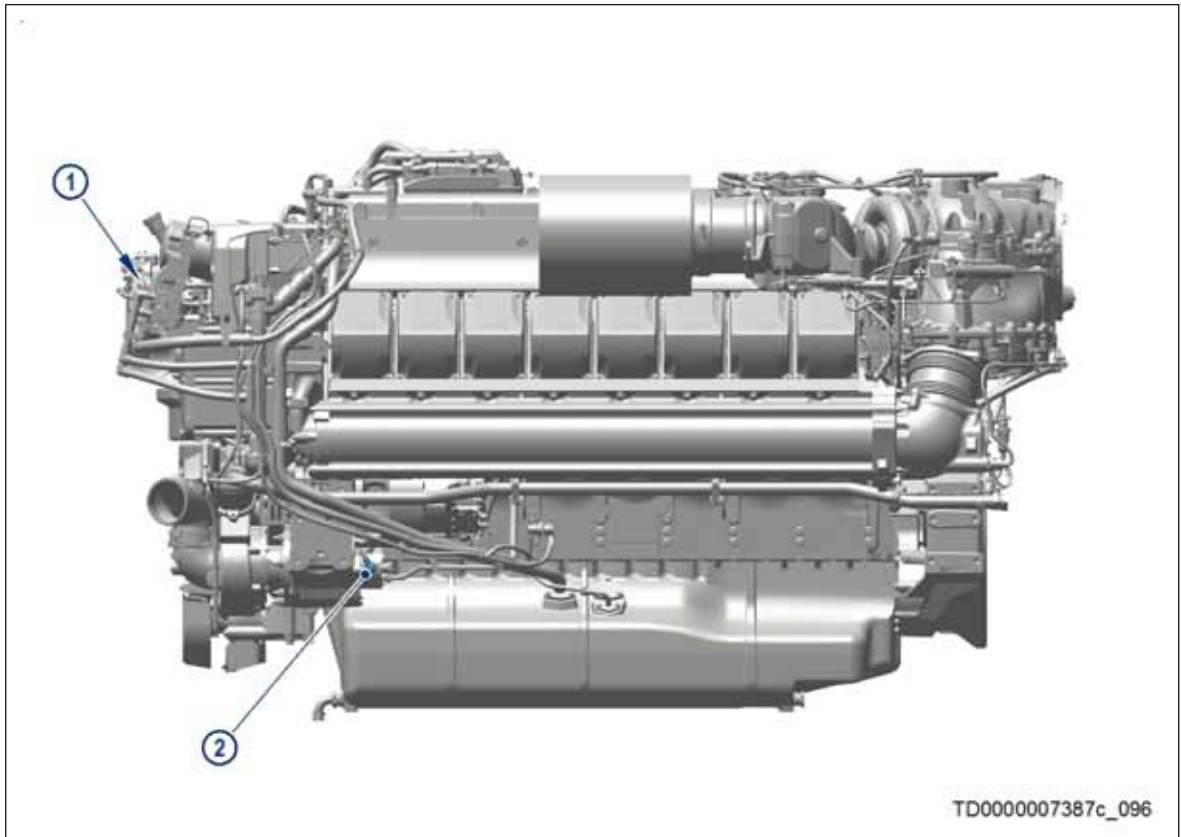
Item	Designation	Monitoring of
1	B13.1	Crankshaft speed
2	B4.22	Exhaust gas temperature ETC, B side
3	B4.21	Exhaust gas temperature ETC, A side
4	B13.2	Crankshaft speed for EMU (optional)
5	Y27.1	Solenoid valve ETC cut-in, A side

Table 7: Sensors and actuators, driving end



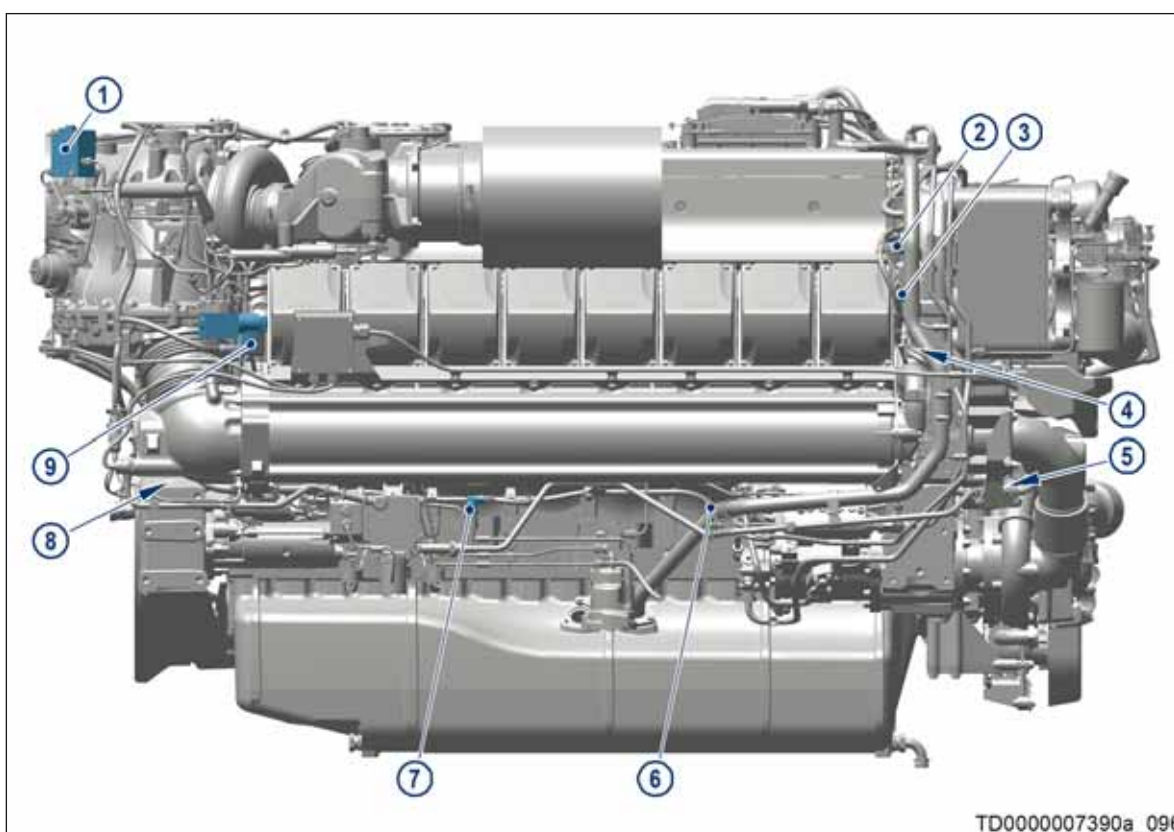
Item	Designation	Monitoring of
1	B5.2	Lube oil pressure after filter (optional)
2	B5.1	Lube oil pressure after filter
3	F33	Coolant level, expansion tank
4	B21	Seawater pressure (optional)
5	B6.2	Coolant temperature (optional)
6	B6.1	Engine coolant temperature
7	B5.3	Lube oil pressure before filter (optional)
8	B34	Fuel pressure after filter

Table 8: Sensors and actuators, free end



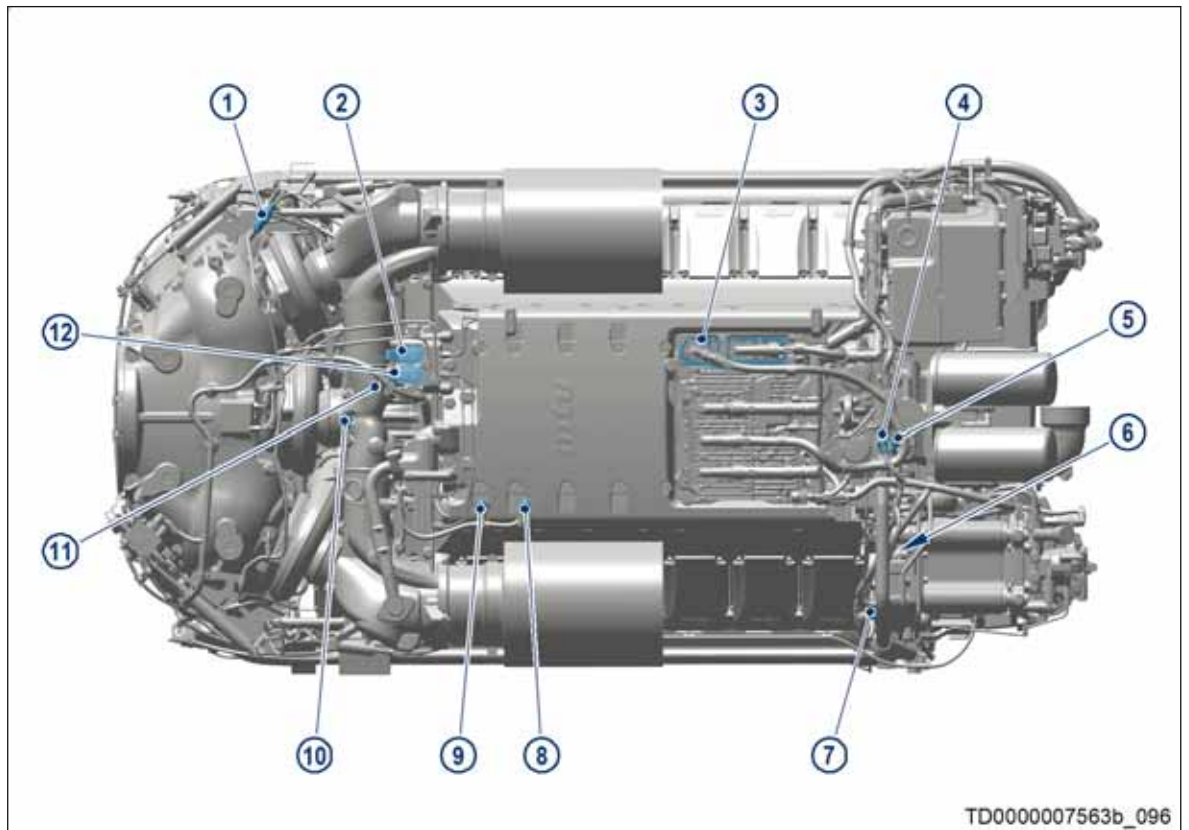
Item	Designation	Monitoring of
1	A18	EIM Engine Interface Module
2	B54	Lube oil pressure, oil replenishment pump

Table 9: Sensors and actuators, A side



TD0000007390a_096

Item	Designation	Monitoring of
1	M52	Pressure regulating valve for wastegate control
2	B33	Fuel temperature
3	Y45	Pressure regulating valve for HP fuel system
4	A19	EIL electronic label
5	B16	Coolant pressure (optional)
6	M8	HP pump control block
7	F46	Leak fuel level (optional)
8	B1	Camshaft speed
9	Y27.2	Solenoid valve ETC cut-in, B side



Item	Designation	Monitoring of
1	B5.8	Lube oil pressure before ETC
2	Y35	Intercooler valve (seawater admission)
3	A77	EMU Engine Monitoring Unit (optional)
4	B50	Crankcase pressure
5	B7	Lube oil temperature
6	B48	High-pressure fuel
7	B33	Fuel temperature
8	B10	Charge-air pressure
9	B9	Charge-air temperature
10	B44	ETC speed
11	B3	Intake air temperature
12	Y56	Charge-air pressure relief valve

Table 10: Sensors and actuators, engine top

5 Technical Data

5.1 Engine data 12V2000M86/M96/M96L/M96X, Marine EPA Tier 3, IMO Tier II

Legend

- DL Reference value: Continuous power; Continuous attainable power under standard conditions
- BL Reference value: Fuel stop power; maximum engine power; Not continuously attainable in some applications (margin for load fluctuations).
- A Design value: Required for design of an external system (plant)
- R Guideline value: Typical average value for information, only conditionally suitable for design
- L Limit value: Value which must not be violated (lower limit value, min. value / upper limit value, max. value), not suitable for design purposes
- N Not yet defined value: Value has not yet been defined or will not be defined
 - Not applicable: Module not applicable to this product type
- X Applicable: Module is applicable to this product type
 - > Actual value must be higher than the specified value
 - < Actual value must be lower than the specified value
- * Value insufficiently guaranteed (tolerance +/- 10%)
- ** Value insufficiently guaranteed (tolerance +/- 5%)

ID	Product type	Application	Engine speed	Rated power	
1	12V2000M86	Marine / ship's main propulsion 1D, continuous operation, variable, medium load	2450 rpm	1268 kW 1700 bhp	Ref. 25 °C/25 °C IMO Tier II (Marpol Convention) IMO Tier II Marpol Comp EPA Marine T3 (40CFR1042) RECREATION EU Marine Directive 2013/53/EU Recreational Craft
2	12V2000M96	Marine / ship's main propulsion 1 DS, continuous operation, variable, low load	2450 rpm	1342 kW 1800 bhp	Ref. 25 °C/25 °C; Heat exchanger engine-mounted IMO Tier II (Marpol Convention) IMO Tier II Marpol Comp EPA Marine T3 (40CFR1042) RECREATION EU Marine Directive 2013/53/EU Recreational Craft

TIM-ID: 000005076 - 007

ID	Product type	Application	Engine speed	Rated power	
3	12V2000M96L	Marine / ship's main propulsion 1 DS, continuous operation, variable, low load	2450 rpm	1432 kW 1920 bhp	Ref. 25 °C/25 °C; Heat exchanger engine-mounted IMO Tier II (Marpol Convention) IMO Tier II Marpol Comp EPA Marine T3 (40CFR1042) RECREATION EU Marine Directive 2013/53/EU Recreational Craft
4	12V2000M96X	Marine / ship's main propulsion 1 DS, continuous operation, variable, low load	2450 rpm	1472 kW 2002 php	Ref. 25 °C/25 °C; Heat exchanger engine-mounted IMO Tier II (Marpol Convention) IMO Tier II Marpol Comp EPA Marine T3 (40CFR1042) RECREATION EU Marine Directive 2013/53/EU Recreational Craft

Reference conditions

ID			1	2	3	4
Intake air temperature		°C	25	25	25	25
Barometric pressure		mbar	1000	1000	1000	1000
Site altitude above sea level		m	100	100	100	100
Raw water inlet temperature		°C	25	25	25	25

Power-related data

ID			1	2	3	4
Rated engine speed	A	rpm	2450	2450	2450	2450
Fuel stop power ISO 3046	A	kW	1268	1342	1432	1472

Site conditions (for maximum power)

ID			1	2	3	4
Intake depression (new filter)	A	mbar	15	15	15	15
Intake depression, max.	L	mbar	30	30	30	30
Exhaust overpressure, max.	L	mbar	85	85	85	85
Fuel temperature at engine supply connection, max.	R	°C	25	25	25	25

Model-related data (basic design)

ID			1	2	3	4
Cylinder configuration: V angle		Degrees (°)	90	90	90	90
Bore		mm	135	135	135	135
Stroke		mm	156	156	156	156
Displacement, per cylinder		Liters	2.23	2.23	2.23	2.23
Total displacement		Liters	26.76	26.76	26.76	26.76
Number of inlet valves per cylinder		-	2	2	2	2
Number of exhaust valves per cylinder		-	2	2	2	2

Raw water circuit (open circuit)

ID			1	2	3	4
Raw water: Pressure in raw water system, max.	L	bar	4.0	4.0	4.0	4.0
Raw water pump: inlet pressure, min.	L	bar	-0.4	-0.4	-0.4	-0.4

Lube oil system

ID			1	2	3	4
Lube oil operating temperature before engine, from	R	°C	75	75	75	75
Lube oil operating temperature before engine, to	R	°C	88	88	88	88
Lube oil operating pressure before engine, from	R	bar	7.0	7.0	7.0	7.0
Lube oil operating pressure before engine, to	R	bar	8.0	8.0	8.0	8.0
Lube oil operating pressure (low idle) (meas. point: before engine)	R	bar	3.5	3.5	3.5	3.5

Fuel system

ID			1	2	3	4
Fuel pressure at engine inlet connection, min. (when engine is running)	L	bar	-0.3	-0.3	-0.3	-0.3
Fuel pressure at engine inlet connection, max. (when engine is starting)	L	bar	0.5	0.5	0.5	0.5

General operating data

ID			1	2	3	4
Firing speed, from	R	rpm	100	100	100	100
Firing speed, to	R	rpm	120	120	120	120

Starting (electric)

ID			1	2	3	4
Starter rated voltage (standard configuration)	R	V=	24	24	24	24

TIM-ID: 000005076 - 007

Inclinations - standard oil system (reference: waterline)

ID			1	2	3	4
Longitudinal inclination, continuous max. driving end down (option: max. operating inclinations)	L	Degrees (°)	15	15	15	15
Longitudinal inclination, temporary max. driving end down (option: max. operating inclinations)	L	Degrees (°)	22.5	22.5	22.5	22.5
Longitudinal inclination, continuous max. driving end up (option: max. operating inclinations)	L	Degrees (°)	15	15	15	15
Longitudinal inclination, temporary max. driving end up (option: max. operating inclinations)	L	Degrees (°)	22.5	22.5	22.5	22.5
Transverse inclination continuous max. (option: max. operating inclinations)	L	Degrees (°)	22.5	22.5	22.5	22.5
Transverse inclination, temporary max. (option: max. operating inclinations)	L	Degrees (°)	35	35	35	35

Capacities

ID			1	2	3	4
Engine coolant capacity, engine side (with cooling equipment)	R	Liters	125	125	125	125
Engine oil, total, for initial filling (standard oil system) (option: max. operating inclinations)	R	Liters	123	123	123	123
Oil change quantity, max. (standard oil system) (option: max. operating inclinations)	R	Liters	113	113	113	113
Oil pan capacity at dipstick mark "min." (standard oil system) (option: max. operating inclinations)	L	Liters	87	87	87	87
Oil pan capacity at dipstick mark "max." (standard oil system) (option: max. operating inclinations)	L	Liters	105	105	105	105

Mass

ID			1	2	3	4
Engine dry weight (with standard accessories installed, w/o coupling)	R	kg	2810	2810	2810	2810

Acoustics

ID			1	2	3	4
Exhaust noise, unsilenced - BL (free-field sound pressure level Lp, 1 m distance, ISO 6798, +3 dB(A) tolerance)	R	dB(A)	115	116	116	116
Engine surface noise with silenced intake noise (filter) - BL (free-field sound pressure level Lp, 1 m distance, ISO 6798, +2 dB(A) tolerance)	R	dB(A)	105	105	106	106

5.2 Engine data 16V2000M86/M96/M96L, Marine EPA Tier 3, IMO Tier II

Legend

- DL Reference value: Continuous power; Continuous attainable power under standard conditions
- BL Reference value: Fuel stop power; Maximum engine power; Not continuously attainable in some applications (margin for load fluctuations).
- A Design value: Value required for design of an external system (plant)
- R Guideline value: Typical average value for information, only conditionally suitable for design
- L Limit value: Value which must not be violated (lower limit value, min. value / upper limit value, max. value), not suitable for design purposes
- N Not yet defined value: Value has not yet been defined or will not be defined
 - Not applicable: Module not applicable to this product type
- X Applicable: Module is applicable to this product type
- > Actual value must be higher than the specified value
- < Actual value must be lower than the specified value
- * Value insufficiently guaranteed (tolerance +/- 10%)
- ** Value insufficiently guaranteed (tolerance +/- 5%)

ID	Product type	Application	Engine speed	Rated power	
1	16V2000M86	Marine / ship's main propulsion 1D, continuous operation, variable, medium load	2450 rpm	1630 kW 2186 bhp	Ref. 25 °C/25 °C IMO Tier II (Marpol Convention) IMO Tier II Marpol Comp EPA Marine T3 (40CFR1042) RECREATION EU Marine Directive 2013/53/EU Recreational Craft
2	16V2000M96	Marine / ship's main propulsion 1 DS, continuous operation, variable, low load	2450 rpm	1790 kW 2400 bhp	Ref. 25 °C/25 °C; Heat exchanger engine-mounted IMO Tier II (Marpol Convention) IMO Tier II Marpol Comp EPA Marine T3 (40CFR1042) RECREATION EU Marine Directive 2013/53/EU Recreational Craft
3	16V2000M96L	Marine / ship's main propulsion 1 DS, continuous operation, variable, low load	2450 rpm	1939 kW 2600 bhp	Ref. 25 °C/25 °C; Heat exchanger engine-mounted IMO Tier II (Marpol Convention) IMO Tier II Marpol Comp EPA Marine T3 (40CFR1042) RECREATION EU Marine Directive 2013/53/EU Recreational Craft

Reference conditions

ID			1	2	3
Intake air temperature		°C	25	25	25
Barometric pressure		mbar	1000	1000	1000
Site altitude above sea level		m	100	100	100
Raw water inlet temperature		°C	25	25	25

Power-related data

ID			1	2	3
Rated engine speed	A	rpm	2450	2450	2450
Fuel stop power ISO 3046	A	kW	1630	1790	1939

Site conditions (for maximum power)

ID			1	2	3
Intake depression (new filter)	A	mbar	15	15	15
Intake depression, max.	L	mbar	30	30	30
Exhaust overpressure, max.	L	mbar	85	85	85
Fuel temperature at engine supply connection, max.	R	°C	25	25	25

Model-related data (basic design)

ID			1	2	3
Cylinder configuration: V angle		Degrees (°)	90	90	90
Bore		mm	135	135	135
Stroke		mm	156	156	156
Displacement, per cylinder		Liters	2.23	2.23	2.23
Displacement, total		Liters	35.68	35.68	35.68
Number of inlet valves per cylinder		-	2	2	2
Number of exhaust valves per cylinder		-	2	2	2

Raw water circuit (open circuit)

ID			1	2	3
Raw water: Pressure in raw water system, max.	L	bar	4.0	4.0	4.0
Raw water pump: Inlet pressure, min.	L	bar	-0.4	-0.4	-0.4

Lube oil system

ID			1	2	3
Lube oil operating temperature before engine, from	R	°C	75	75	75
Lube oil operating temperature before engine, to	R	°C	85	85	85
Lube oil operating pressure before engine, from	R	bar	6.5	6.5	6.5
Lube oil operating pressure before engine, to	R	bar	7.5	7.5	7.5
Lube oil operating pressure (low idle) (meas. point: before engine)	R	bar	2.5	2.5	2.5

Fuel system

ID			1	2	3
Fuel pressure at engine supply connection, min. (when engine is running)	L	bar	-0.3	-0.3	-0.3
Fuel pressure at engine supply connection, max. (when engine is starting)	L	bar	0.5	0.5	0.5

General operating data

ID			1	2	3
Firing speed, from	R	rpm	100	100	100
Firing speed, to	R	rpm	120	120	120

TIM-ID: 0000055075 - 006

Starting (electric)

ID			1	2	3
Starter rated voltage (standard configuration)	R	V=	24	24	24

Inclinations - standard oil system (reference: waterline)

ID			1	2	3
Longitudinal inclination, continuous max. driving end down (option: max. operating inclinations)	L	Degrees (°)	15	15	15
Longitudinal inclination, temporary max. driving end down (option: max. operating inclinations)	L	Degrees (°)	22.5	22.5	22.5
Longitudinal inclination, continuous max. driving end up (option: max. operating inclinations)	L	Degrees (°)	5	5	5
Longitudinal inclination, temporary max. driving end up (option: max. operating inclinations)	L	Degrees (°)	10	10	10
Transverse inclination continuous max. (option: max. operating inclinations)	L	Degrees (°)	22.5	22.5	22.5
Transverse inclination, temporary max. (option: max. operating inclinations)	L	Degrees (°)	32	32	32

Capacities

ID			1	2	3
Engine coolant capacity, engine side (with cooling equipment)	R	Liters	135	135	135
Engine oil, total, for initial filling (standard oil system) (option: max. operating inclinations)	R	Liters	145	145	145
Oil change quantity, max. (standard oil system) (option: max. operating inclinations)	R	Liters	134	134	134
Oil pan capacity at dipstick mark "min." (standard oil system) (option: max. operating inclinations)	L	Liters	106	106	106
Oil pan capacity at dipstick mark "max." (standard oil system) (option: max. operating inclinations)	L	Liters	134	134	134

Mass

ID			1	2	3
Engine dry weight (with standard accessories installed, w/o coupling)	R	kg	3450	3450	3450

Acoustics

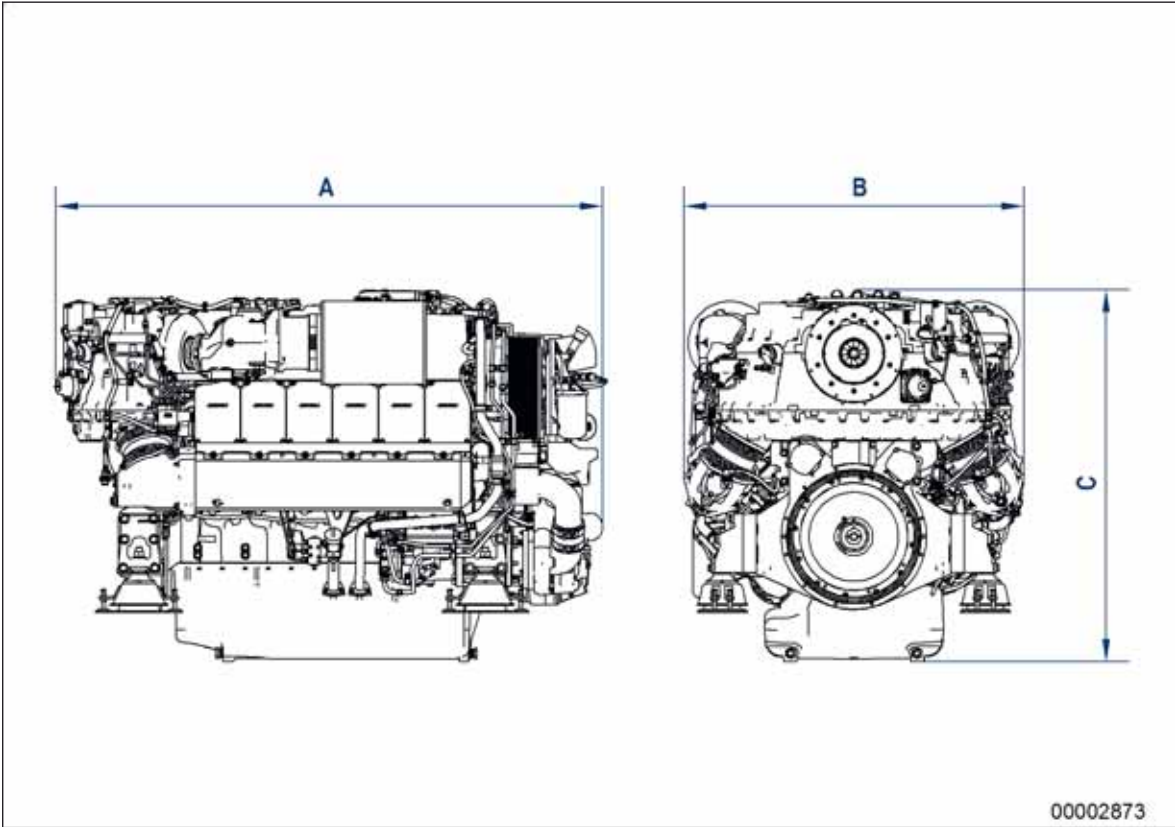
ID			1	2	3
Exhaust noise, unsilenced - BL (free-field sound pressure level Lp, 1 m distance, ISO 6798, +3 dB(A) tolerance)	R	dB(A)	114	115	116
Engine surface noise with silenced intake noise (filter) - BL (free-field sound pressure level Lp, 1 m distance, ISO 6798, +2 dB(A) tolerance)	R	dB(A)	106	106	106

5.3 Firing order

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

5.4 Engine - Main dimensions

Main dimensions



Engine model	Length (A)	Width (B)	Height (C)
16V2000M86 16V2000M96 16V2000M96L	2495 mm	1293 mm	1453 mm
12V2000M86 12V2000M96 12V2000M96L 12V2000M96X	2082 mm	1293 mm	1414 mm

6 Operation

6.1 Preparations for putting into operation after extended out-of-service periods (>3 months)

Preconditions

- ☒ Engine is stopped and starting disabled
- ☒ Preservation and Represervation Specifications (A001070/..) are available

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

Item	Action
Engine	Depreserve (→ Preservation and Represervation Specifications A001070/..).
Lube oil system	Check engine oil level (→ Page 177).
Fuel prefilter	Fill with fuel (→ Page 169). Vent fuel system (→ Page 154).
Fuel prefilter, pressure gauge	Align adjustable pointer with position of pressure indicator (→ Page 160).
Fuel system	Vent (→ Page 154).
Raw water pump (if located above waterline)	Fill with water (approx. 3 to 4 liters). Filling point (→ Page 182).
Coolant circuit	If engine is out of service for more than one year, change engine coolant (→ Page 187).
Coolant circuit	Check coolant level (→ Page 186).
Coolant circuit	Heat engine coolant with coolant preheating unit (optional).
Engine Control Unit ECU	Check plug connections (→ Page 214).
Engine Interface Module EIM	Check plug connections (→ Page 216).
Engine Monitoring Unit EMU	Check plug connections (→ Page 215).

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

Preconditions

☒ Engine is stopped and starting disabled.

Putting into operation

Item	Measure
Lube oil system	Check engine oil level (→ Page 177).
Coolant circuit	Check coolant level (→ Page 186).
Coolant circuit	If necessary, heat up coolant with coolant preheating unit if $T < 5\text{ °C}$.
Fuel prefilter	Drain water and contaminants (→ Page 162).
Battery-charging generator drive	Check condition of drive belt (→ Page 142).
Engine Control Unit ECU	Check plug connections (→ Page 214).
Engine Interface Module EIM	Check plug connections (→ Page 216).
Engine Monitoring Unit EMU	Check plug connections (→ Page 215).

6.3 Emissions label – Check

Checking emissions label

Note: If there are any irregularities, notify your MTU contact person/service partner without delay.

1. Check that emissions labels are present (there can be more than one).
2. Check emissions labels for intactness.
3. Check that emissions labels are fully legible.
4. Check content of emissions label:
 - Does the label on the engine match the label document in the Business Portal/Equipment?
 - Does the engine number on the emissions label match the engine nameplate?
 - Does the Manufacturing Date match the year of manufacture on the nameplate?

6.4 Re-starting the engine following an automatic safety shutdown

NOTICE



Re-starting the engine following an automatic safety shutdown.

Risk of severe engine damage!

- Before starting the engine, make sure the root cause of the safety shutdown was eliminated.
- If the root cause cannot be identified or eliminated, contact Service.

- Note:
- If an engine has been shutdown by a fault (red alarm), the engine may only be re-started when the fault has been identified and eliminated.

Procedure following an automatic safety shutdown

1. Eliminate fault.
2. If the root cause cannot be identified or eliminated, contact Service.




Important

The function "Overdrive safety system" (if fitted), which is only used in emergency situations, is not affected.

6.5 Engine – Start

Preconditions

- ☒ External start interlock is not activated.

DANGER 	Rotating and moving engine parts. Risk of crushing, danger of parts of the body being caught or pulled in! <ul style="list-style-type: none">Before cranking the engine with starter system, make sure that there are no persons in the engine's danger zone.
WARNING 	A high level of noise is produced when the engine is running. Risk of hearing loss! <ul style="list-style-type: none">Wear suitable hearing protection.
NOTICE 	Re-starting the engine following an automatic safety shutdown. Risk of severe engine damage! <ul style="list-style-type: none">Before starting the engine, make sure the root cause of the safety shutdown was eliminated.If the root cause cannot be identified or eliminated, contact Service.

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 Operating Station LOS	(→ Operating instructions for electronic system)
CCU	(→ Operating instructions for electronic system)

6.6 Fuel treatment system – Checks prior to putting into operation

Checks prior to putting into operation

1. Check tank and entire pipework for cleanness. If microorganisms are detected:
 - a) Clean affected components.
 - b) Disinfect affected components with biocides (→ 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 74).
 5. Check direction of rotation of pump.
 6. Vent bypass and fuel lines of system.
 - a) Open ball valve for pressure tank.
 - b) Open ball valve for overflow tank.
- Result: Bypass line is vented via overflow tank.
- c) Close ball valve at inlet to fuel treatment system.
 - d) Open ball valve at inlet to fuel treatment system.

7. Check fuel treatment system for leaks.

Result: Fuel treatment system is ready for operation.

6.7 Fuel treatment system – Switching on

Preconditions

- ☒ The on-board power supply is switched on.

NOTICE



Risk of damage to engine/system.

Risk of severe damage to property!

- Before switching on, ensure that the engine/system is ready for operation.
- Before switching on, ensure that all housings are closed.
- Before switching on, ensure that no work is in progress anywhere on the entire system.

Fuel treatment system – Switching on

1. Carry out checks prior to start-up (→ Page 73).
2. Switch on master switch on switchgear cabinet.
Result: Signal lamp “Control voltage present” lights up.
3. Switch on switch for pump.
Result: Signal lamp “Pump running” lights up.

6.8 Operational checks

DANGER



Rotating, moving parts during operation.

Risk of crushing, danger of limbs being caught up or drawn in!

- Personnel must only stay in the operating room of the engine/engine-generator set as long as necessary and only if on-site attendance is expressly required in the descriptions.
- Keep away from the danger zone of the engine/engine-generator set.

WARNING



A high level of noise is produced when the engine is running.

Risk of hearing loss!

- Wear suitable hearing protection.

Operational checks

Item	Action
Engine under load, engine at nominal speed	Visually inspect engine for leaks and general condition; Check for abnormal running noises and vibration; Check exhaust color (→ Page 118).
Fuel prefilter	Check if reading on service indicator of fuel prefilter is within the limit (→ Page 160). Drain water and contaminants (→ Page 162).
Air filter	Check signal ring position of service indicator (→ Page 176). Replace air filter (→ Page 174), if the signal ring is completely visible in the service indicator observation window.
HT coolant pump	Check relief bore for oil and coolant discharge as well as contamination (→ Page 191).
Raw water pump	Check relief bore for oil and water discharge as well as contamination (→ Page 196).
Intercooler	Check condensate drain (if applicable) (→ Page 172).
Engine oil	Check engine oil level (→ Page 177).

6.9 Engine shutdown via the automation system

NOTICE



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

Risk of overheating, damage to components!

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

Engine shutdown via the automation system

Item	Measure
Automation system	Shut down engine via the automation system (→ Automation system Operating Instructions).

6.10 Engine – Shutdown

Preconditions

- ☒ Engine is running in Local mode

CAUTION



Shutting down from full-load operation may cause hot water to escape from the expansion tank.

Risk of scalding!

- Allow engine to cool down.
- Wear protective clothing, protective gloves, and safety goggles / safety mask.

NOTICE



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

Risk of overheating, damage to components!

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

The engine can be stopped 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)

6.11 Engine – Emergency shutdown

CAUTION



Shutting down from full-load operation may cause hot water to escape from the expansion tank.

Risk of scalding!

- Allow engine to cool down.
- Wear protective clothing, protective gloves, and safety goggles / safety mask.

NOTICE



An emergency stop subjects the engine system to an extremely high load.

Risk of overheating, damage to components!

- Trigger an emergency stop only in emergency situations.

The engine can be stopped from the following points in an emergency

Important

Check coolant level and top up as necessary to compensate loss during emergency shutdown.

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)

6.12 After stopping the engine

Preconditions

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

NOTICE



Engine coolant with inadequate freeze protection. Water remaining in the pressure sensors freezes at temperatures below 0 °C.

Risk of sensor damage!

- Remove pressure sensors and shake off residual water.

After stopping the engine

Item	Action
Coolant circuit	Drain coolant (→ Page 188) if: <ul style="list-style-type: none">• freezing temperatures are to be expected and the engine is to remain out of service for an extended period and if no antifreeze has been added to the coolant;• 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 <ul style="list-style-type: none">• if freezing temperatures are expected and the engine is to remain out of service for a longer period.
Engine control system	Switch off.
Air intake and exhaust system	Out-of-service-period > 1 week: <ul style="list-style-type: none">• Seal engine's air and exhaust sides.
Engine	Out-of-service-period > 1 month: <ul style="list-style-type: none">• Preserve engine (→ Preservation and Represervation Specifications A001070/..).

6.13 Plant – Cleaning

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ No operating voltage is applied.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
High-pressure cleaner	(→ Tools Catalog)	1
Cleaner (Hakupur 449)	X00071179	1

WARNING



Compressed air gun ejects a jet of pressurized air.

Risk of injury to eyes and damage to hearing, risk of rupturing internal organs!

- Never direct air jet at people.
- Always wear safety goggles/face mask and hearing protection.

WARNING



Water jet from high-pressure cleaning unit.

Risk of eye injury, risk of scalding!

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

NOTICE



Cleaning agents should not be left to take effect for too long.

Damage to components is possible!

- Observe manufacturer's instructions.

NOTICE



Blowing down product with compressed air.

Entry of dirt and damage to components is possible!

- Do not aim compressed air gun directly at seals or electronic components such as connectors or ECUs.

Plant – Cleaning

Important information






Always adhere to the latest version of the Fluids and Lubricants Specifications. Further approved cleaning agents may be used.

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 high-pressure cleaning units carefully and observe the safety precautions.
 3. The following requirements apply for cleaning the plant outside with a high-pressure cleaning unit:
 - The pressure of the high-pressure jet (cleaning jet) must not exceed 50 bar.
 - A minimum distance between spray nozzle and plant of 1 m must be observed.
 - The temperature of the cleaning medium must not exceed 80 °C.
 4. For external cleaning with high-pressure jet, use a fan jet nozzle only.
- Note: Never direct compressed air directly at electronic components.
5. Carry out external cleaning as follows:
 - a) Seal all openings in a suitable way.
 - b) Remove coarse dirt.
- Note: Observe the instructions from the manufacturer of the cleaner!
- c) Spray on cleaner sparingly and leave it for 1 to 5 minutes.
 - d) Use high-pressure jet to remove loosened dirt.
 - e) Dry engine with compressed air.

7 Maintenance

7.1 Maintenance points – Symbols

Overview

Symbol	Description
	This symbol indicates a maintenance activity which can be performed during a break in operation without disassembling the engine.
	The symbol calls for visual inspection of the component concerned.
	The symbol calls for testing, measuring or adjustment etc. of the component concerned.
	The symbol calls for filling or draining of a certain medium.
	The symbol calls for repair, disassembly or overhaul etc. of the component concerned.

7.2 Maintenance points, QL1 - Overview

Maintenance points, driving end

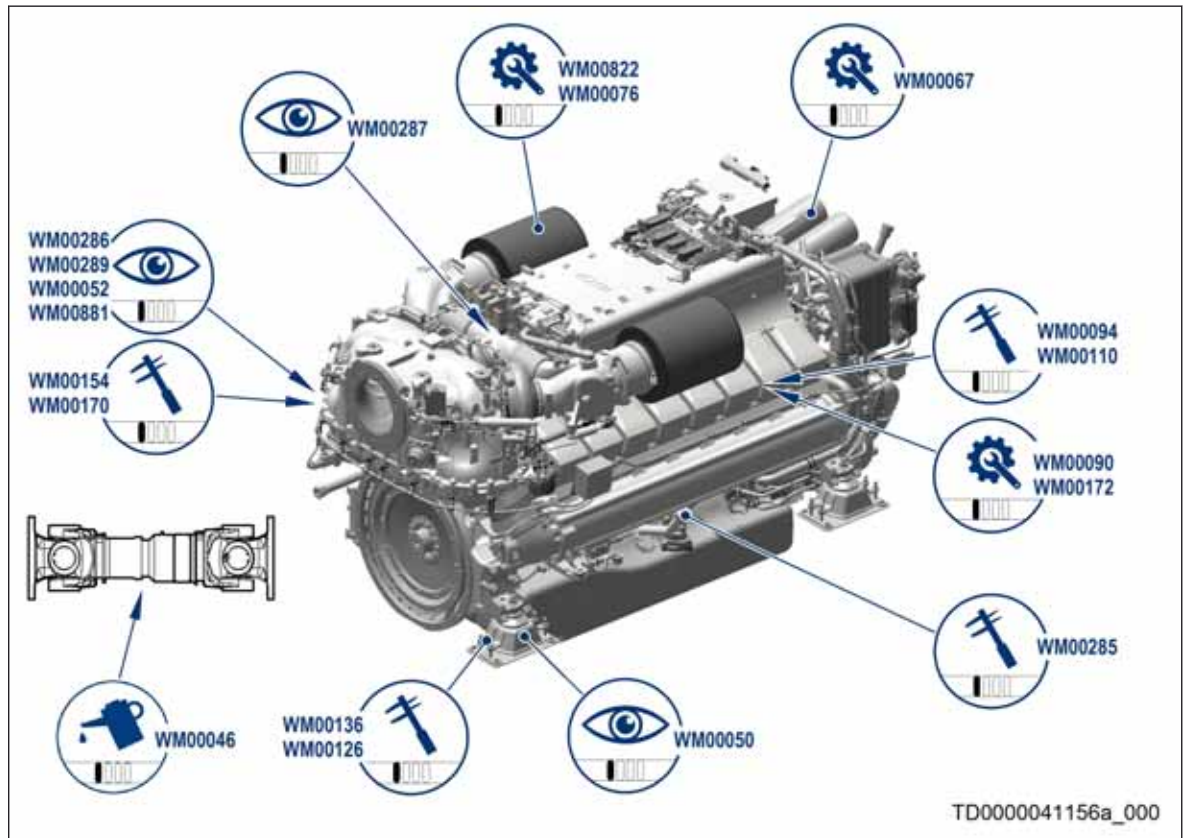


Figure shows example (16V)

Maintenance points, free end

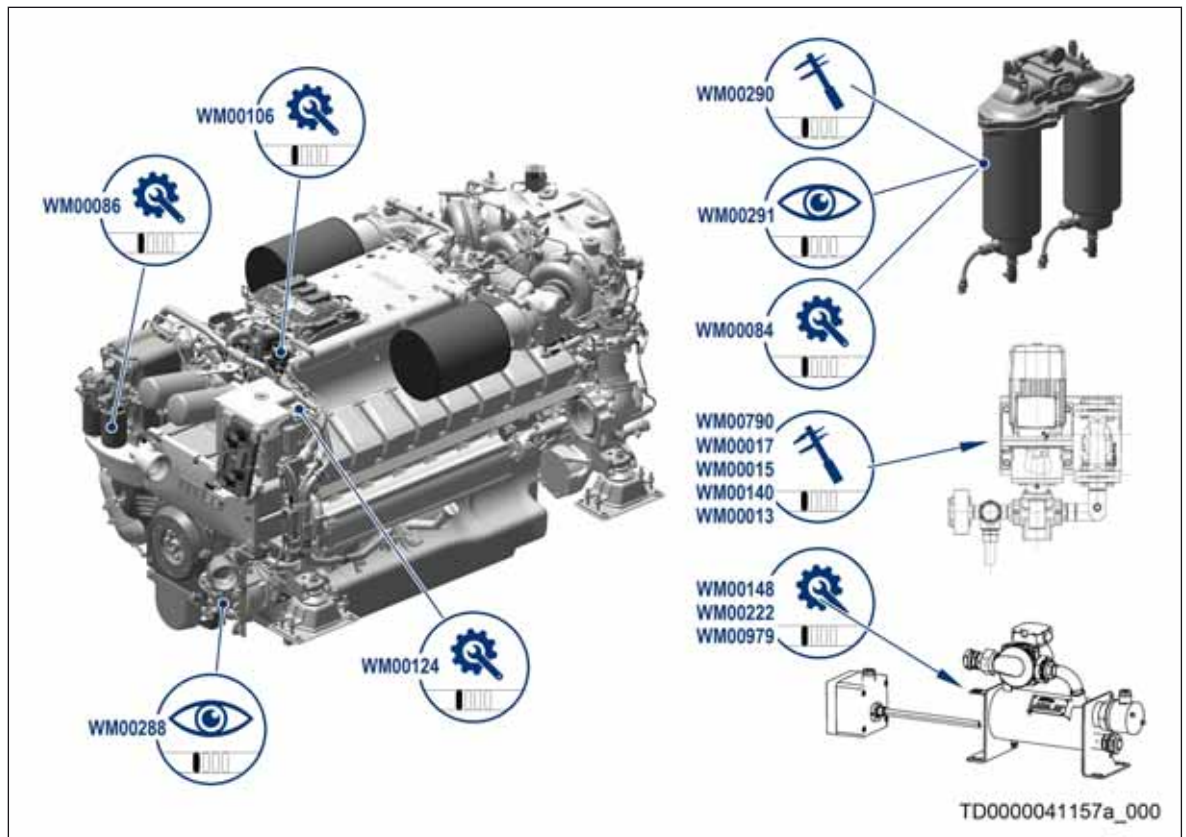


Figure shows example (16V)

7.3 Maintenance task reference table [QL1] for Non-EPA regions

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

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

Task	Item	Measures	Option	
WM00285	ENGINE OPERATIONAL CHECKS	Check engine oil level		(→ Page 177)
WM00286	ENGINE OPERATIONAL CHECKS	Visually inspect engine for leaks and general condition		(→ Page 75)
WM00287	ENGINE OPERATIONAL CHECKS	Check maintenance indicator of air filter	X	(→ Page 75)
WM00288	ENGINE OPERATIONAL CHECKS	Check relief bore of coolant pump		(→ Page 75)
WM00289	ENGINE OPERATIONAL CHECKS	When the engine is running: Check for abnormal running noises, exhaust gas color and vibrations		(→ Page 75)
WM00290	ENGINE OPERATIONAL CHECKS	Drain water and contaminants from fuel prefilter	X	(→ Page 75)
WM00291	ENGINE OPERATIONAL CHECKS	Check position of service indicator of fuel prefilter	X	(→ Page 75)
WM00050	ENGINE MOUNTING	Check general condition of rubber mounts (visual inspection)		(→ Page 197)
WM00136	ENGINE MOUNTING	Check securing screws for secure seating		(→ Page 197)
WM00822	AIR SUPPLY SYSTEM	Check air filter, replace as necessary	X	(→ Page 174)
WM00067	LUBE OIL SYSTEM	Replace oil filter at each oil change or when the time limit (years) is reached, at the latest		(→ Page 179)
WM00076	AIR SUPPLY SYSTEM	Replace air filter	X	(→ Page 174)
WM00124	COOLANT SYSTEM	Replace valve cover		(→ Page 193)
WM00126	ENGINE MOUNTING	Measure height of rubber element		(→ Page 199)
WM00084	FUEL SYSTEM (LOW PRESSURE)	Fuel prefilter, replace filter	X	(→ Page 169)
WM00086	FUEL SYSTEM (LOW PRESSURE)	Replace easy-change fuel filter		(→ Page 157)
WM00170	AUXILIARY PTO	Check condition of belt and replace as necessary. Adjust tension	X	(→ Page 142)
WM00090	FUEL SYSTEM (HIGH PRESSURE)	Replace fuel injection valve/injector		(→ Page 148)
WM00094	VALVE GEAR	Check valve clearance, adjust if necessary. IMPORTANT! First adjustment after 1,000 operating hours on a new engine and after 1,000 operating hours following each cylinder head overhaul		(→ Page 144)
WM00110	RUNNING GEAR	Examine cylinder liner with endoscope		(→ Page 139)
WM00154	ENGINE CONTROL UNIT	Reset parameters of drift correction (CDC) and enter injector coding (IIG)		(→ Page 211)
WM00106	CRANKCASE BREATHER	Replace oil separator (impactor)		(→ Page 141)
WM00052	BATTERY-CHARGING GENERATOR	Check condition of coupling	X	(→ Page 207)
WM00172	HP FUEL LINE / HP LINE	Replace HP line		(→ Page 149)
WM00222	PREHEATING	Preheater, check for function and leaks	X	(→ Page 195)
WM00148	PREHEATING	Preheater, replace thermostat (electric)	X	(→ Page 194)
WM00979	PREHEATING	Overhaul or replace preheating unit	X	See manufacturer's documentation
WM00881	BENDING/TORSIONALLY RESILIENT COUPLING & STEEL-SPRING COUPLING	Check coupling (visual inspection), replace as necessary	X	(→ Page 200)
WM00790	FUEL TREATMENT PLANT	Check water drain valve	X	(→ Page 201)
WM00017	FUEL TREATMENT PLANT	Differential pressure gauge, check alarm function	X	(→ Page 204)
WM00015	FUEL TREATMENT PLANT	Fuel pump, check pump performance	X	(→ Page 206)
WM00140	FUEL TREATMENT PLANT	Replace filter element	X	(→ Page 201)
WM00013	FUEL TREATMENT PLANT	Check function of rod electrode	X	(→ Page 205)
WM00046	DRIVE SHAFT	Grease lubrication points of drive shaft, driving end	X	(→ Page 210)

Table 11: Maintenance task reference table [QL1]

7.4 Maintenance task reference table [QL1] for EPA regions

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

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

Task	Item	Measures	Option	
WM00112	LABELS AND MISCELLANEOUS MATERIALS	Check that emissions label is present, check readability and content		(→ Page 70)
WM00285	ENGINE OPERATIONAL CHECKS	Check engine oil level		(→ Page 177)
WM00286	ENGINE OPERATIONAL CHECKS	Visually inspect engine for leaks and general condition		(→ Page 75)
WM00287	ENGINE OPERATIONAL CHECKS	Check maintenance indicator of air filter	X	(→ Page 75)
WM00288	ENGINE OPERATIONAL CHECKS	Check relief bore of coolant pump		(→ Page 75)
WM00289	ENGINE OPERATIONAL CHECKS	When the engine is running: Check for abnormal running noises, exhaust gas color and vibrations		(→ Page 75)
WM00290	ENGINE OPERATIONAL CHECKS	Drain water and contaminants from fuel prefilter	X	(→ Page 75)
WM00291	ENGINE OPERATIONAL CHECKS	Check position of service indicator of fuel prefilter	X	(→ Page 75)
WM00050	ENGINE MOUNTING	Check general condition of rubber mounts (visual inspection)		(→ Page 197)
WM00136	ENGINE MOUNTING	Check securing screws for secure seating		(→ Page 197)
WM00822	AIR SUPPLY SYSTEM	Check air filter, replace as necessary	X	(→ Page 174)
WM00067	LUBE OIL SYSTEM	Replace oil filter at each oil change or when the time limit (years) is reached, at the latest		(→ Page 179)
WM00076	AIR SUPPLY SYSTEM	Replace air filter	X	(→ Page 174)
WM00124	COOLANT SYSTEM	Replace valve cover		(→ Page 193)
WM00126	ENGINE MOUNTING	Measure height of rubber element		(→ Page 199)
WM00084	FUEL SYSTEM (LOW PRESSURE)	Fuel prefilter, replace filter	X	(→ Page 169)
WM00086	FUEL SYSTEM (LOW PRESSURE)	Replace easy-change fuel filter		(→ Page 157)
WM00170	AUXILIARY PTO	Check condition of belt and replace as necessary. Adjust tension	X	(→ Page 142)
WM00094	VALVE GEAR	Check valve clearance, adjust as necessary. IMPORTANT! First adjustment after 1,000 operating hours on a new engine and after 1,000 operating hours following each cylinder head overhaul		(→ Page 144)
WM00052	BATTERY-CHARGING GENERATOR	Check condition of coupling	X	(→ Page 207)
WM00106	CRANKCASE BREATHER	Replace oil separator (impactor)		(→ Page 141)
WM00090	FUEL SYSTEM (HIGH PRESSURE)	Replace fuel injection valve/injector		(→ Page 148)
WM00154	ENGINE CONTROL UNIT	Reset parameters of drift correction (CDC) and enter injector coding (IIG)		(→ Page 211)
WM00172	HP FUEL LINE / HP LINE	Replace HP line		(→ Page 149)
WM00222	PREHEATING	Preheater, check for function and leaks	X	(→ Page 195)
WM00148	PREHEATING	Preheater, replace thermostat (electric)	X	(→ Page 194)
WM00979	PREHEATING	Overhaul or replace preheating unit	X	See manufacturer's documentation
WM00881	BENDING/TORSIONALLY RESILIENT COUPLING & STEEL-SPRING COUPLING	Check coupling (visual inspection), replace as necessary	X	(→ Page 200)
WM00790	FUEL TREATMENT PLANT	Check water drain valve	X	(→ Page 201)
WM00017	FUEL TREATMENT PLANT	Differential pressure gauge, check alarm function	X	(→ Page 204)
WM00015	FUEL TREATMENT PLANT	Fuel pump, check pump performance	X	(→ Page 206)
WM00140	FUEL TREATMENT PLANT	Replace filter element	X	(→ Page 202)
WM00013	FUEL TREATMENT PLANT	Check function of rod electrode	X	(→ Page 205)
WM00046	DRIVE SHAFT	Grease lubrication points of drive shaft, driving end	X	(→ Page 210)

Table 12: Maintenance task reference table [QL1]

8 Troubleshooting

8.1 Fault messages

Possible engine responses to yellow alarm:

Warning, power limitation/reduction, speed limitation, engine stop

Possible engine responses to red alarm:

Engine stop, power limitation/reduction, speed limitation, warning

Procedure following an automatic safety shutdown (→ Page 71)

3 – HI T-Fuel

SPN: 174 – FMI: 15

Cause	Corrective action
The fuel temperature at sensor B33 has violated limit value 1. Fuel temperature is too high.	1. Reduce power. 2. Check fuel cooling system (if applicable). 3. Contact Service.

4 – SS T-Fuel

SPN: 174 – FMI: 0

Cause	Corrective action
The fuel temperature at sensor B33 has violated limit value 2. Fuel temperature is too high.	1. Reduce power. 2. Check fuel cooling system (if applicable). 3. Contact Service.

5 – HI T-Charge Air

SPN: 105 – FMI: 15

Cause	Corrective action
The charge-air temperature at sensor B9 has violated limit value 1. The charge-air temperature is too high.	1. Reduce power. 2. Contact Service.

6 – SS T-Charge Air

SPN: 105 – FMI: 0

Cause	Corrective action
The charge-air temperature at sensor B9 has violated limit value 2. The charge-air temperature is too high.	1. Reduce power. 2. Contact Service.

15 – LO P-Lube Oil

SPN: 100 – FMI: 17

Cause	Corrective action
The lube oil pressure at sensor B5.1 has violated limit value 1. The lube oil pressure is too low.	► Contact Service.

16 – SS P-Lube Oil

SPN: 100 – FMI: 1

Cause	Corrective action
The lube oil pressure at sensor B5.1 has violated limit value 2. The lube oil pressure is too low.	1. Check engine oil level, top up as necessary (→ Page 177). 2. Check engine oil filter, replace as necessary (→ Page 179). 3. Contact Service.

19 – HI T-Exhaust A

SPN: 2434 – FMI: 15

Cause	Corrective action
The A side exhaust gas temperature at sensor B4.21 has violated limit value 1. Exhaust temperature is too high.	1. Reduce power. 2. Run injector test according to DiaSys description. Contact Service if no DiaSys is available.

20 – SS T-Exhaust A

SPN: 2434 – FMI: 0

Cause	Corrective action
The A side exhaust gas temperature measured at sensor B4.21 has violated limit value 2. Exhaust temperature is too high.	1. Reduce power. 2. Run injector test according to DiaSys description. Contact Service if no DiaSys is available.

21 – HI T-Exhaust B

SPN: 2433 – FMI: 15

Cause	Corrective action
The B side exhaust gas temperature at sensor B4.22 has violated limit value 1. Exhaust temperature is too high.	1. Reduce power. 2. Run injector test according to DiaSys description. Contact Service if no DiaSys is available.

22 – SS T-Exhaust B

SPN: 2433 – FMI: 0

Cause	Corrective action
The B side exhaust gas temperature measured at sensor B4.22 has violated limit value 2. Exhaust temperature is too high.	1. Reduce power. 2. Run injector test according to DiaSys description. Contact Service if no DiaSys is available.

TIM-ID: 0000074920 - 002

23 – LO Coolant Level

SPN: 111 – FMI: 17

Cause	Corrective action
The coolant level at level switch F33 in HT circuit is too low.	<ol style="list-style-type: none">1. Check engine coolant level (→ Page 186).2. Check relief bore of engine coolant pump (→ Page 191).3. Check intercooler drain line for coolant leakage and obstruction (→ Page 172).4. Check coolant circuit visually for leaks.5. Contact Service.

25 – HI P-Diff-Lube Oil

SPN: 99 – FMI: 15

Cause	Corrective action
The differential oil pressure at sensors B5.1 and B5.3 has violated limit value 1. The differential oil pressure is too high.	<ol style="list-style-type: none">1. Replace engine oil filter (→ Page 179).2. Contact Service.

26 – SS P-Diff-Lube Oil

SPN: 99 – FMI: 0

Cause	Corrective action
The differential oil pressure at sensors B5.1 and B5.3 has violated limit value 2. The differential oil pressure is too high.	<ol style="list-style-type: none">1. Replace engine oil filter (→ Page 179).2. Contact Service.

27 – HI Level Leakage Fuel

SPN: 1239 – FMI: 15

Cause	Corrective action
Switch F46 in the collecting tank has been tripped. The HP fuel system is leaking.	► Contact Service.

30 – SS Engine Overspeed

SPN: 190 – FMI: 0

Cause	Corrective action
The engine speed has violated the upper limit or the engine overspeed test was tripped. An emergency engine shutdown has been initiated.	<ol style="list-style-type: none">1. Restart the engine if the emergency stop was tripped by the engine overspeed test.2. Contact Service if the emergency stop was tripped by the engine.

31 – HI ETC1 Overspeed

SPN: 103 – FMI: 15

Cause	Corrective action
The exhaust turbocharger speed at sensor B44 has violated limit value 1. The exhaust turbocharger speed is too high.	1. Reduce power. 2. Contact Service.

32 – SS ETC1 Overspeed

SPN: 103 – FMI: 0

Cause	Corrective action
The exhaust turbocharger speed at sensor B44 has violated limit value 2. The exhaust turbocharger speed is too high.	1. Reduce power. 2. Contact Service.

51 – HI T-Lube Oil

SPN: 175 – FMI: 15

Cause	Corrective action
The lube oil temperature at sensor B7 has violated limit value 1. Lube-oil temperature is too high.	1. Reduce power. 2. Check engine coolant level (→ Page 186). 3. Contact Service.

52 – SS T-Lube Oil

SPN: 175 – FMI: 0

Cause	Corrective action
The lube oil temperature at sensor B7 has violated limit value 2. Lube-oil temperature is too high.	1. Check engine coolant level (→ Page 186). 2. Contact Service.

57 – LO P-Coolant

SPN: 109 – FMI: 17

Cause	Corrective action
The coolant pressure at sensor B16 has violated limit value 1. Coolant pressure is too low.	1. Check relief bore of engine coolant pump (→ Page 191). 2. Check engine coolant level (→ Page 186). 3. Check engine visually for leakage. 4. Contact Service.

58 – SS P-Coolant

SPN: 109 – FMI: 1

Cause	Corrective action
The coolant pressure at sensor B16 has violated limit value 2. Coolant pressure is too low.	1. Check relief bore of engine coolant pump (→ Page 191). 2. Check engine coolant level (→ Page 186). 3. Contact Service.

TIM-ID: 0000074920 - 002

63 – HI P-Crank Case

SPN: 101 – FMI: 15

Cause	Corrective action
The crankcase pressure at sensor B50 has violated limit value 1. The crankcase pressure is too high.	1. Stop engine. 2. Contact Service.

64 – SS P-Crank Case

SPN: 101 – FMI: 0

Cause	Corrective action
The crankcase pressure at sensor B50 has violated limit value 2. The crankcase pressure is too high.	► Contact Service.

65 – LO P-Fuel

SPN: 520286 – FMI: 17

Cause	Corrective action
The fuel pressure at sensor B34 has violated limit value 1. The fuel pressure is too low.	1. Inspect engine for fuel leakage. 2. Replace fuel filter (→ Page 157). 3. Replace fuel prefilter (→ Page 169). 4. Contact Service.

66 – SS P-Fuel

SPN: 520286 – FMI: 1

Cause	Corrective action
The fuel pressure at sensor B34 has violated limit value 2. The fuel pressure is too low.	1. Inspect engine for fuel leakage. 2. Replace fuel filter (→ Page 157). 3. Replace fuel prefilter (→ Page 169). 4. Contact Service.

67 – HI T-Coolant

SPN: 110 – FMI: 15

Cause	Corrective action
The coolant temperature at sensor B6.1 has violated limit value 1. Coolant temperature too high.	1. Reduce power. 2. Check engine coolant level (→ Page 186). 3. Contact Service.

68 – SS T-Coolant

SPN: 110 – FMI: 0

Cause	Corrective action
The coolant temperature at sensor B6.1 has violated limit value 2. Coolant temperature too high.	1. Reduce power. 2. Check engine coolant level (→ Page 186). 3. Contact Service.

82 – HI P-Fuel (Common Rail)

SPN: 157 – FMI: 15

Cause	Corrective action
The HP fuel pressure at sensor B48 has violated the limit value. Fuel pressure is too high.	1. Check connectors at HP fuel control block M8 (→ Page 48). 2. Contact Service.

83 – LO P-Fuel (Common Rail)

SPN: 157 – FMI: 1

Cause	Corrective action
The HP fuel pressure at sensor B48 is below the limit value. The fuel pressure is too low.	1. Check connectors at HP fuel control block M8 (→ Page 48). 2. Contact Service.

85 – HI T-Umbblasen

SPN: 520254 – FMI: 15

Cause	Corrective action
The temperature measured at sensor B49 has violated the limit value. The blow over temperature is too high, because exhaust gas is flowing to the air side. The blow over valve is closed.	► Contact Service.

89 – SS Engine Speed too Low

SPN: 190 – FMI: 1

Cause	Corrective action
The engine speed has violated the limit value. An emergency engine shutdown has been initiated.	1. Acknowledge alarm. 2. Check additional messages. 3. Contact Service.

102 – AL Fuel Cons. Counter Defect

SPN: 250 – FMI: 31

Cause	Corrective action
The fuel consumption calculated by the ECU and stored on stopping the engine cannot be read out properly on restarting the engine.	► Contact Service.

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104 – AL Eng Hours Counter Defect

SPN: 247 – FMI: 31

Cause	Corrective action
The operating hours calculated by the ECU and stored on stopping the engine cannot be read out properly on restarting the engine.	► Contact Service.

118 – LO ECU Power Supply Voltage

SPN: 158 – FMI: 17

Cause	Corrective action
The ECU supply voltage has violated the defined limit value 1.	<ol style="list-style-type: none">1. Check condition of batteries (plant side).2. Check plug connections to Engine Control Unit (→ Page 214).3. Contact Service.

119 – LOLO ECU Power Supply Voltage

SPN: 158 – FMI: 1

Cause	Corrective action
The ECU supply voltage has violated the defined limit value 2.	<ol style="list-style-type: none">1. Check condition of batteries (plant side).2. Check plug connections to Engine Control Unit (→ Page 214).3. Contact Service.

120 – HI ECU Power Supply Voltage

SPN: 158 – FMI: 15

Cause	Corrective action
The ECU supply voltage has violated limit value 1.	<ol style="list-style-type: none">1. Check condition of batteries (plant side).2. Check plug connections to Engine Control Unit (→ Page 214).3. Contact Service.

121 – HIHI ECU Power Supply Voltage

SPN: 158 – FMI: 0

Cause	Corrective action
ECU supply voltage has violated limit value 2.	<ol style="list-style-type: none">1. Check condition of batteries (plant side).2. Check plug connections to Engine Control Unit (→ Page 214).3. Contact Service.

122 – HI T-ECU

SPN: 1136 – FMI: 15

Cause	Corrective action
The temperature at the sensor inside the ECU has violated the limit value. The temperature inside the housing is too high.	<ol style="list-style-type: none">1. Check whether alarms 9 and/or 10 are active.2. If ECU cooling is connected, check flow.3. Contact Service.

180 – AL CAN1 Node Lost

SPN: 521006 – FMI: 31

Cause	Corrective action
Connection or communication with a device on CAN bus 1 has failed.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 209).2. Disconnect power supply, then reconnect.3. Contact Service.

181 – AL CAN2 Node Lost

SPN: 521007 – FMI: 31

Cause	Corrective action
Connection or communication with a device on CAN bus 2 has failed.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 209).2. Disconnect power supply, then reconnect.3. Contact Service.

182 – AL CAN Wrong Parameters

SPN: 521008 – FMI: 31

Cause	Corrective action
Wrong parameter values entered in data record.	► Contact Service.

183 – AL CAN No PU-Data

SPN: 521009 – FMI: 31

Cause	Corrective action
The ECU expects project configuration data (PU data) from the Backup Data Module server (BDM), e.g. SAM or LOP, during initial start-up.	► Contact Service.

184 – AL CAN PU-Data Flash Error

SPN: 521010 – FMI: 31

Cause	Corrective action
The project configuration data (PU data) from the Backup Data Module server (BDM), e.g. SAM or LOP, saved during initial start-up cannot be properly read out.	► Contact Service.

186 – AL CAN1 Bus Off

SPN: 521011 – FMI: 31

Cause	Corrective action
CAN bus 1 to MTU automation system (e.g. ECU/MAU/SAM) disrupted or faulty.	<ol style="list-style-type: none">1. Check plug connections to Engine Control Unit (→ Page 214).2. Contact Service.

187 – AL CAN1 Error Passive

SPN: 521012 – FMI: 31

Cause	Corrective action
CAN bus 1 to MTU automation system (e.g. ECU/MAU/SAM) disrupted or faulty.	1. Check plug connections to Engine Control Unit (→ Page 214). 2. Contact Service.

188 – AL CAN2 Bus Off

SPN: 521013 – FMI: 31

Cause	Corrective action
CAN bus 2 to plant automation system (e.g. Murphy display) disrupted or faulty.	1. Check connection between plant automation system and MTU automation system. 2. Contact Service.

189 – AL CAN2 Error Passive

SPN: 521014 – FMI: 31

Cause	Corrective action
CAN bus 2 to plant automation system (e.g. Murphy display) disrupted or faulty.	1. Check connection between plant automation system and MTU automation system. 2. Contact Service.

190 – AL EMU Parameter Not Supported

SPN: 521230 – FMI: 31

Cause	Corrective action
ECU9-FSW cannot support a later EMU parameter set version. New EMU parameters cannot therefore be set via ECU9.	► Contact Service.

201 – SD T-Coolant

SPN: 110 – FMI: 11

Cause	Corrective action
The signal from the coolant temperature sensor (B6.1) on the coolant distribution housing is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

202 – SD T-Fuel

SPN: 174 – FMI: 11

Cause	Corrective action
The signal from the fuel temperature sensor (B33) on the HP distributor is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

203 – SD T-Charge Air

SPN: 105 – FMI: 11

Cause	Corrective action
The signal from the A side charge-air temperature sensor (B9) is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

206 – SD T-Exhaust A

SPN: 2434 – FMI: 11

Cause	Corrective action
The signal from the exhaust gas temperature sensor (B4.21) in the exhaust pipe on A side is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

207 – SD T-Exhaust B

SPN: 2433 – FMI: 11

Cause	Corrective action
The signal from the charge-air temperature sensor (B4.22) B side is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

208 – SD P-Charge Air

SPN: 3563 – FMI: 11

Cause	Corrective action
The signal from the charge-air pressure sensor (B10) after the HP intercooler is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

211 – SD P-Lube Oil

SPN: 100 – FMI: 11

Cause	Corrective action
The signal from the lube oil pressure sensor after filter (B5.1) is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

212 – SD P-Coolant

SPN: 109 – FMI: 11

Cause	Corrective action
The signal from the coolant pressure sensor after coolant pump (B16) is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

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214 – SD P-Crankcase

SPN: 101 – FMI: 11

Cause	Corrective action
The signal from the crankcase pressure sensor (B50) is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

215 – SD P-HD

SPN: 157 – FMI: 11

Cause	Corrective action
The signal from the rail pressure sensor (B48) is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

216 – SD T-Lube Oil

SPN: 175 – FMI: 11

Cause	Corrective action
The signal from the lube oil temperature sensor (B7) is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

219 – SD T-Intake Air

SPN: 172 – FMI: 11

Cause	Corrective action
The signal from the intake air temperature sensor (B3) is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

220 – SD Level Coolant Water

SPN: 111 – FMI: 11

Cause	Corrective action
The signal from the coolant level sensor (F33) is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

221 – SD P-Diff Lube Oil

SPN: 99 – FMI: 11

Cause	Corrective action
The signal from the lube oil pressure sensors B5.3 and/or B5.1 is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

222 – SD Level Leakage Fuel

SPN: 1239 – FMI: 11

Cause	Corrective action
The signal from the fuel leakage sensor (F46) is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

227 – SD P-Lube Oil before Filter

SPN: 1208 – FMI: 11

Cause	Corrective action
The signal from the oil pressure sensor before filter (B5.3) is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

229 – AL Stop Camshaft Sensor Defect

SPN: 521016 – FMI: 31

Cause	Corrective action
Emergency engine stop following failure of the crankshaft sensor (B13) and camshaft sensor (B1).	► Contact Service.

230 – SD Crankshaft Speed

SPN: 520258 – FMI: 11

Cause	Corrective action
The signal from the crankshaft speed sensor (B13) is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

231 – SD Camshaft Speed

SPN: 520257 – FMI: 11

Cause	Corrective action
The signal from the camshaft speed sensor (B1) is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

232 – SD Charger 1 Speed

SPN: 103 – FMI: 11

Cause	Corrective action
The signal from the speed sensor (B44) of the A side ETC is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

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240 – SD P-Fuel

SPN: 164 – FMI: 11

Cause	Corrective action
The signal from the fuel pressure sensor after main fuel filter (B34) is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

241 – SD T-Umbblasen

SPN: 520254 – FMI: 11

Cause	Corrective action
The signal from the temperature sensor before the blow over valve (B49) is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

245 – SD ECU Power Supply Voltage

SPN: 158 – FMI: 11

Cause	Corrective action
The signal from the voltage sensor in the ECU is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

266 – SD Speed Demand

SPN: 898 – FMI: 31

Cause	Corrective action
The analog nominal speed setting signal is missing.	1. Switch on plant automation. 2. Check propulsion control lever. 3. Contact Service.

321 – AL Wiring Cylinder A1

SPN: 520900 – FMI: 31

Cause	Corrective action
Short circuit fault in the injector wiring for cylinder A1 or injector faulty.	1. Check wiring of affected injector (→ Page 209). 2. Replace injector (→ Page 148). 3. Contact Service.

322 – AL Wiring Cylinder A2

SPN: 520901 – FMI: 31

Cause	Corrective action
Short circuit fault in the injector wiring for cylinder A2 or injector faulty.	1. Check wiring of affected injector (→ Page 209). 2. Replace injector (→ Page 148). 3. Contact Service.

323 – AL Wiring Cylinder A3

SPN: 520902 – FMI: 31

Cause	Corrective action
Short circuit fault in the injector wiring for cylinder A3 or injector faulty.	1. Check wiring of affected injector (→ Page 209). 2. Replace injector (→ Page 148). 3. Contact Service.

324 – AL Wiring Cylinder A4

SPN: 520903 – FMI: 31

Cause	Corrective action
Short circuit fault in the injector wiring for cylinder A4 or injector faulty.	1. Check wiring of affected injector (→ Page 209). 2. Replace injector (→ Page 148). 3. Contact Service.

325 – AL Wiring Cylinder A5

SPN: 520904 – FMI: 31

Cause	Corrective action
Short circuit fault in the injector wiring for cylinder A5 or injector faulty.	1. Check wiring of affected injector (→ Page 209). 2. Replace injector (→ Page 148). 3. Contact Service.

326 – AL Wiring Cylinder A6

SPN: 520905 – FMI: 31

Cause	Corrective action
Short circuit fault in the injector wiring for cylinder A6 or injector faulty.	1. Check wiring of affected injector (→ Page 209). 2. Replace injector (→ Page 148). 3. Contact Service.

327 – AL Wiring Cylinder A7

SPN: 520906 – FMI: 31

Cause	Corrective action
Short circuit fault in the injector wiring for cylinder A7 or injector faulty.	1. Check wiring of affected injector (→ Page 209). 2. Replace injector (→ Page 148). 3. Contact Service.

328 – AL Wiring Cylinder A8

SPN: 520907 – FMI: 31

Cause	Corrective action
Short circuit fault in the injector wiring for cylinder A8 or injector faulty.	1. Check wiring of affected injector (→ Page 209). 2. Replace injector (→ Page 148). 3. Contact Service.

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329 – AL Wiring Cylinder A9

SPN: 520908 – FMI: 31

Cause	Corrective action
Short circuit fault in the injector wiring for cylinder A9 or injector faulty.	1. Check wiring of affected injector (→ Page 209). 2. Replace injector (→ Page 148). 3. Contact Service.

330 – AL Wiring Cylinder A10

SPN: 520909 – FMI: 31

Cause	Corrective action
Short circuit fault in injector wiring cylinder A10 or injector faulty.	1. Check wiring of affected injector (→ Page 209). 2. Replace injector (→ Page 148). 3. Contact Service.

331 – AL Wiring Cylinder B1

SPN: 520910 – FMI: 31

Cause	Corrective action
Short circuit fault in injector wiring for cylinder B1 or injector faulty.	1. Check wiring of affected injector (→ Page 209). 2. Replace injector (→ Page 148). 3. Contact Service.

332 – AL Wiring Cylinder B2

SPN: 520911 – FMI: 31

Cause	Corrective action
Short circuit fault in injector wiring for cylinder B2 or injector faulty.	1. Check wiring of affected injector (→ Page 209). 2. Replace injector (→ Page 148). 3. Contact Service.

333 – AL Wiring Cylinder B3

SPN: 520912 – FMI: 31

Cause	Corrective action
Short circuit fault in injector wiring for cylinder B3 or injector faulty.	1. Check wiring of affected injector (→ Page 209). 2. Replace injector (→ Page 148). 3. Contact Service.

334 – AL Wiring Cylinder B4

SPN: 520913 – FMI: 31

Cause	Corrective action
Short circuit fault in injector wiring for cylinder B4 or injector faulty.	1. Check wiring of affected injector (→ Page 209). 2. Replace injector (→ Page 148). 3. Contact Service.

335 – AL Wiring Cylinder B5

SPN: 520914 – FMI: 31

Cause	Corrective action
Short circuit fault in injector wiring for cylinder B5 or injector defective.	1. Check wiring of affected injector (→ Page 209). 2. Replace injector (→ Page 148). 3. Contact Service.

336 – AL Wiring Cylinder B6

SPN: 520915 – FMI: 31

Cause	Corrective action
Short circuit fault in injector wiring for cylinder B6 or injector defective.	1. Check wiring of affected injector (→ Page 209). 2. Replace injector (→ Page 148). 3. Contact Service.

337 – AL Wiring Cylinder B7

SPN: 520916 – FMI: 31

Cause	Corrective action
Short circuit fault in injector wiring for cylinder B7 or injector defective.	1. Check wiring of affected injector (→ Page 209). 2. Replace injector (→ Page 148). 3. Contact Service.

338 – AL Wiring Cylinder B8

SPN: 520917 – FMI: 31

Cause	Corrective action
Short circuit fault in injector wiring for cylinder B8 or injector defective.	1. Check wiring of affected injector (→ Page 209). 2. Replace injector (→ Page 148). 3. Contact Service.

339 – AL Wiring Cylinder B9

SPN: 520918 – FMI: 31

Cause	Corrective action
Short circuit fault in injector wiring for cylinder B9 or injector faulty.	1. Check wiring of affected injector (→ Page 209). 2. Replace injector (→ Page 148). 3. Contact Service.

340 – AL Wiring Cylinder B10

SPN: 520919 – FMI: 31

Cause	Corrective action
Short circuit fault in the injector wiring for cylinder B10 or injector faulty.	1. Check wiring of affected injector (→ Page 209). 2. Replace injector (→ Page 148). 3. Contact Service.

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341 – AL Open Load Cylinder A1

SPN: 520930 – FMI: 31

Cause	Corrective action
Disruption fault in injector wiring to cylinder A1.	1. Check wiring of affected injector (→ Page 209). 2. Contact Service.

342 – AL Open Load Cylinder A2

SPN: 520931 – FMI: 31

Cause	Corrective action
Disruption fault in injector wiring cylinder A2.	1. Check wiring of affected injector (→ Page 209). 2. Contact Service.

343 – AL Open Load Cylinder A3

SPN: 520932 – FMI: 31

Cause	Corrective action
Disruption fault in injector wiring cylinder A3.	1. Check wiring of affected injector (→ Page 209). 2. Contact Service.

344 – AL Open Load Cylinder A4

SPN: 520933 – FMI: 31

Cause	Corrective action
Disruption fault in injector wiring cylinder A4.	1. Check wiring of affected injector (→ Page 209). 2. Contact Service.

345 – AL Open Load Cylinder A5

SPN: 520934 – FMI: 31

Cause	Corrective action
Disruption fault in injector wiring cylinder A5.	1. Check wiring of affected injector (→ Page 209). 2. Contact Service.

346 – AL Open Load Cylinder A6

SPN: 520935 – FMI: 31

Cause	Corrective action
Disruption fault in injector wiring cylinder A6.	1. Check wiring of affected injector (→ Page 209). 2. Contact Service.

347 – AL Open Load Cylinder A7

SPN: 520936 – FMI: 31

Cause	Corrective action
Open circuit fault in the injector wiring for cylinder A7.	1. Check wiring of affected injector (→ Page 209). 2. Contact Service.

348 – AL Open Load Cylinder A8

SPN: 520937 – FMI: 31

Cause	Corrective action
Open circuit fault in the injector wiring for cylinder A8.	1. Check wiring of affected injector (→ Page 209). 2. Contact Service.

349 – AL Open Load Cylinder A9

SPN: 520938 – FMI: 31

Cause	Corrective action
Open circuit fault in the injector wiring for cylinder A9.	1. Check wiring of affected injector (→ Page 209). 2. Contact Service.

350 – AL Open Load Cylinder A10

SPN: 520939 – FMI: 31

Cause	Corrective action
Open circuit fault in the injector wiring for cylinder A10.	1. Check wiring of affected injector (→ Page 209). 2. Contact Service.

351 – AL Open Load Cylinder B1

SPN: 520940 – FMI: 31

Cause	Corrective action
Disruption fault in injector wiring cylinder B1.	1. Check wiring of affected injector (→ Page 209). 2. Contact Service.

352 – AL Open Load Cylinder B2

SPN: 520941 – FMI: 31

Cause	Corrective action
Disruption fault in injector wiring cylinder B2.	1. Check wiring of affected injector (→ Page 209). 2. Contact Service.

353 – AL Open Load Cylinder B3

SPN: 520942 – FMI: 31

Cause	Corrective action
Disruption fault in injector wiring cylinder B3.	1. Check wiring of affected injector (→ Page 209). 2. Contact Service.

354 – AL Open Load Cylinder B4

SPN: 520943 – FMI: 31

Cause	Corrective action
Disruption fault in injector wiring cylinder B4.	1. Check wiring of affected injector (→ Page 209). 2. Contact Service.

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355 – AL Open Load Cylinder B5

SPN: 520944 – FMI: 31

Cause	Corrective action
Disruption fault in injector wiring cylinder B5.	1. Check wiring of affected injector (→ Page 209). 2. Contact Service.

356 – AL Open Load Cylinder B6

SPN: 520945 – FMI: 31

Cause	Corrective action
Disruption fault in injector wiring cylinder B6.	1. Check wiring of affected injector (→ Page 209). 2. Contact Service.

357 – AL Open Load Cylinder B7

SPN: 520946 – FMI: 31

Cause	Corrective action
Open circuit fault in the injector wiring for cylinder B7.	1. Check wiring of affected injector (→ Page 209). 2. Contact Service.

358 – AL Open Load Cylinder B8

SPN: 520947 – FMI: 31

Cause	Corrective action
Open circuit fault in the injector wiring for cylinder B8.	1. Check wiring of affected injector (→ Page 209). 2. Contact Service.

359 – AL Open Load Cylinder B9

SPN: 520948 – FMI: 31

Cause	Corrective action
Open circuit fault in the injector wiring for cylinder B9.	1. Check wiring of affected injector (→ Page 209). 2. Contact Service.

360 – AL Open Load Cylinder B10

SPN: 520949 – FMI: 31

Cause	Corrective action
Open circuit fault in the injector wiring for cylinder B10.	1. Check wiring of affected injector (→ Page 209). 2. Contact Service.

361 – AL Power Stage Low

SPN: 521020 – FMI: 31

Cause	Corrective action
The output stage voltage to control the injectors is too low.	1. Check power supply (plant-side). 2. Contact Service.

362 – AL Power Stage High

SPN: 521021 – FMI: 31

Cause	Corrective action
The output stage voltage to control the injectors is too high.	1. Check power supply (plant-side). 2. Contact Service.

363 – AL Stop Power Stage

SPN: 521022 – FMI: 31

Cause	Corrective action
The output stage voltage to control the injectors is too low. engine stop	1. Check power supply (plant-side). 2. Contact Service.

365 – AL Stop MV-Wiring Ground

SPN: 521023 – FMI: 31

Cause	Corrective action
Short circuit of injector positive connection to ground of one or more injectors. Short circuit of the injector negative connection or of one or more injectors to ground.	1. Check wiring (→ Page 209). 2. Restart engine. 3. Contact Service.

381 – AL Wiring TOP 1

SPN: 520952 – FMI: 31

Cause	Corrective action
Short circuit or wire break on transistor output 1, plant-side (TOP 1).	1. Check wiring (→ Page 209). 2. Contact Service.

382 – AL Wiring TOP 2

SPN: 520953 – FMI: 31

Cause	Corrective action
Short circuit or wire break on transistor output 2, plant-side (TOP 2).	1. Check wiring (→ Page 209). 2. Contact Service.

383 – AL Wiring TOP 3

SPN: 520954 – FMI: 31

Cause	Corrective action
Short circuit or wire break on transistor output 3, plant-side (TOP 3).	1. Check wiring (→ Page 209). 2. Contact Service.

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384 – AL Wiring TOP 4

SPN: 520955 – FMI: 31

Cause	Corrective action
Short circuit or wire break on transistor output 4, plant-side (TOP 4).	1. Check wiring (→ Page 209). 2. Contact Service.

408 – AL Open Load Emerg. Stop Input ESI

SPN: 521024 – FMI: 31

Cause	Corrective action
Open load detected at the emergency stop input.	1. Check wiring (→ Page 209). 2. Contact Service.

410 – LO U-PDU

SPN: 520982 – FMI: 17

Cause	Corrective action
The ECU voltage to control the injectors has violated limit value 1.	1. Check power supply (plant-side). 2. Check wiring (→ Page 209). 3. Contact Service.

411 – LOLO U-PDU

SPN: 520982 – FMI: 1

Cause	Corrective action
The ECU voltage to control the injectors has violated limit value 2.	1. Check power supply (plant-side). 2. Check wiring (→ Page 209). 3. Contact Service.

412 – HI U-PDU

SPN: 520982 – FMI: 15

Cause	Corrective action
The ECU voltage to control the injectors has violated limit value 1.	1. Check power supply (plant-side). 2. Check wiring (→ Page 209). 3. Contact Service.

413 – HIHI U-PDU

SPN: 520982 – FMI: 0

Cause	Corrective action
The ECU voltage to control the injectors has violated limit value 2.	1. Check power supply (plant-side). 2. Check wiring (→ Page 209). 3. Contact Service.

444 – SD U-PDU

SPN: 520982 – FMI: 11

Cause	Corrective action
Fault in internal supply voltage of injector end stage.	► Contact Service.

445 – SD P-Ambient Air

SPN: 521060 – FMI: 11

Cause	Corrective action
The signal from the ambient pressure sensor in the ECU is faulty or missing.	► Contact Service.

448 – HI P-Charge Air

SPN: 3563 – FMI: 15

Cause	Corrective action
The charge-air pressure at sensor B10 has violated limit value 1. Charge-air pressure is too high.	<ol style="list-style-type: none">1. Power reduction.2. Check sensor B10, replace as necessary.3. Contact Service.

449 – SS P-Charge Air

SPN: 3563 – FMI: 0

Cause	Corrective action
The charge-air pressure at sensor B10 has violated limit value 2. Charge-air pressure is too high.	<ol style="list-style-type: none">1. Power reduction.2. Check sensor B10, replace as necessary.3. Contact Service.

454 – SS Power Reduction Active

SPN: 521026 – FMI: 31

Cause	Corrective action
Power reduction activated. A main alarm that has occurred activates the power reduction.	<ol style="list-style-type: none">1. Check additional messages.2. Contact Service.

462 – HI T-Coolant EMU

SPN: 521099 – FMI: 15

Cause	Corrective action
The engine coolant temperature monitored by the EMU has violated the temperature limit value at sensor B6.2. The coolant temperature is high.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 209).2. Check sensor B6.2, replace as necessary.3. Contact Service.

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470 – SD T-ECU

SPN: 1136 – FMI: 11

Cause	Corrective action
The signal from the temperature sensor in the ECU is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

472 – AL Stop SD

SPN: 521027 – FMI: 31

Cause	Corrective action
This fault is output if one or more sensors which have been configured to initiate an engine stop are faulty.	1. Check engine wiring (→ Page 209). 2. Contact Service.

474 – AL Wiring FO

SPN: 521028 – FMI: 31

Cause	Corrective action
Short circuit or wire break at the frequency output.	1. Check engine wiring (→ Page 209). 2. Contact Service.

475 – AL CR Trigger Engine Stop

SPN: 521223 – FMI: 31

Cause	Corrective action
The Crash Recorder is tripped by an engine shutdown.	► No action required.

476 – AL Crash Rec. Init. Error

SPN: 520990 – FMI: 31

Cause	Corrective action
The Crash Recorder data module was detected as being faulty after reading out the flash memory.	1. Check engine wiring (→ Page 209). 2. Contact Service.

478 – AL Comb. Alarm Yel (Plant)

SPN: 624 – FMI: 31

Cause	Corrective action
This alarm is raised when a plant device on the PCS5-CAN signals the ECU to set a yellow summary alarm.	1. Check additional messages. 2. Contact Service.

479 – AL Comb. Alarm Red (Plant)

SPN: 623 – FMI: 31

Cause	Corrective action
This alarm is raised when a plant device on the PCS5-CAN signals the ECU to set a red summary alarm.	<ol style="list-style-type: none">1. Check additional messages.2. Contact Service.

480 – AL Ext. Engine Protection

SPN: 521029 – FMI: 31

Cause	Corrective action
External engine protection function is active.	<ol style="list-style-type: none">1. Check plant signal.2. Contact Service.

510 – AL Override applied

SPN: 1237 – FMI: 31

Cause	Corrective action
The override function has been activated. Override suppresses other alarms.	► No action required.

536 – AL Wiring PWM_CM1

SPN: 520970 – FMI: 31

Cause	Corrective action
HP fuel control block M8 of the HP fuel pump cannot be activated.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 209).2. Contact Service.

549 – AL Power Cut-Off detected

SPN: 521031 – FMI: 31

Cause	Corrective action
ECU operating voltage was switched off while the engine was running. Do not disconnect the power supply until the engine is at standstill.	<ol style="list-style-type: none">1. Check engine wiring if the power supply was not disconnected manually (→ Page 209).2. Contact Service.

551 – SS Engine Overspeed Camshaft

SPN: 520257 – FMI: 0

Cause	Corrective action
The engine speed measured at camshaft sensor B1 has violated limit value 2 or the engine overspeed test was tripped. An emergency engine shutdown has been initiated.	► Contact Service.

TIM-ID: 0000074920 - 002

581 – AL Wiring PWM_CM3

SPN: 520972 – FMI: 31

Cause	Corrective action
Pressure regulating valve Y45 in the HP fuel system cannot be activated.	1. Check engine wiring (→ Page 209). 2. Contact Service.

582 – AL Emergency Stop Failed

SPN: 521061 – FMI: 31

Cause	Corrective action
This alarm is raised if the engine fails to come to a standstill within a defined time following an emergency stop signal.	► Contact Service.

586 – LO P-Oil Refill Pump

SPN: 521119 – FMI: 17

Cause	Corrective action
The refill pump lube oil pressure measured at sensor B54 has violated the limit value. The oil pressure at the refill pump is too low.	1. Top up engine oil (→ Page 178). 2. Contact Service.

588 – SD P-Oil Refill Pump

SPN: 521119 – FMI: 11

Cause	Corrective action
The signal from the refill pump lube oil pressure sensor (B54) is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

596 – AL Develop PR Set

SPN: 520804 – FMI: 31

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

597 – AL Wiring PWM_CM5

SPN: 520974 – FMI: 31

Cause	Corrective action
Disruption or short circuit in the wiring to the electronic control unit M61 for the actuator cylinder for pre-opening the exhaust flap (12V only).	1. Check engine wiring (→ Page 209). 2. Contact Service.

606 – AL Double Nodes Lost CAN 1 + 2

SPN: 521039 – FMI: 31

Cause	Corrective action
Unable to detect one of the connected and monitored CAN bus devices on CAN bus 1 and CAN bus 2.	1. Check engine wiring (→ Page 209). 2. Contact Service.

608 – AL Wiring PWM_CM6

SPN: 520975 – FMI: 31

Cause	Corrective action
Valve Y35 to cut raw water into second stage charge-air cooling (TB) cannot be activated.	1. Check engine wiring (→ Page 209). 2. Contact Service.

609 – AL Wiring PWM_CM7

SPN: 520976 – FMI: 31

Cause	Corrective action
Valve Y56 for air recirculation (10V), or relief charge-air pressure (16V) cannot be activated.	1. Check engine wiring (→ Page 209). 2. Contact Service.

615 – AL EIL Protection

SPN: 521040 – FMI: 31

Cause	Corrective action
The engine number in EIL (A19) does not match engine number stored in ECU	1. Check engine wiring (→ Page 209). 2. Contact Service.

616 – AL EIL Error

SPN: 521041 – FMI: 31

Cause	Corrective action
ECU can not detect EIL (A19).	► Contact Service.

TIM-ID: 0000074920 - 002

626 – AL Wiring PWM_CM8

SPN: 520977 – FMI: 31

Cause	Corrective action
Disruption or short circuit in wiring to pressure regulating valve M52 for wastegate control.	1. Check engine wiring (→ Page 209). 2. Contact Service.

627 – AL Wiring PWM_CM9

SPN: 520978 – FMI: 31

Cause	Corrective action
Solenoid valve Y27.1 to cut-in the A side exhaust turbocharger cannot be activated.	1. Check engine wiring (→ Page 209). 2. Contact Service.

628 – AL Wiring PWM_CM10

SPN: 520979 – FMI: 31

Cause	Corrective action
Solenoid valve Y27.2 to cut in the B side exhaust turbocharger cannot be activated.	1. Check engine wiring (→ Page 209). 2. Contact Service.

782 – SD-P-Lubeoil ETC A

SPN: 104 – FMI: 11

Cause	Corrective action
The signal from the lube oil pressure sensor (B5.8) before exhaust turbocharger A side is faulty or missing.	1. Check engine wiring (→ Page 209). 2. Contact Service.

832 – AL EIL Different Engine Number

SPN: 521151 – FMI: 31

Cause	Corrective action
The engine number in EIL (A19) does not match engine number stored in ECU.	1. Check engine wiring (→ Page 209). 2. Contact Service.

836 – AL Speed Demand Failure

SPN: 520875 – FMI: 31

Cause	Corrective action
The ECU is unable to receive a speed demand signal via the CAN bus. Alarm 266 is signaled simultaneously.	1. Switch on plant automation. 2. Contact Service.

851 – AL External Start and HD too high

SPN: 521155 – FMI: 31

Cause	Corrective action
The pressure measured at sensor B48 was too high prior to starter engagement after initiating engine start.	► Contact Service.

852 – AL Max. Blank Shot time expired

SPN: 521156 – FMI: 31

Cause	Corrective action
The alarm is generated with the engine stationary if the pressure in the HP accumulator could not be released within the specified time.	► Contact Service.

867 – AL L1 P-Lubeoil ETC A

SPN: 104 – FMI: 17

Cause	Corrective action
The lube oil pressure before exhaust turbocharger A side measured at sensor B5.8 has undershot limit value 1. The lube oil pressure is too low.	<ol style="list-style-type: none">1. Reduce power.2. Check engine oil level (→ Page 177).3. Contact Service.

868 – AL L2 P-Lubeoil ETC A

SPN: 104 – FMI: 1

Cause	Corrective action
The lube oil pressure before exhaust turbocharger A side measured at sensor B5.8 has undershot limit value 2. The lube oil pressure is too low.	<ol style="list-style-type: none">1. Reduce power.2. Check engine oil level (→ Page 177).3. Contact Service.

947 – AL Invalid LSI Channel Config

SPN: 521207 – FMI: 31

Cause	Corrective action
Incorrect LSI channel configuration.	► Contact Service.

TIM-ID: 0000074920 - 002

948 – AL ESI activated

SPN: 521275 – FMI: 31

Cause	Corrective action
The emergency stop was activated externally.	► Check emergency chain.

956 – AL p5 ctrlvar limit min active

SPN: 521073 – FMI: 31

Cause	Corrective action
The charge-air pressure controller is attempting to adjust its setpoint value, but has reached its lower limit. Pressure regulating valve M52 for wastegate control is fully open.	1. Check operation of pressure regulating valve. 2. Contact Service.

973 – AL Check Sum IIG

SPN: 521351 – FMI: 31

Cause	Corrective action
The IIG value entered does not match the defined input format.	1. Check the IIG input in DiaSys, repeat as necessary. 2. Contact Service.

983 – AL Stop on Trigger Crashrecorder

SPN: 521437 – FMI: 31

Cause	Corrective action
This alarm indicates that the Crash Recorder has been tripped and a start interlock activated as a result.	► Contact Service.

1126 – AL L1 PCV Defect

SPN: 521386 – FMI: 15

Cause	Corrective action
The pressure regulating valve of the HP fuel system has violated the opening time (limit value 1) or the number of opening cycles has violated the limit value.	► Contact Service.

1127 – AL L2 PCV Defect

SPN: 521386 – FMI: 0

Cause	Corrective action
The pressure regulating valve of the HP fuel system has violated the opening time (limit value 2) or the number of opening cycles has violated the limit value.	► Contact Service.

1130 – AL Short Circuit Analog Out 1

SPN: 521388 – FMI: 6

Cause	Corrective action
Incorrect plant value at analog output 1 (e.g. moving-coil instrument, output signal for HT circuit fan control)	► Contact Service.

1131 – AL Short Circuit Analog Out 2

SPN: 521389 – FMI: 6

Cause	Corrective action
Incorrect plant value at analog output 2 (e.g. moving-coil instrument, output signal for LT circuit fan control)	► Contact Service.

1170 – AL Permanent Injection

SPN: 521461 – FMI: 31

Cause	Corrective action
The ECU has detected continuous injection at one or more injectors based on the pressure gradient in the HP fuel system (B48).	► Contact Service.

1370 – SD P-HD Constant Value

SPN: 157 – FMI: 31

Cause	Corrective action
The ECU has not detected any variation in pressure at HP fuel sensor B48. HP fuel sensor B48 is faulty.	► Contact Service.

TIM-ID: 0000074920 - 002

1442 – AL Emergency Stop Active

SPN: 520826 – FMI: 31

Cause	Corrective action
The engine was shut down by an emergency stop	► Contact Service.

1544 – AL Blow Over Temperature Error

SPN: 520331 – FMI: 31

Cause	Corrective action
The temperature and/or temperature gradient measured at temperature sensor B49 before the air recirculation valve is too high. The air recirculation valve is not opened.	1. Check sensor B49, replace as necessary. 2. Contact Service.

1773 – AL Security Mode PCV Open

SPN: 521953 – FMI: 31

Cause	Corrective action
This alarm is tripped when the pressure regulating valve of the first rail has fully opened.	► Contact Service.

8.2 Troubleshooting

Engine does not turn when starter is actuated

Cause	Corrective action
Battery flat or faulty.	► Charge or replace (see manufacturer's documentation).
Cable connections on battery are faulty.	► Check cable connections for secure seating (see manufacturer's documentation).
Engine wiring or starter faulty.	► Check cable connections for secure seating, contact Service.
Engine wiring is faulty.	► Check (→ Page 209).
Plug connections are loose at interface module EIM or the EIM is faulty.	1. Check plug connections (→ Page 216). 2. Check DiLa flash code.

Crankshaft rotates during starting but engine does not fire (Note: Ignition only takes place from 300 bar rail pressure)

Cause	Corrective action
Poor turning on starter: Battery flat or faulty.	► Charge or replace battery (see manufacturer's documentation).
Engine wiring is faulty.	► Check (→ Page 209).
Air in fuel system	► Vent fuel system (→ Page 154).
Engine Control Unit ECU is faulty.	► Contact Service.
Fuel supply blocked.	► Open shut-off valve.
HP fuel control block faulty.	► Contact Service.
LP pump faulty.	► Contact Service.
HP pump faulty.	► Contact Service.

Engine fires unevenly

Cause	Corrective action
Injector faulty.	► Replace (→ Page 148).
HP pump is faulty.	► Contact Service.
Engine wiring is faulty.	► Check (→ Page 209).
Air in fuel system	► Vent fuel system (→ Page 154).
Engine Control Unit ECU is faulty.	► Contact Service.

Engine does not reach rated speed

Cause	Corrective action
Fuel supply blocked.	► Completely open shut-off valve before fuel prefilter.
Fuel prefilter contaminated.	► Replace filter element (→ Page 169).
Easy-change fuel filter is contaminated.	► Replace (→ Page 157).
Air filter is contaminated.	► Check signal ring position of contamination indicator (→ Page 176).
Injector faulty.	► Replace (→ Page 148).
HP pump is faulty.	► Contact Service.
Engine wiring is faulty.	► Check (→ Page 209).
Overload.	► Contact Service.

Engine speed is not steady

Cause	Corrective action
Injector faulty	► Replace (→ Page 148).
HP pump faulty	► Contact Service.
Speed sensor is faulty.	► Contact Service.
Air in fuel system	► Vent fuel system (→ Page 154).
Engine Control Unit ECU is faulty.	► Contact Service.
Gearbox/propeller/drive shaft faulty.	► Contact Service.
Engine overloaded.	► Contact Service.

Charge-air temperature is too high

Cause	Corrective action
Engine coolant concentration incorrect	► Check (MTU test kit).
Intercooler is contaminated.	► Contact Service.
Air inlet temperature in engine room is too high.	► Check fan; check air supply / exhaust ducts.
Coolant level too low.	►
Seawater temperature too high.	► Contact Service.
Seawater flow rate too low / valve to intercooler not fully opened.	► Contact Service.

Charge-air pressure is too low

Cause	Corrective action
Air filter is contaminated.	1. Check signal ring position of contamination indicator (→ Page 176). 2. Replace air filter (→ Page 174).
Intercooler (EC or FW circuit) is dirty.	► Contact Service.
Exhaust turbocharger is faulty.	► Contact Service.
Wastegate / wastegate control faulty.	► Contact Service.

Coolant discharge at intercooler

Cause	Corrective action
Major coolant discharge at drain valve of intercooler. Intercooler is leaking.	► Contact Service.

Seawater outlet at intercooler

Cause	Corrective action
Major coolant discharge at drain valve of intercooler. Intercooler is leaking.	► Contact Service.

Black exhaust gas

Cause	Corrective action
Air filter is contaminated.	1. Check signal ring position of contamination indicator (→ Page 176). 2. Replace air filter (→ Page 174).
Injector faulty.	► Replace (→ Page 148).
HP pump is faulty.	► Contact Service.
Lack of air or incorrect quality/quantity of fuel injected.	► Contact Service.
Fuel quality is not correct (fuel sample required).	►

Blue exhaust gas

Cause	Corrective action
Too much engine oil in engine	► Drain engine oil (→ Page 178).
Exhaust turbocharger is faulty.	► Contact Service.
Cylinder head is faulty.	► Contact Service.
Piston rings are faulty.	► Contact Service.
Cylinder liner is faulty.	► Contact Service.
Oil in combustion chamber or exhaust pipe.	► Contact Service.

White exhaust gas

Cause	Corrective action
Engine is not at operating temperature.	► Run engine to reach operating temperature.
Water in fuel	► Check fuel system at fuel prefilter. Drain water from fuel prefilter (→ Page 162).
Intercooler is leaking.	► Contact Service.

TIM-ID: 000005288 - 006

9 Task Description

9.1 SOLAS

9.1.1 SOLAS shielding as per MTN 5233 – Installation

Preconditions

- ☒ Engine is stopped and starting disabled

Special tools, Material, Spare parts

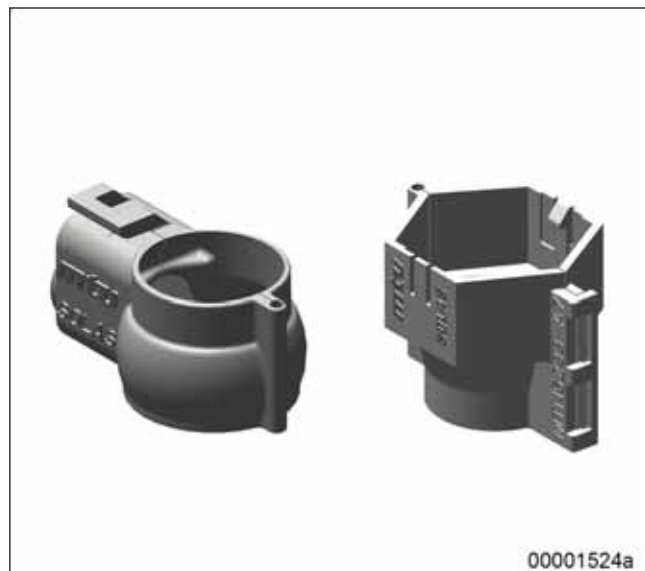
Designation / Use	Part No.	Qty.
Shield A4 / 12V	735233000100	13
Shield A4 / 16V	735233000100	14
Shield A5 / 12V	735233000101	34
Shield A5 / 16V	735233000101	37
Shield A6	735233000102	1
Shield A7	735233000103	8
Shield B2	735233000200	2

Installing SOLAS shielding

Important

The engine is only SOLAS-compliant when the parts have been reassembled.

1. Pinpoint installation location (→ Page 124).
2. Install suitable shielding.
3. Press shielding until locked.



9.1.2 SOLAS shielding – Installation of exhaust insulation

Preconditions

- ☒ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
HT insulating molding for exhaust pipe bellows	(→ Spare Parts Catalog)	
HT insulating molding for exhaust elbow	(→ Spare Parts Catalog)	

Installing exhaust insulation for SOLAS

Important

The engine is only SOLAS-compliant when the parts have been reassembled.



1. Pinpoint installation location (→ Page 124).
2. Install suitable shielding.
3. Secure shielding with Velcro® fastener or tension springs.



TIM-ID: 00000093570 - 001

9.1.3 SOLAS shielding, oil filter – Installation

Preconditions

- ☒ Engine is stopped and starting disabled
- ☒ Engine is cooled down to ambient temperature

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Oil filter shield	X00009628	2

Installing SOLAS shielding for oil filter

Important

The engine is only SOLAS-compliant when the parts have been reassembled.

1. Pinpoint installation location (→ Page 124).
2. Install suitable cover.

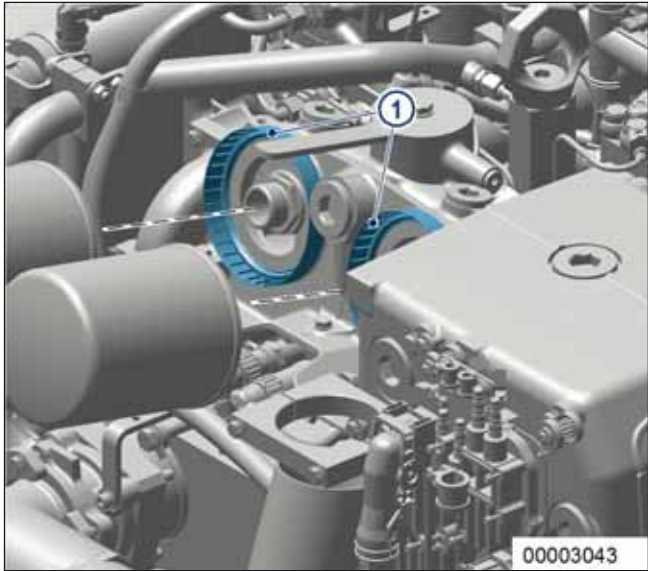


9.1.4 SOLAS shielding – Installation locations

General

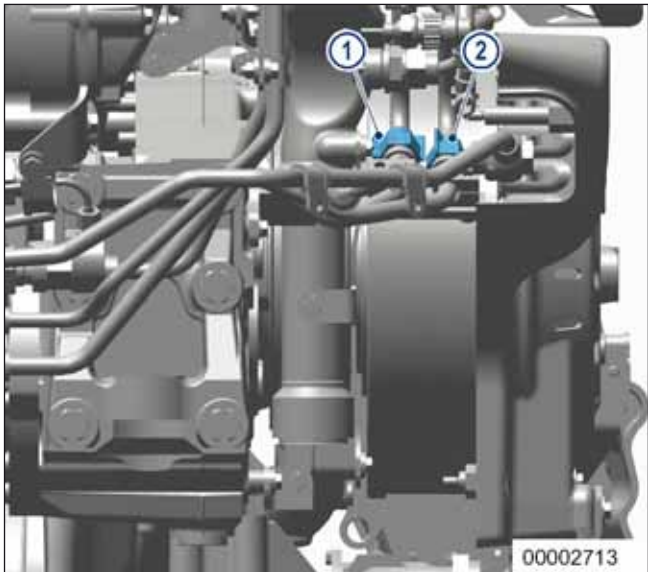
Install SOLAS shielding as per MTN 5233 as a matter of priority (→ Page 121).

Cover on lube oil filter



Item	Type of shielding	Comments
1	Cover	Cover on lube oil filter

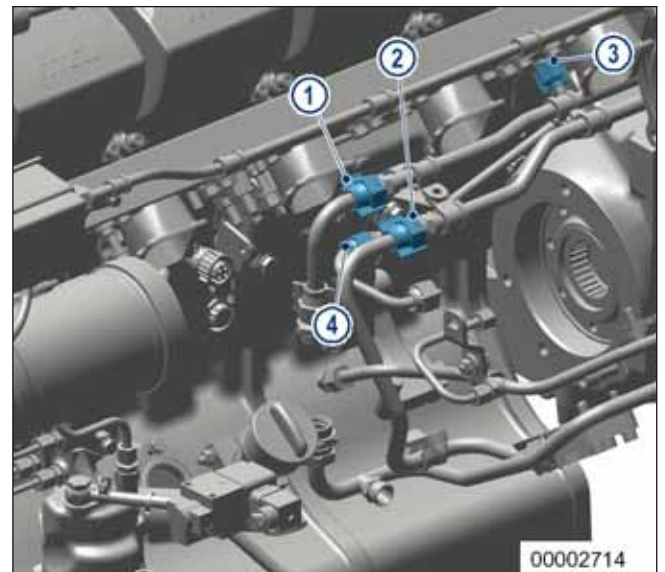
Free end, B side



Item	Type of shielding	Comments
1	Shield (A7)	For fuel priming pump
2	Shield (A7)	For HP fuel pump

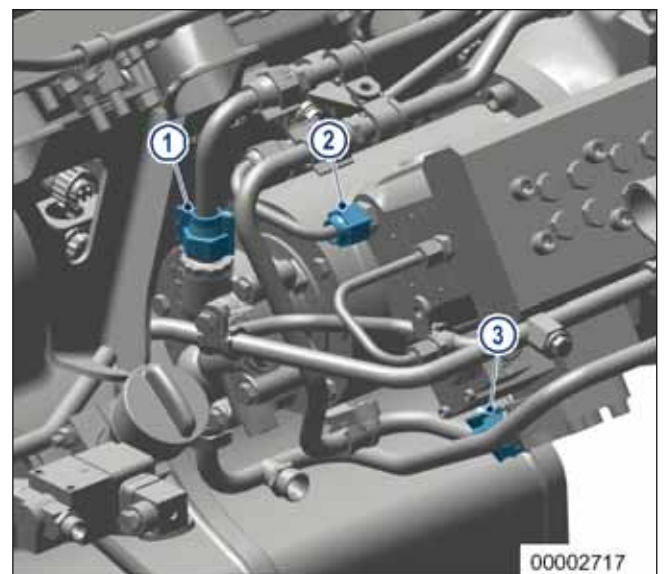
Table 13: SOLAS, free end, B side

TIM-ID: 0000064358 - 003



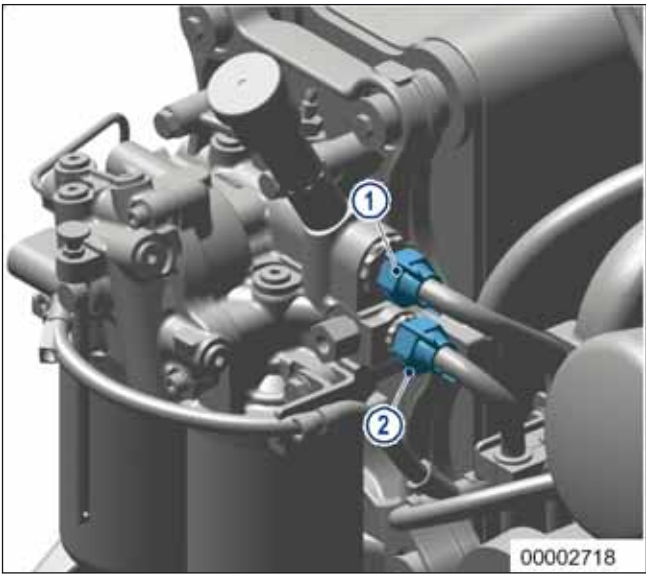
Item	Type of shielding	Comments
1	Shield (A7)	For fuel priming pump
2	Shield (A7)	For HP fuel pump
3	Shield (A5)	Oil line for HP fuel pump
4	Shield (A5)	Oil line for HP fuel pump

Table 14: SOLAS, free end, B side



Item	Type of shielding	Comments
1	Shield (A7)	HP fuel pump outlet
2	Shield (A6)	Lubrication of HP fuel pump
3	Shield (A7)	HP fuel pump supply line

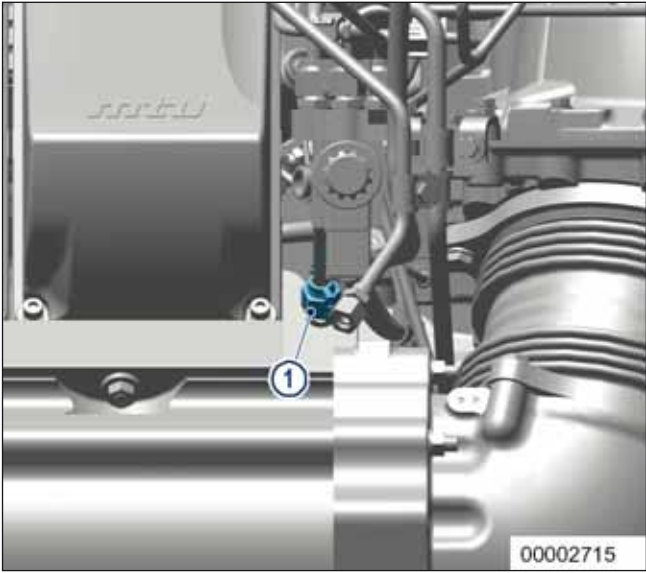
Table 15: SOLAS, free end, B side



Item	Type of shielding	Comments
1	Shield (A7)	Fuel priming pump supply line
2	Shield (A7)	Fuel priming pump return line

Table 16: SOLAS, free end, B side

A side

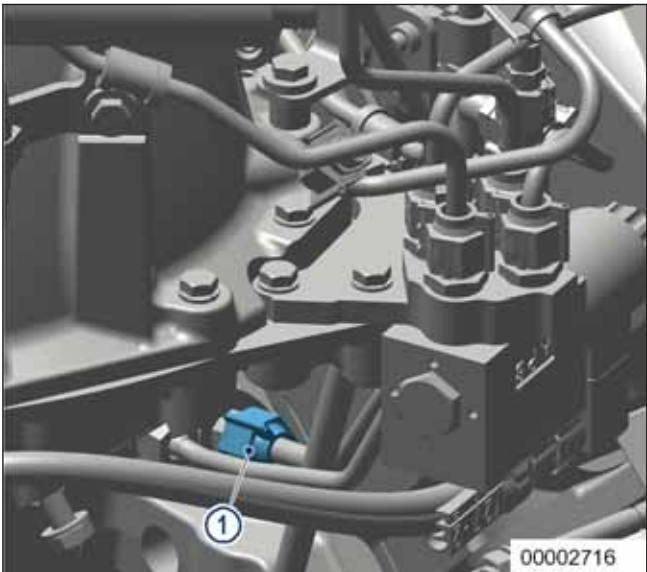


Item	Type of shielding	Comments
1	Shield (A5)	Oil sampling point on crankcase

Table 17: SOLAS, A side

TIM-ID: 0000064358 - 003

B side



Item	Type of shielding	Comments
1	Shield (A5)	Oil sampling point on crankcase

Table 18: SOLAS, B side

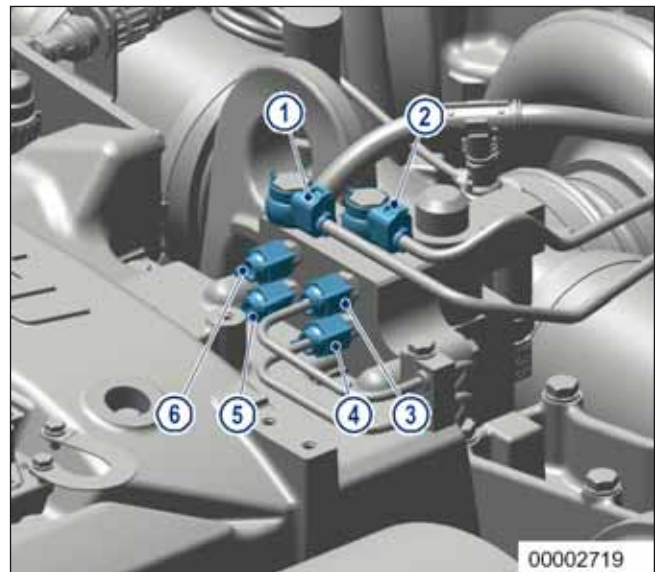
Driving end, A and B sides



Item	Type of shielding	Comments
1	Shield (A5)	On flywheel housing

Table 19: SOLAS, A side

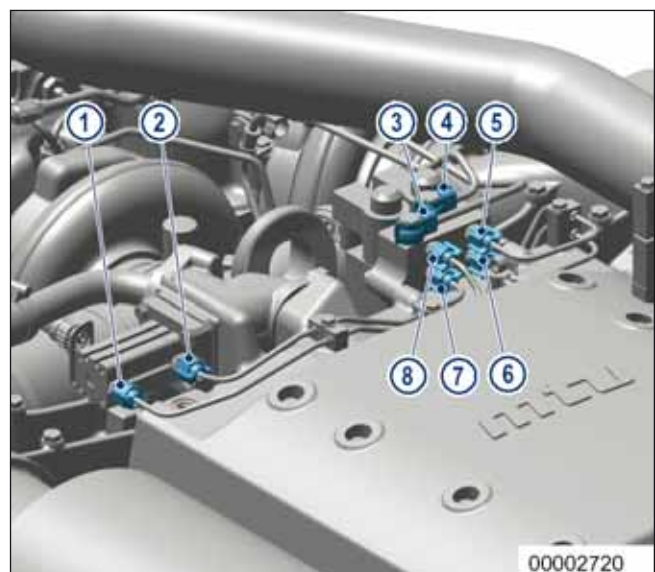
Area of valve block 12V (without bleeder valve)



Item	Type of shielding	Comments
1	Shield (B2)	Oil return line from valve
2	Shield (B2)	Oil supply line
3	Shield (A4)	Oil supply to seawater valve, cylinder
4	Shield (A4)	Oil supply to seawater valve, cylinder
5	Shield (A4)	Remove shield from bleeder valve
6	Shield (A4)	Remove shield from bleeder valve

Table 20: SOLAS, area of valve block 12V (without bleeder valve)

Area of bleeder valve 16V

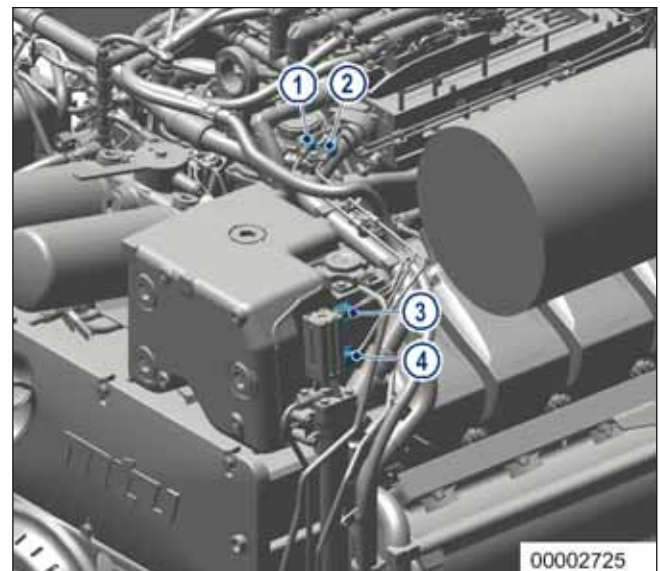


TIM-ID: 00000064 358 - 003

Item	Type of shielding	Comments
1	Shield (A5)	Connection on bleeder valve
2	Shield (A5)	Connection on bleeder valve
3	Shield (B2)	Oil return line from valve
4	Shield (B2)	Oil supply line
5	Shield (A4)	Oil supply to seawater valve, cylinder
6	Shield (A4)	Oil supply to seawater valve, cylinder
7	Shield (A4)	Connection to bleeder valve
8	Shield (A4)	Connection to bleeder valve

Table 21: SOLAS, area of bleeder valve 16V

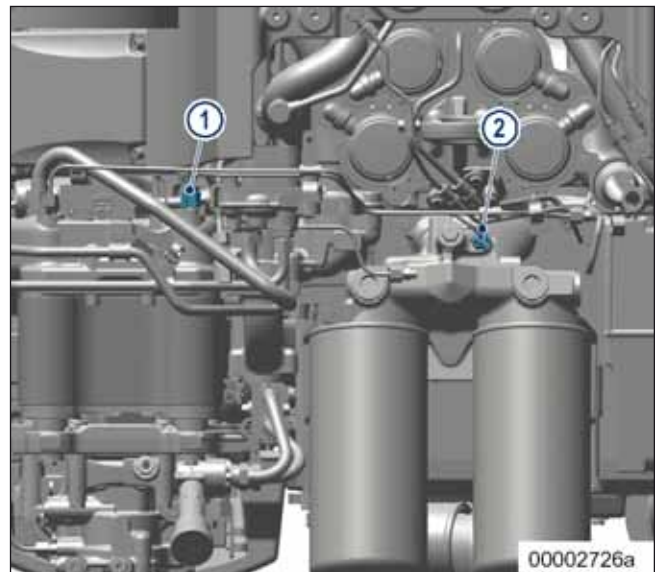
Free end, A side



Item	Type of shielding	Comments
1	Shield (A4)	Oil supply to cylinder, seawater shutoff valve
2	Shield (A4)	Oil supply to cylinder, seawater shutoff valve
3	Shield (A5)	Oil supply to cylinder, seawater shutoff valve
4	Shield (A5)	Oil supply to cylinder, seawater shutoff valve

Table 22: SOLAS, free end, A side

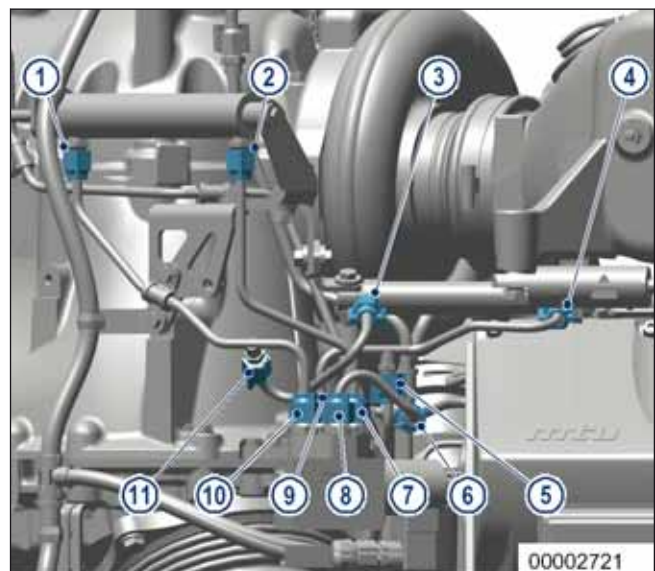
Area of coolant distribution housing



Item	Type of shielding	Comments
1	Shield (A4)	From coolant distribution housing
2	Shield (A4)	In oil filter

Table 23: SOLAS, area of coolant distribution housing

Area of hydraulic cylinder, B side



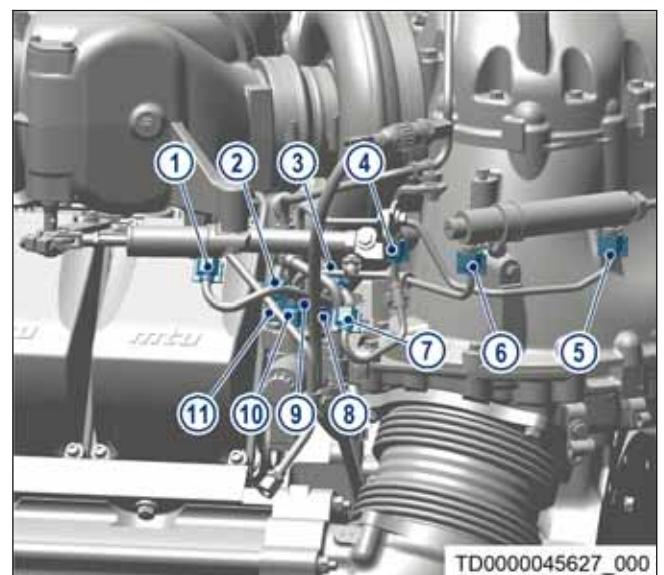
Item	Type of shielding	Comments
1	Shield (A5)	Exhaust turbocharger flaps
2	Shield (A5)	Exhaust turbocharger flaps
3	Shield (A5)	Oil supply for air flap
4	Shield (A5)	Oil supply for air flap
5	Shield (A4)	Oil supply for air flap

TIM-ID: 00000064358 - 003

Item	Type of shielding	Comments
6	Shield (A5)	Oil supply for exhaust turbocharger
7	Shield (A5)	On valve plate
8	Shield (A5)	On valve plate
9	Shield (A5)	On valve plate
10	Shield (A5)	On valve plate
11	Shield (A4)	On brazed-on union

Table 24: SOLAS, area of hydraulic cylinder, B side

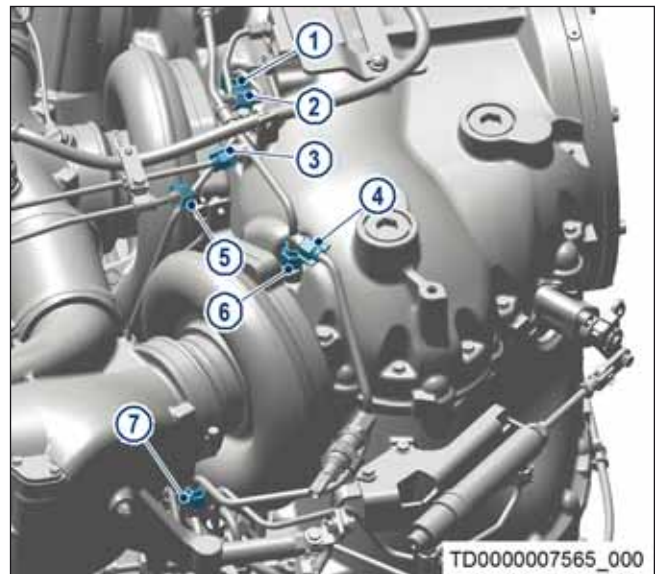
Area of hydraulic cylinder, A side 12V



Item	Type of shielding	Comments
1	Shield (A5)	Oil supply for air flap
2	Shield (A4)	Oil return line in crankcase
3	Shield (A4) 12V Shield (A5) 16V	Oil return line in crankcase
4	Shield (A4)	Oil supply for air flap
5	Shield (A5)	Exhaust turbocharger flaps
6	Shield (A5)	Exhaust turbocharger flaps
7	Shield (A5)	Oil supply for air flap
8	Shield (A5)	On valve plate
9	Shield (A5)	On valve plate
10	Shield (A5)	On valve plate
11	Shield (A5)	On valve plate

Table 25: SOLAS, area of hydraulic cylinder, A side

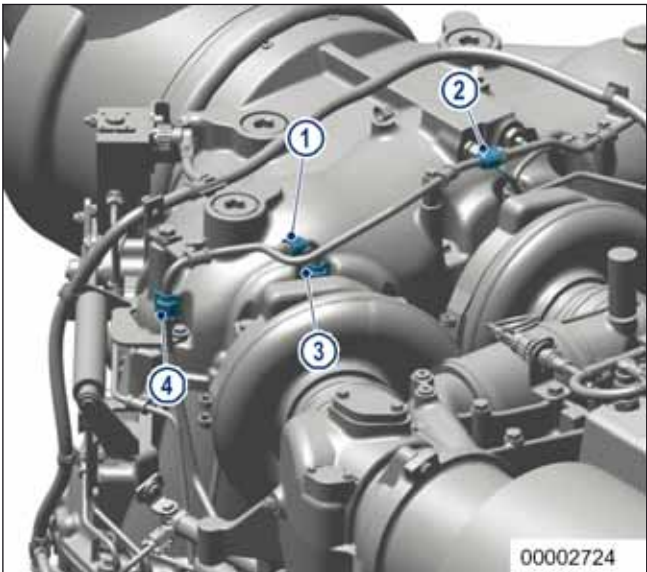
Area above carrier housing, A side



Item	Type of shielding	Comments
1	Shield (A5)	Exhaust turbocharger lubrication, center
2	Shield (A4)	Exhaust turbocharger lubrication, center
3	Shield (A5)	Oil supply for actuating cylinder
4	Shield (A5)	Exhaust turbocharger lubrication, left
5	Shield (A5)	Exhaust flap
6	Shield (A5)	Exhaust turbocharger lubrication, left
7	Shield (A5)	Oil supply for exhaust turbocharger

Table 26: SOLAS, area above carrier housing, A side

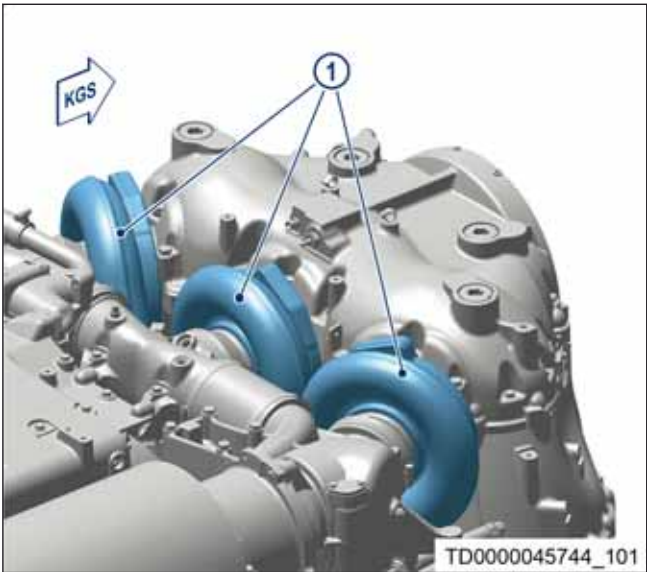
Area above carrier housing, B side



Item	Type of shielding	Comments
1	Shield (A4)	Exhaust turbocharger lubrication, right
2	Shield (A5)	Oil supply
3	Shield (A5)	Exhaust turbocharger lubrication, right
4	Shield (A5)	Oil supply for exhaust turbocharger

Table 27: SOLAS, area above carrier housing, B side

SOLAS, compressor housing



Item	Type of shielding	Comments
1	Silicone insulation	For compressor housing

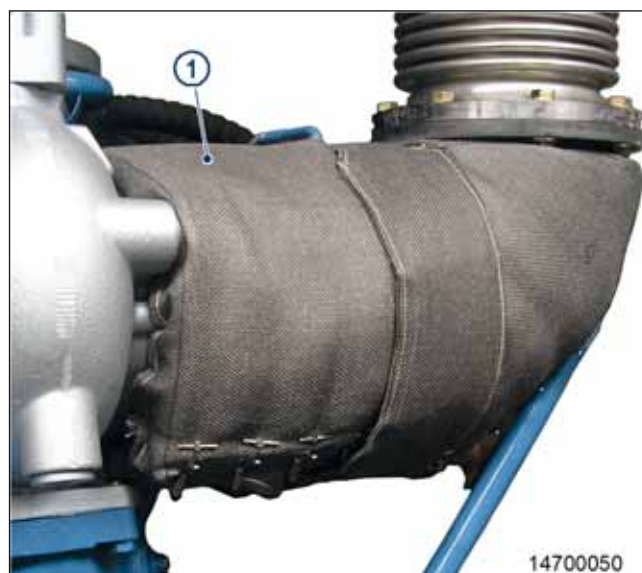
Table 28: SOLAS, exhaust gas turbocharger area

SOLAS – Exhaust insulation



Item	Type of shielding	Comments
1	HT insulating molding	For exhaust pipe bellows

Table 29: SOLAS, exhaust insulation for exhaust pipe bellows



Item	Type of shielding	Comments
1	HT insulating molding	For exhaust elbow

Table 30: SOLAS, exhaust insulation for exhaust elbow

9.2 Engine

9.2.1 Engine - Cranking manually

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Barring tool	F6783914	1
Ratchet bit with extension	F30006212	1
Cranking flange	(→ Spare Parts Catalog)	

DANGER



Rotating and moving engine parts.

Risk of crushing, danger of parts of the body being caught or pulled in!

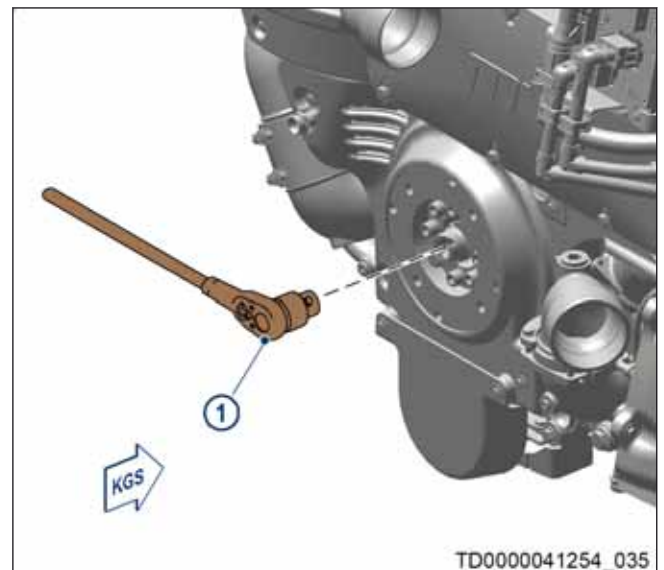
- Before barring the engine, make sure that there are no persons in the engine's danger zone.
- After finishing work on the engine, make sure that all safety devices are put back in place and all tools are removed from the engine.

Cranking engine manually

Note: The engine can be cranked without removing the protective cover.

1. Insert ratchet with barring tool (1) into barring flange on vibration damper (free end) (barring flange is preassembled on engine).
2. Crank crankshaft in engine direction of rotation. Apart from the normal compression resistance, there should be no resistance.

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



9.2.2 Engine - Barring with starting system

Preconditions

- ☑ Engine is disengaged.
- ☑ Engine is stopped and starting disabled.
- ☑ LOP is accessible and open.

DANGER



Rotating and moving engine parts.

Risk of crushing, danger of parts of the body being caught or pulled in!

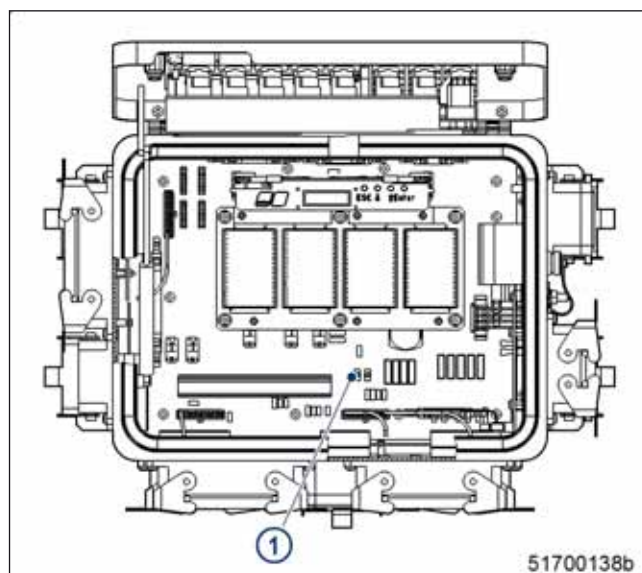
- Before barring the engine, make sure that there are no persons in the engine's danger zone.
- After finishing work on the engine, make sure that all safety devices are put back in place and all tools are removed from the engine.

Barring

1. Press and hold the "Turn" button on the LMB motherboard of the LOP.

Result: Engine is barred by starter for max. 20 seconds.

2. Release "Turn" button.



9.3 Cylinder Liner

9.3.1 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	Explanations/Action
Minor dirt scores	Minor dirt scores can occur during the assembly of a new engine (honing products, particles, broken-off burrs). Removed cylinders clearly show such scoring on the running surface under endoscope magnification. Cannot be felt with the fingernail. Findings not critical
Single scores	Clearly visible scores caused by hard particles. They usually start in the TDC area and cross through the honing 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
Polished area	Polished areas are on the running surface but almost the whole honing pattern is still visible. Polished areas appear brighter and more shiny 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 the 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 moisture (condensate) 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 preliminary stage of burn marks. They are visible as a clear discoloration from TDC to BDC in the running surface and the start of localized damage to the honing pattern. Cylinder liners with a large number of black lines around the running surface have limited service life and should be replaced.
Burn mark	These are caused by a disturbance in the liner / ring tribo system. 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 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.

Table 31: Endoscopic examination – Terms used

Evaluation of findings and further measures

The findings in the start phase of oxidation discoloration and burn marks 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.

9.3.2 Cylinder liner – Endoscopic examination

Preconditions

- ☑ Engine is stopped and starting disabled

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Endoscope	Y20097353	1

Preparatory steps

1. Remove cylinder head cover (→ Page 143).
2. Remove injector (→ Page 149).

Moving piston into BDC position

1. Crank engine manually until piston of cylinder to be checked is in BDC position.(→ Page 135)
2. Insert endoscope into cylinder liner / combustion chamber through injector seat.

Examining cylinder liners / combustion chamber with endoscope

Findings	Action
<ul style="list-style-type: none">• Thin carbon coating around carbon scraper ring• Slight localized additive deposits at top edge• Localized smooth areas at bottom edge• Carbon deposits on entire circumference 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• Faultless, even honing pattern• First signs of marks left by lower cooling bores• Running pattern seems darker	No actions required
<ul style="list-style-type: none">• Dark areas with even or varying degrees of discoloration• Beginning and end of the discoloration are not sharply defined and do not cover the entire stroke area• Discoloration in the upper section of the cooling bore, remaining circumference can not be faultless• Piston ring set faultless	Further endoscopic examination required as part of maintenance work
<ul style="list-style-type: none">• On the entire circumference, apart from light areas of discoloration (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 ring set	Cylinder liner must be replaced, contact Service.

1. Compile endoscopic report using the table.
2. Use technical terms to describe the liner surface (→ Page 137).
3. Depending on findings:
 - Do not take any action or
 - carry out a further endoscopic examination as part of maintenance work or
 - contact Service; Cylinder liner must be replaced.

Final steps

1. Install injector (→ Page 149).
2. Install cylinder head cover (→ Page 143).
3. Start engine.
4. Perform a leak test.

9.4 Crankcase Breather

9.4.1 Crankcase breather – Fine oil mist separator replacement

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine oil		
Fine oil mist separator	(→ Spare Parts Catalog)	
O-ring	(→ Spare Parts Catalog)	

WARNING



Oil is hot.

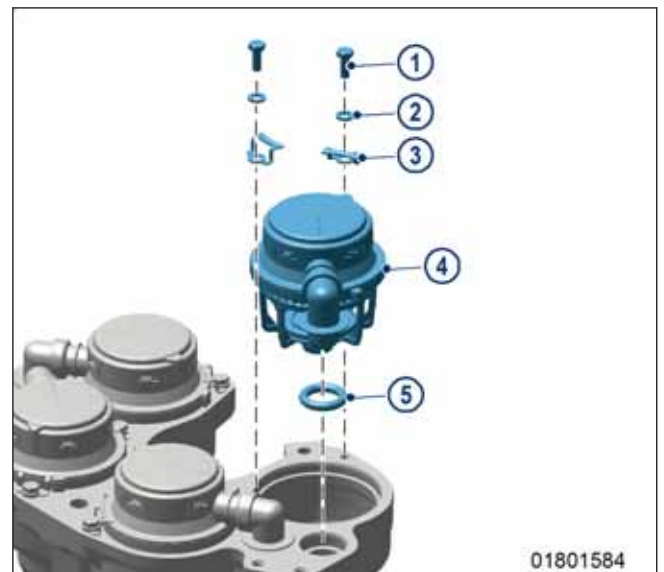
Oil can contain residue/substances which are harmful to health.

Risk of injury and poisoning!

- Allow the product to cool to below 50 °C before beginning work.
- Wear protective clothing, protective gloves and goggles/safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

Replacing fine oil mist separator

1. Remove screws (1) with washer (2) from impactor mount.
2. Remove both retainers (3).
3. Remove fine oil mist separator (4) from impactor carrier and replace.
4. Replace O-ring (5) as necessary.
5. Install new fine oil mist separator in impactor carrier in reverse order.
6. Replace other fine oil mist separators in the same way.



9.5 Belt Drive

9.5.1 Drive belt – Condition check

Preconditions

- ☑ Engine is stopped and starting disabled.

WARNING



Exposed rotating parts can eject drawn-in components or draw in body parts.

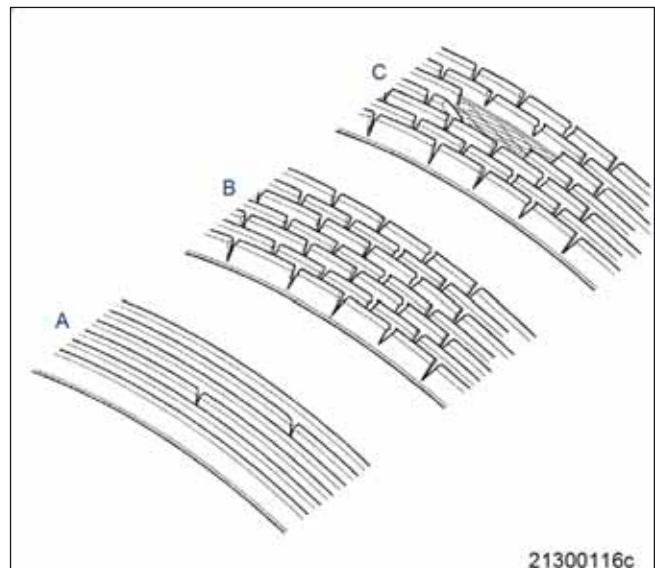
Risk of crushing, limbs or extremities may be pinched, trapped or entangled!

Risk of injury due to flying parts!

- Install rotating components at a suitable distance from other components.
- Never operate the engine without protective covers or safety guards which meet applicable accident prevention regulations.
- Ensure that the safety guards can prevent body parts from being drawn in by rotating components.

Drive belt – Condition check

1. Remove cover.



2. Checking drive belt condition:

Item	Findings	Action
Drive belt A	Singular cracks	None
Drive belt B	Cracks on entire circumference	Replace (→ Page 208)
Drive belt C	Chunking	
Drive belt	Belt is oily, shows signs of over-heating	

3. Install cover.

9.6 Valve Drive

9.6.1 Cylinder head cover – Removal and installation

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 8–40 Nm	F30043446	1
Seal	(→ Spare Parts Catalog)	

Preparatory steps

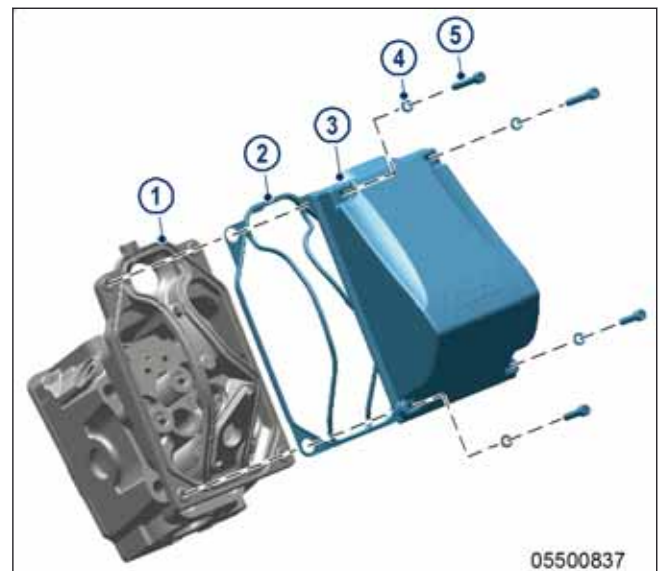
1. Remove air filter (→ Page 175).
2. Remove air guide housing.

Removing and installing cylinder head cover

1. Unscrew screws (5) and take off with washers (4).
2. Remove cylinder head cover (3) with gasket (2) from lower part of cylinder head cover (1).
3. Clean mating face of lower part of cylinder head cover.
4. Check condition of gasket (2) on cylinder head cover.

Result: Replace damaged gaskets.

5. Place screws (5) with washers (4) in position and tighten to specified tightening torque.



Final steps

1. Install air guide housing.
2. Install air filter (→ Page 175).
3. Check leak-tightness of cylinder head cover.

9.6.2 Valve clearance – Check and adjustment

Preconditions

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

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Feeler gauge	Y4345893	1
Barring tool	F6783914	1
Ratchet bit with extension	F30006212	1
Double-head box wrench	F30002800	1
Offset screwdriver	F30453001	1
Insertion socket wrench, 17 mm	F30030450	1
Torque wrench, 20–100 Nm	F30026582	1
Ratchet bit	F30027340	1
Measuring jig	Y4348409	1

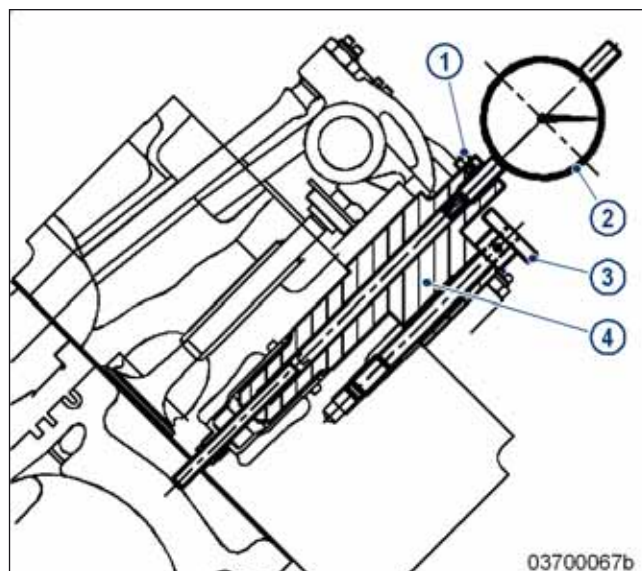
Preparatory steps

1. Remove air filter (→ Page 175).
2. Remove cylinder head cover (→ Page 143).
3. Remove HP line and injector (→ Page 149)

Positioning piston of cylinder A1 at firing TDC

- Note: With cylinder head and valve drive installed
1. Insert preloaded dial gauge (2) into measuring jig (4) and use screw (1) to fasten.
 2. Install measuring jig (4) in cylinder head and use knurled screw (3) to fasten.
 3. Set dial gauge (2) to zero.
 4. Use barring tool to crank engine until piston A1 reaches firing TDC.

Result: The piston is at firing TDC when both rocker arms are unloaded, i.e. have clearance.



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Checking valve clearance at two crankshaft positions

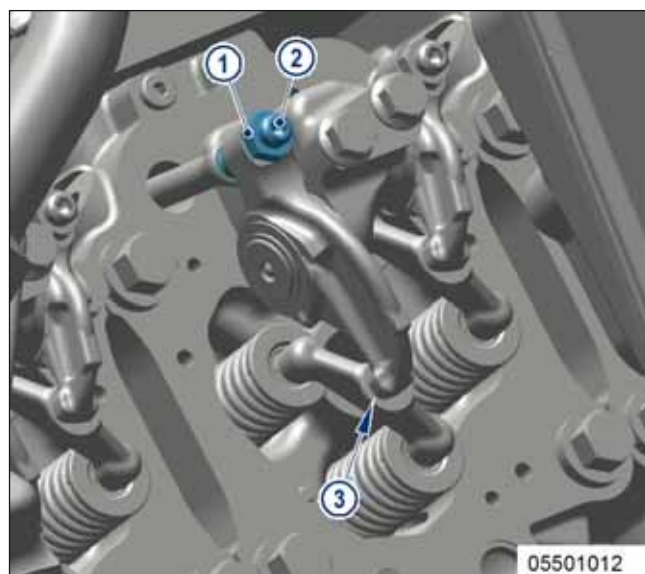
- Check TDC position of piston in cylinder 1, bank A:
 - If the rocker arms are unloaded on cylinder 1, bank A, the piston is in firing TDC.
 - If the rocker arms are loaded on cylinder 1, bank A, the piston is in overlap TDC.
- Check valve clearance with cold engine (at max. 40 °C):
 - Inlet (E) = 0.3 mm +0.1 mm
 - Inlet (E) = 0.3 mm -0 mm
 - Exhaust (A) = 0.4 mm +0.1 mm
 - Exhaust (A) = 0.4 mm -0 mm
- Check all valve clearance values at two crankshaft positions (firing TDC and overlap TDC) according to the table below.
- Use feeler gauge to determine the distance between valve bridge and rocker arm.
- If the deviation from the specified value exceeds 0.1 mm, adjust valve clearance.

Adjusting valve clearance

Position	Cylinder	1	2	3	4	5	6	7	8	9	10		
12V													
Firing TDC in cylinder A1	Side A	(E) (A)	(E) –	– (A)	(E) –	– (A)	– –						
	Side B	(E) –	– –	– (A)	(E) –	(E) (A)	– (A)						
Overlap TDC at cylinder A1	Side A	– –	– (A)	(E) –	– (A)	(E) –	(E) (A)						
	Side B	– (A)	(E) (A)	(E) –	– (A)	– –	(E) –						
16V													
Firing TDC in cylinder A1	Side A	(E) (A)	– (A)	– (A)	(E) –	– (A)	(E) –	– –	– –				
	Side B	(E) –	– (A)	– –	(E) –	(E) (A)	(E) –	(E) (A)	– (A)				
Overlap TDC at cylinder A1	Side A	– –	(E) –	(E) –	– (A)	(E) –	– (A)	(E) (A)	(E) (A)				
	Side B	– (A)	(E) –	(E) (A)	– (A)	– –	– (A)	– –	(E) –				
(E)	Inlet valve adjustment permissible												
(A)	Exhaust valve adjustment permissible												
–	Valve adjustment not permissible												

Table 32: Valve clearance settings

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



4. Use a torque wrench to tighten locknut (1) to specified tightening torque, holding the adjusting screw (2) to prevent it from turning.

Name	Size	Type	Lubricant	Value/Standard
Locknut	M12x1	Tightening torque		50 Nm

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

Result: Repeat valve clearance adjustment if this is not the case.

Final steps

1. Remove barring tool.
2. Install HP line and injector (→ Page 149).
3. Install cylinder head cover (→ Page 143).
4. Install air filter (→ Page 175).

9.7 Injection Pump / HP Pump

9.7.1 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 and explosive.

Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

WARNING



Oils/oil vapors are combustible/explosive.

Risk of fire and explosion!

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

NOTICE



HP fuel pump not filled with engine oil.

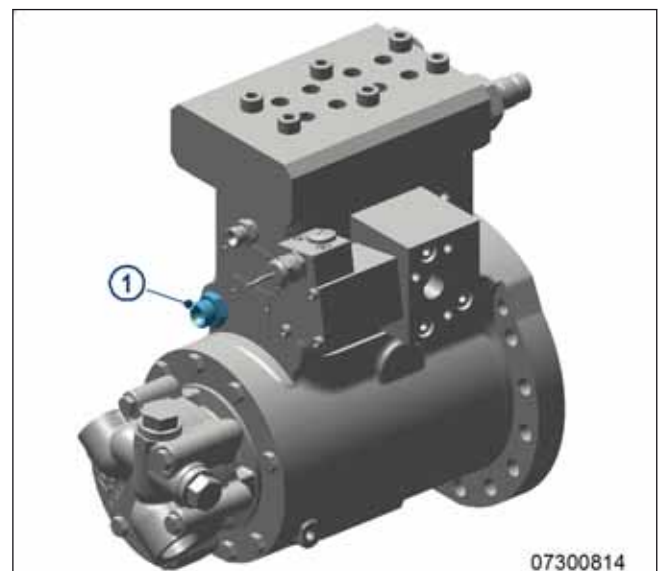
Damage to components, major material damage!

- Ensure that th HP fuel pump is filled with engine oil before it is installed or put into operation.

Filling HP pump

Note: Pump is delivered with filler neck.

1. Fill HP pump with engine oil using pump oiler until engine oil emerges.
2. After installation, connect oil line to (1).



9.8 Injector

9.8.1 Injector – Replacement

Special tools, Material, Spare parts

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

Injector – Replacement

- ▶ Remove injector and install new one (→ Page 149).

9.8.2 Injector – Removal and installation

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Socket wrench	F30452389	1
Socket	F30454548	1
Extraction device	F6790992	1
Mounting sleeve	F30454554	1
Alignment jig	F6795554	1
Alignment mandrel	F6795777	1
Alignment jig	F6795725	1
Torque wrench, 1–5 Nm	F30452774	1
Torque wrench, 20–100 Nm	F30026582	1
Assembly compound (Klute Hakuform 30-15)	X00067620	1
Engine oil		
Sealing ring	(→ Spare Parts Catalog)	
O-ring	(→ Spare Parts Catalog)	
O-ring	(→ Spare Parts Catalog)	

WARNING



Fuels are combustible and explosive.

Risk of fire and explosion!

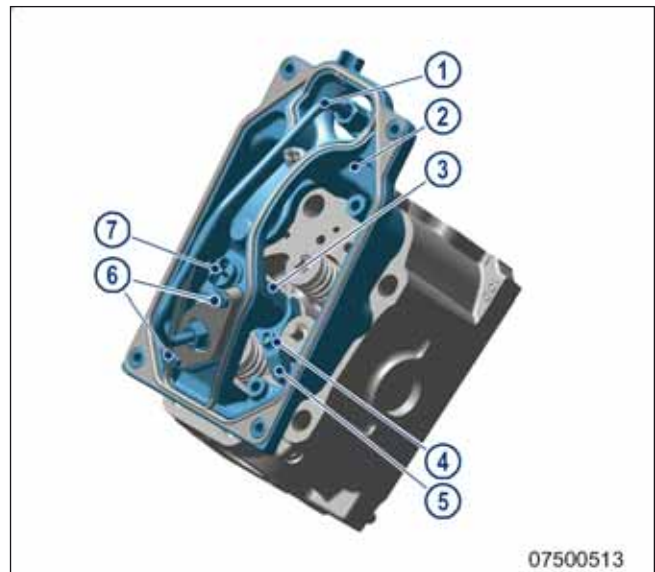
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

Preparatory steps

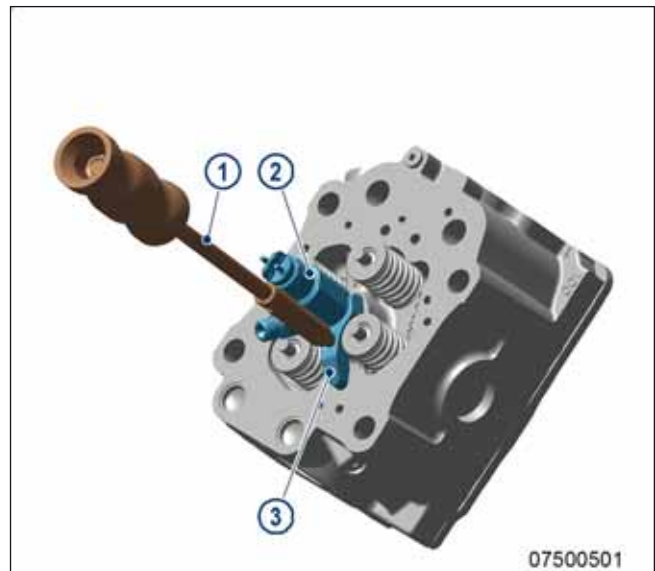
1. Shut off fuel supply to engine.
2. Remove cylinder head cover upper section (→ Page 143).

Removing injector

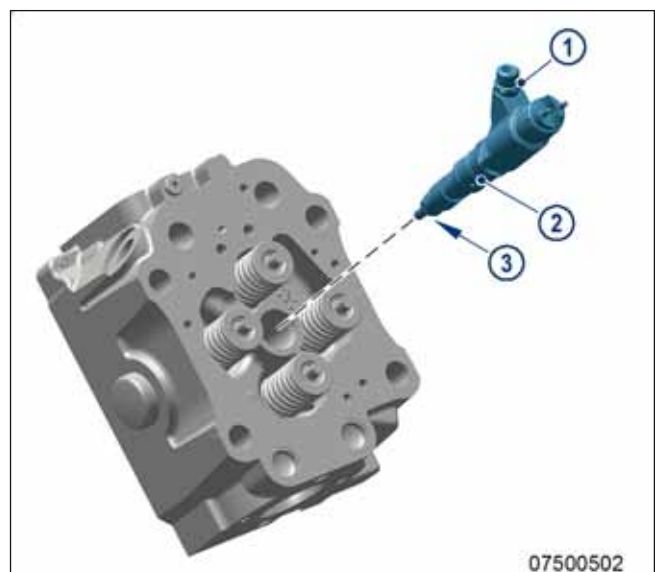
1. Remove HP line (1) using socket wrench.
2. Disconnect cable at control cable connection (7) of injector (3).
3. Remove cylinder head cover lower section (2).
4. Release both screws (6) on flange.
5. Remove retaining screw (4) from hold-down clamp (5) with socket.



6. Fit puller (1) on hold-down clamp (3).
7. Withdraw injector (2) and hold-down clamp (3) with puller (1).



8. Remove O-ring (1) from injector (2).
9. Remove sealing ring (3) from injector (2).
10. Mask all connections and bores or seal with suitable plugs.



Installing injector

1.

Remove all covers and plugs prior to installation.
- Note:

Lubrication is not required if a bond-coated O-ring is used.
2.

Fit new O-ring on injector with assembly sleeve and coat with assembly compound.
3.

Secure new sealing ring with assembly compound on injector (2).
- Note:

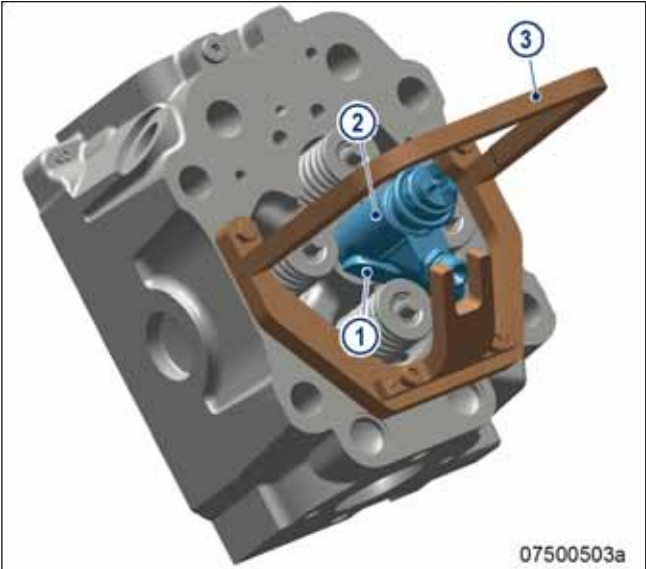
Make sure that nothing falls into the combustion chamber.
4.

Clean sealing surface on cylinder head and protective sleeve.
5.

Press down injector (2) with hold-down clamp (1) in cylinder head.
6.

Align HP line connection with alignment jig F6795554 (3).
7.

Fit hold-down clamp (1) in correct position, coat retaining screw of hold-down clamp with engine oil.



8.

Screw in retaining screw for hold-down clamp and use a socket with torque wrench to tighten to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Retaining screw	M8	Preload torque	(Engine oil)	40 +4 Nm

- Note:

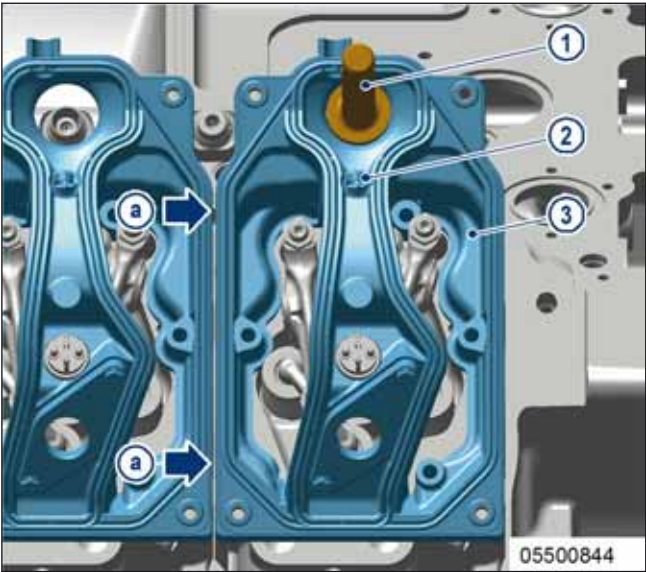
Check and clean surface of bottom side of cylinder head cover lower section.
9.

Align cylinder head cover lower section (3) with alignment mandrel (1) and install.
- Note:

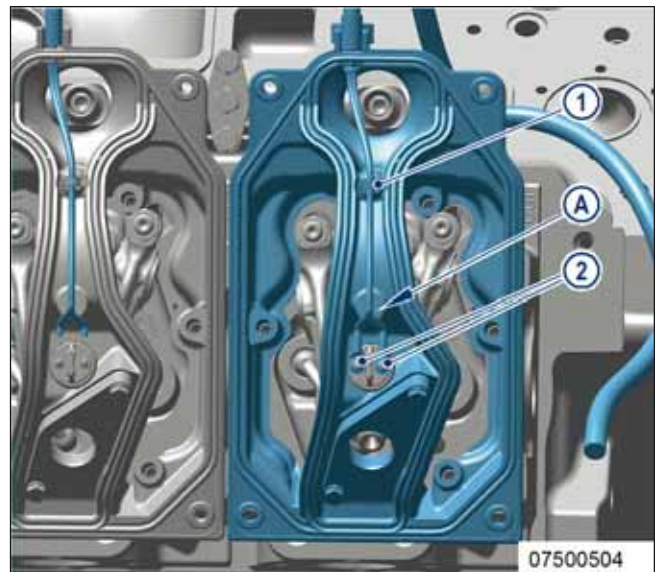
If the covers are bolted on, ensure that gap (a) between the covers is even.
10.

Install cable clamps (2) and draw in the injector cable.
11.

Screw cable onto control cable connection of injector.



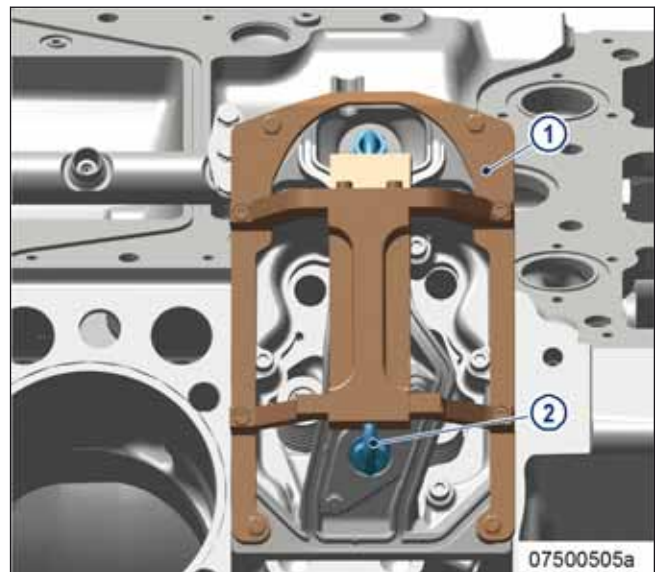
- Note: Ensure they run centrally (A). Do not pinch them.
12. Secure cables (1) together with cable clamps.



13. Tighten cables (2) with battery-powered shutoff wrench to specified torque.

Name	Size	Type	Lubricant	Value/Standard
Crimped spade lug	M4	Tightening torque		2 ±0.25 Nm

14. Coat thread and sealing cone of HP line and injector with engine oil.
15. Align HP line (2) with alignment jig F6795725 (1).
16. Place HP line in position on HP accumulator and tighten by hand.
17. Place HP line in position on injector and tighten by hand.



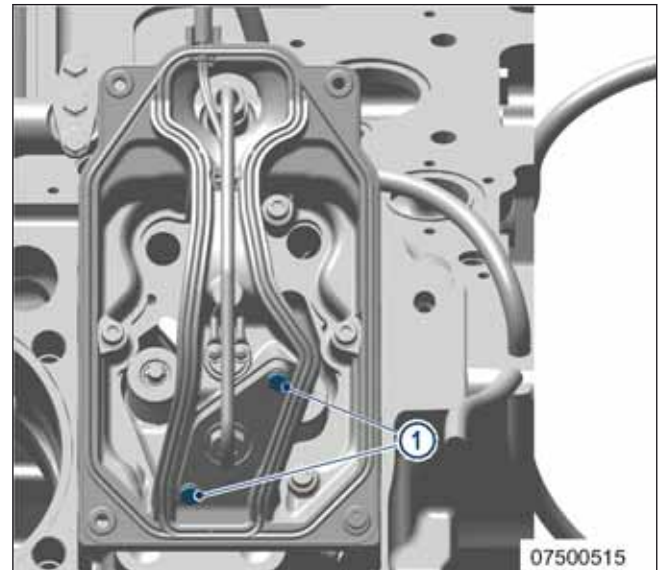
18. Use a socket and torque wrench to tighten HP line to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
HP line		Tightening torque	(Engine oil)	37 Nm +6 Nm

19. Tighten both screws (1) on flange to specified torque.

Note: If the drift correction (CDC) is not reset, the emission certification of the engine becomes void.

20. Reset drift correction (CDC) with DiaSys® and enter injector coding (IIG) (→ Page 211).



Final steps

1. Install cylinder head cover upper section (→ Page 143).
2. Open fuel supply to engine.

9.9 Fuel System

9.9.1 Fuel system – Venting

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 8–40 Nm	F30453004/21	1
Box wrench, 22 mm	F30038494	1

DANGER



Components are moving or rotating.

Risk of crushing, danger of parts of the body being caught or pulled in!

- Operate the engine at low load only. Keep clear of the danger zone of the engine.

WARNING



Liquid or gaseous media, e.g. fuel, are poisonous.

Escaping vapors of highly volatile media, e.g. fuel or ether.

Risk of fatal injury through swallowing; risk of poisoning through inhalation; irritation to eyes and skin!

- Seek medical attention immediately; do not induce vomiting.
- Do not inhale vapors or smoke.
- Wear protective clothing, protective gloves, and safety glasses.
- If contact is made with skin, wash off with water and soap.
- Keep the engine room well ventilated at all times.

WARNING



A high level of noise is produced when the engine is running.

Risk of hearing loss!

- Wear suitable hearing protection.

WARNING



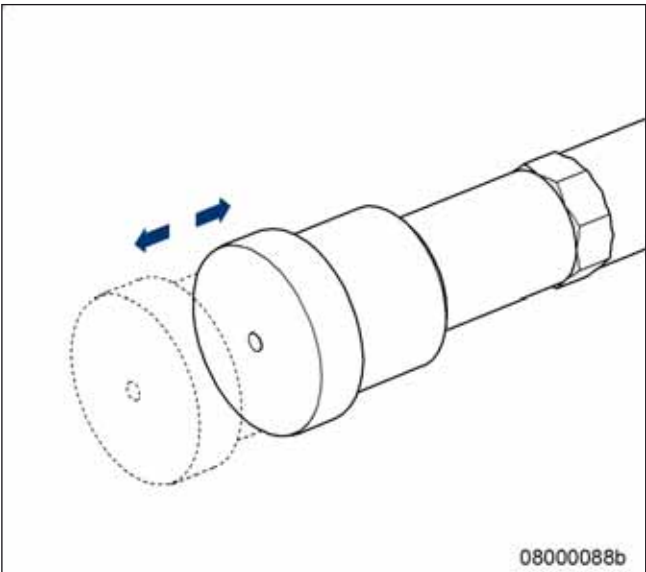
Fuels are combustible and explosive.

Risk of fire and explosion!

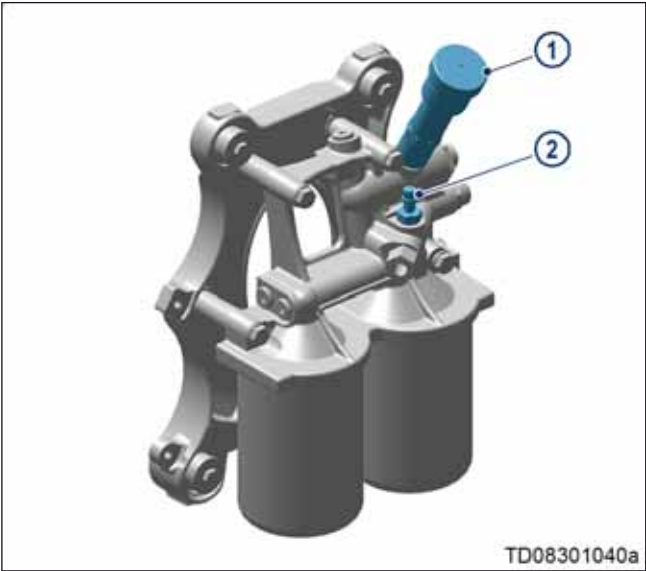
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

Venting fuel system with non-switchable filters

1. Unlock fuel priming pump, unscrew handle.



2. Loosen threaded vent plug (2) on filter head.
3. Operate pump with handle (1) until bubble-free fuel emerges from threaded vent plug (2).



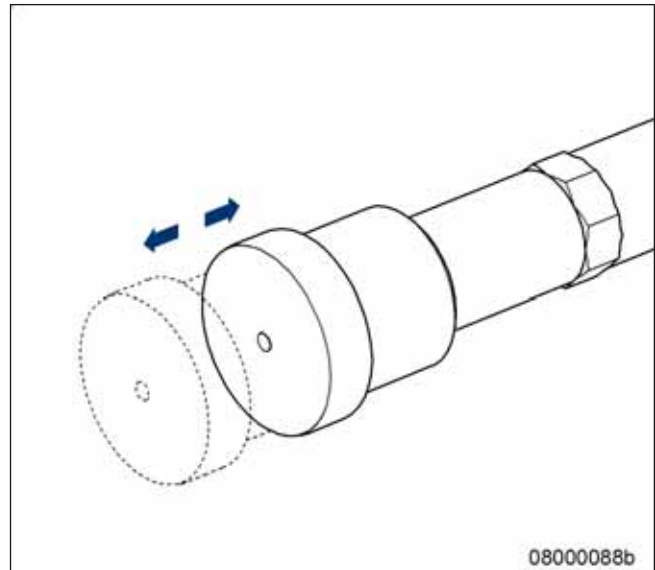
4. Tighten threaded vent plug (2) to specified tightening torque:

Name	Size	Type	Lubricant	Value/Standard
Threaded vent plug	M8	Tightening torque		6 Nm +2 Nm

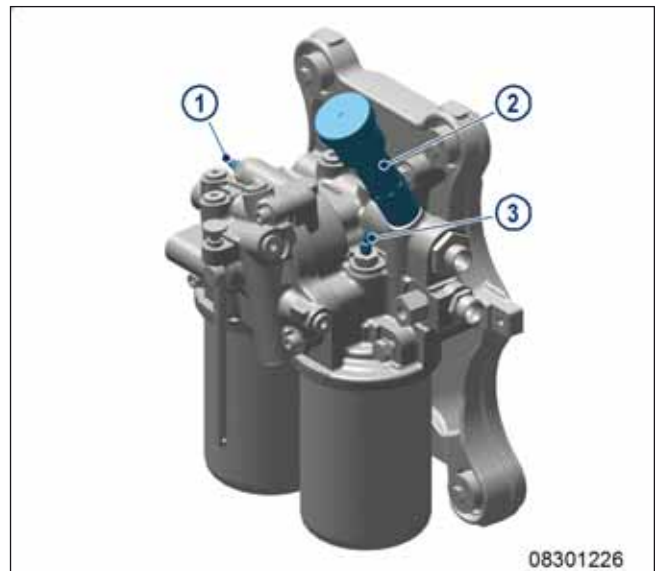
5. Secure fuel priming pump.
6. Screw in handle (2) on fuel priming pump.

Venting fuel system with switchable filters

1. Unlock fuel priming pump, unscrew handle.



2. Loosen threaded vent plugs (1) and (3).
3. Operate handle (2) until bubble-free fuel emerges from the threaded vent plugs (1) and (3).



4. Tighten threaded vent plugs (1) and (3) to specified tightening torque:

Name	Size	Type	Lubricant	Value/Standard
Threaded vent plug	M8	Tightening torque		6 Nm +2 Nm

5. Secure fuel priming pump.
6. Screw in handle (2) on fuel priming pump.

9.10 Fuel Filter

9.10.1 Fuel filter – Replacement

Preconditions

- ☑ Engine is stopped and starting disabled (only in case of switchable fuel filter)
- ☑ Coolant temperature below 40°C (only in case of switchable fuel filter)
- ☑ Shut off fuel supply to engine.

Special tools, Material, Spare parts

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

DANGER



Components are moving or rotating.

Risk of crushing, danger of parts of the body being caught or pulled in!

- Operate the engine at low load only. Keep clear of the danger zone of the engine.

WARNING



Liquid or gaseous media, e.g. fuel, are poisonous.

Escaping vapors of highly volatile media, e.g. fuel or ether.

Risk of fatal injury through swallowing; risk of poisoning through inhalation; irritation to eyes and skin!

- Seek medical attention immediately; do not induce vomiting.
- Do not inhale vapors or smoke.
- Wear protective clothing, protective gloves, and safety glasses.
- If contact is made with skin, wash off with water and soap.
- Keep the engine room well ventilated at all times.

WARNING



Fuels are combustible and explosive.

Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

WARNING



A high level of noise is produced when the engine is running.

Risk of hearing loss!

- Wear suitable hearing protection.

NOTICE



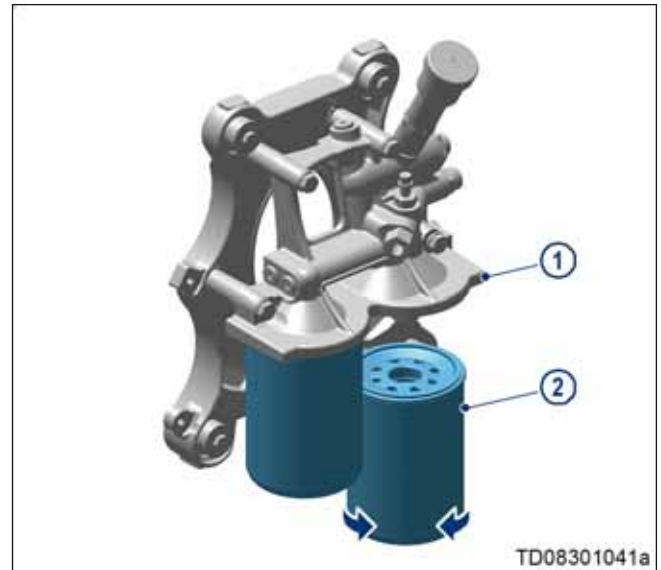
Damage to component!

Severe material damage!

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

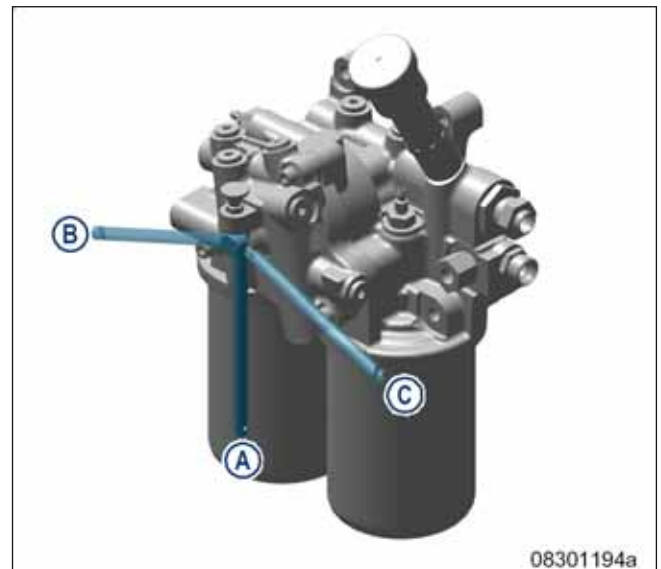
Changing fuel filter with non-switchable filters and engine at standstill

1. Stop engine and disable engine start.
2. Use oil filter wrench to unscrew easy-change filter (2) from filter base (1).
3. Clean sealing surface on filter head.
4. Check sealing ring of new easy-change filter and wet it with fuel.
5. Install and tighten new easy-change filter by hand.
6. Replace other fuel filters in the same way.
7. Vent fuel system (→ Page 154).



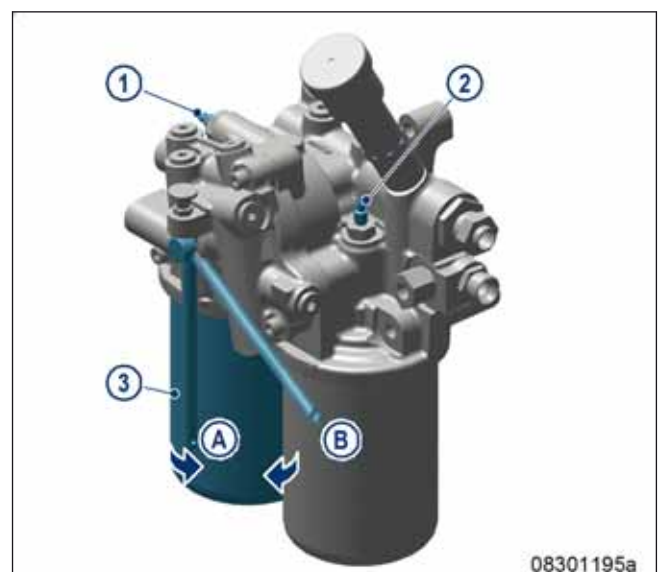
Changing fuel filter with switchable filters and engine at standstill

1. Stop engine and disable engine start.
2. Set lever to position A.
3. Unscrew both filters with oil filter wrench.
4. Clean sealing surface on filter head.
5. Check sealing ring on new easy-change filter and wet it with fuel.
6. Install and tighten new easy-change filter by hand.
7. Vent fuel system (→ Page 154).



Changing fuel filter with switchable filters and running engine

1. Cut out filter to be changed, e.g. set 3-way cock to position (B) to cut out filter (3) to be replaced.
2. Open threaded vent plug (3) on filter head to depressurize and check it.
3. Unscrew cut-out easy-change filter (3) with oil filter wrench.
4. Clean sealing surface on filter head.
5. Check sealing ring on new easy-change filter (3) and wet it with fuel.
6. Screw on easy-change filter (3) and tighten manually.
7. Set 3-way cock to position (A) so that both filters are in operation (normal position); when doing this, keep vent nipple opened until bubble-free fuel emerges.
8. Replace further fuel filters in the same way.



9. Tighten threaded vent plugs (1) and (2) to specified tightening torque:

Name	Size	Type	Lubricant	Value/Standard
Threaded vent plug	M8	Tightening torque		6 Nm +2 Nm

9.10.2 Fuel prefilter – Differential pressure gauge check and adjustment

DANGER



Components are moving or rotating.

Risk of crushing, danger of parts of the body being caught or pulled in!

- Operate the engine at low load only. Keep clear of the danger zone of the engine.

WARNING



A high level of noise is produced when the engine is running.

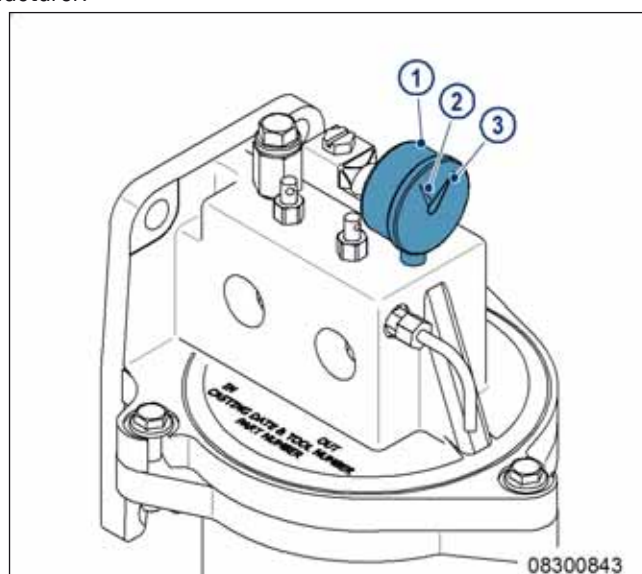
Risk of hearing loss!

- Wear suitable hearing protection.

Note: Follow the instructions of the fuel prefilter manufacturer!

Setting differential pressure gauge with single-stage filter

1. After putting new filter element into operation, align adjustable pointer (2) with pressure-indicating pointer (3) of pressure gauge (1).
2. Verify that differential pressure is within the limit.

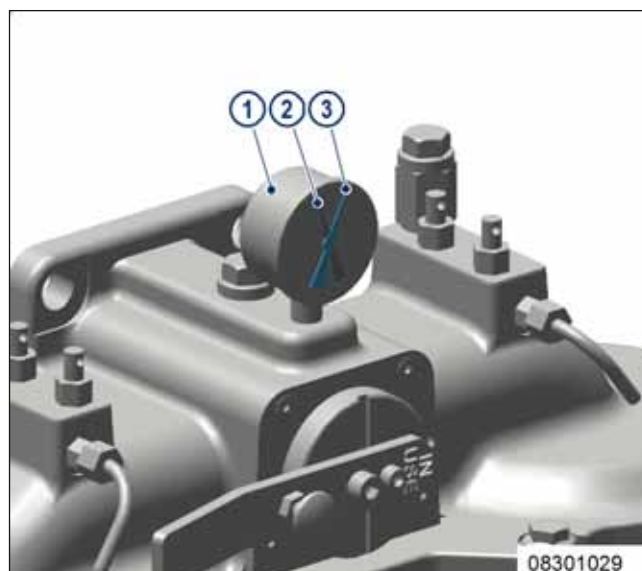


Fuel prefilter – Checking differential pressure with single-stage filter

1. With the engine running at full load or rated power, read off pressure at gauge (1).
2. If differential pressure as indicated between position of adjustable pointer (2) and pressure-indicating pointer (3) is ≥ 0.3 bar, flush filter element of the cut-in filter (→ Page 165).

Setting differential pressure gauge with switchable duplex filter

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



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Fuel prefilter – Checking differential pressure with switchable duplex filter

1. With the engine running at full load or rated power, read off pressure at gauge (1).
2. If differential pressure as indicated between position of adjustable pointer (2) and pressure-indicating pointer (3) of pressure gauge is ≥ 0.3 bar, flush filter element of the cut-in filter (→ Page 165).

9.10.3 Fuel prefilter – Draining

Preconditions

- ☑ Engine is stopped and starting disabled. (only with single-stage fuel prefilter)
- ☑ Close off fuel supply before the filter

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Diesel fuel		

DANGER



Components are moving or rotating.

Risk of crushing, danger of parts of the body being caught or pulled in!

- Operate the engine at low load only. Keep clear of the danger zone of the engine.

WARNING



Liquid or gaseous media, e.g. fuel, are poisonous.

Escaping vapors of highly volatile media, e.g. fuel or ether.

Risk of fatal injury through swallowing; risk of poisoning through inhalation; irritation to eyes and skin!

- Seek medical attention immediately; do not induce vomiting.
- Do not inhale vapors or smoke.
- Wear protective clothing, protective gloves, and safety glasses.
- If contact is made with skin, wash off with water and soap.
- Keep the engine room well ventilated at all times.

WARNING



A high level of noise is produced when the engine is running.

Risk of hearing loss!

- Wear suitable hearing protection.

WARNING



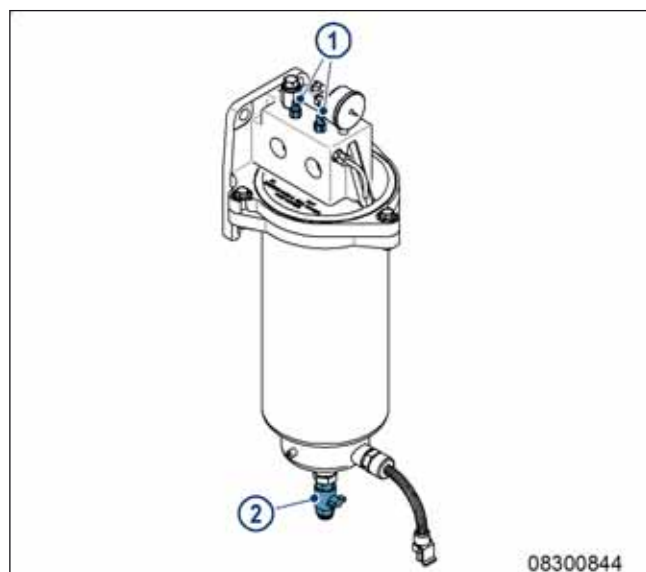
Fuels are combustible and explosive.

Risk of fire and explosion!

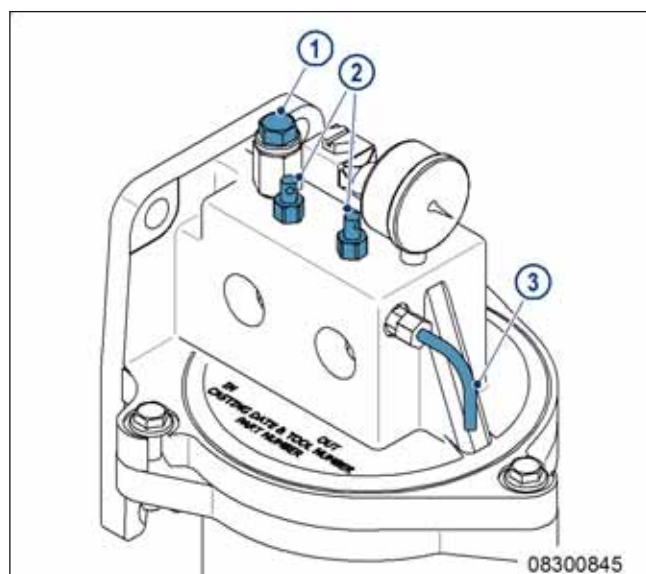
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

Draining fuel prefilter with single-stage filter

1. Loosen threaded vent plugs (1).
2. Open drain valve (2).
3. Drain water and contaminants from filter until pure fuel emerges.
4. Close drain valve (2).

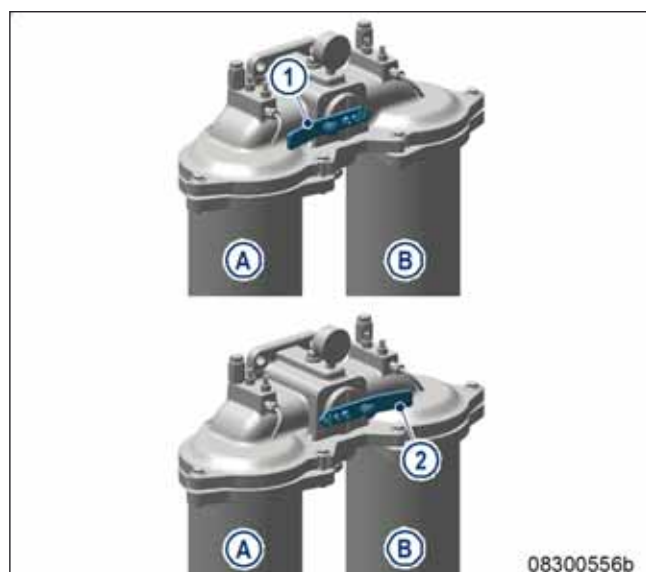


5. Connect filling pump to filling connection (1) on intake side of filter.
6. Loosen threaded vent plugs (2) and fill with fuel until fuel emerges from vent pipe (3).
7. Close threaded vent plugs (2).

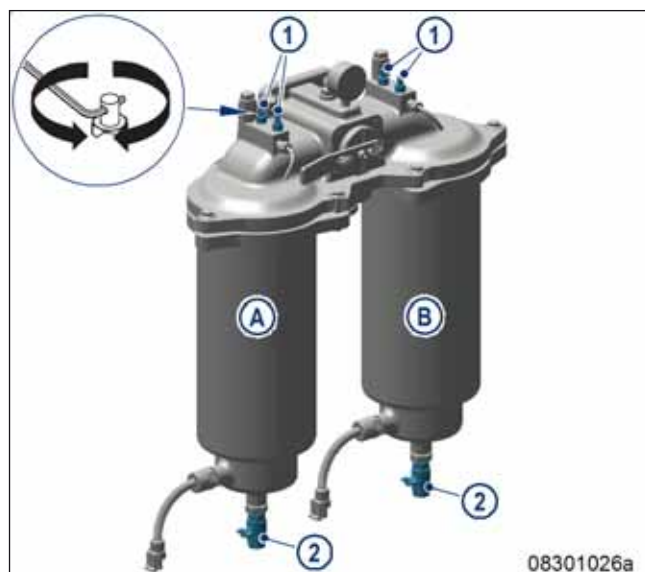


Draining fuel prefilter with switchable duplex filter

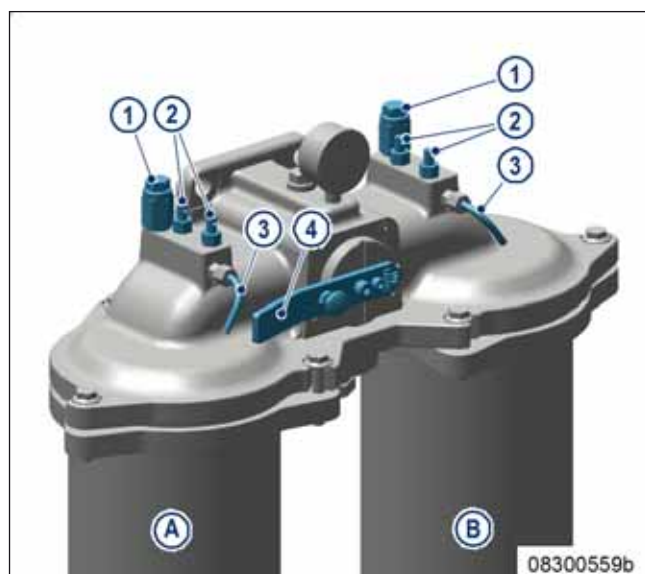
1. Switch off filter which is to be drained (A or B):
 - 1 Filter A switched off
 - 2 Filter B switched off



2. Loosen threaded vent plug (1) of filter to be drained.
3. Open drain valve (2).
4. Drain water and contaminants from filter until pure fuel emerges.
5. Close drain valve (2).



6. Connect filling pump to filling connection (1) on intake side of filter.
7. Open vent valve (2) and fill with fuel until fuel emerges from vent pipe (3).
8. Close vent valve (2).
9. Open rotary slide valve (4) a little (by approx. 30°) and open vent valve(s) (2), until fuel emerges from vent pipe (3).
10. Close vent valve(s) (2).
11. Turn rotary slide valve (4) back to locked position.



9.10.4 Fuel prefilter – Flushing

Preconditions

- ☒ Engine is stopped and starting disabled (only with single-stage fuel prefilter)

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Diesel fuel		

DANGER



Components are moving or rotating.

Risk of crushing, danger of parts of the body being caught or pulled in!

- Operate the engine at low load only. Keep clear of the danger zone of the engine.

WARNING



Liquid or gaseous media, e.g. fuel, are poisonous.

Escaping vapors of highly volatile media, e.g. fuel or ether.

Risk of fatal injury through swallowing; risk of poisoning through inhalation; irritation to eyes and skin!

- Seek medical attention immediately; do not induce vomiting.
- Do not inhale vapors or smoke.
- Wear protective clothing, protective gloves, and safety glasses.
- If contact is made with skin, wash off with water and soap.
- Keep the engine room well ventilated at all times.

WARNING



Fuels are combustible and explosive.

Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

WARNING



A high level of noise is produced when the engine is running.

Risk of hearing loss!

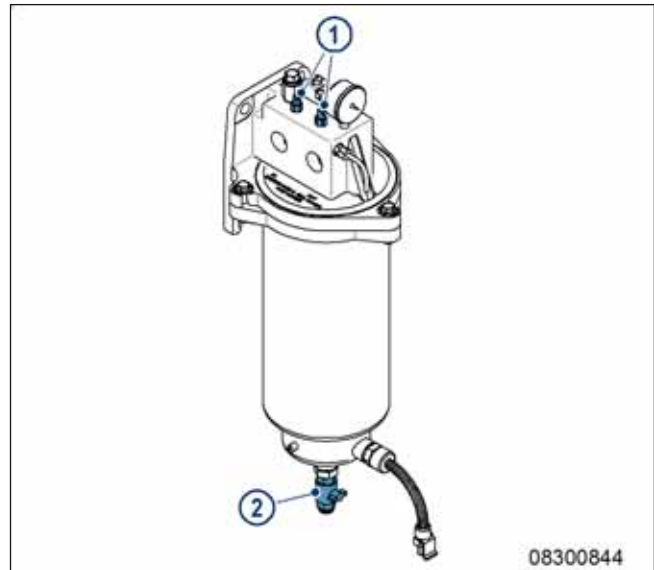
- Wear suitable hearing protection.

Flushing fuel prefilter with single-stage filter

1. Close fuel shutoff valve.
2. Loosen threaded vent plugs (1).
3. Open drain valve (2) and drain fuel.

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

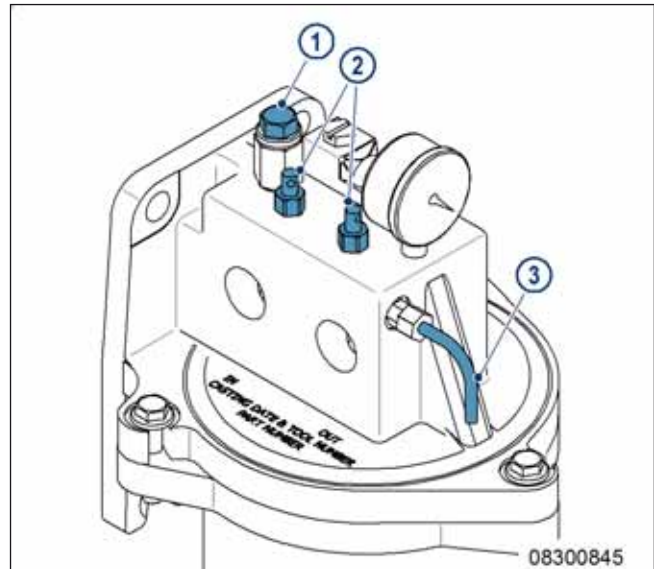
4. Close threaded vent plugs (1) and drain valve (2).



Filling fuel prefilter with single-stage filter

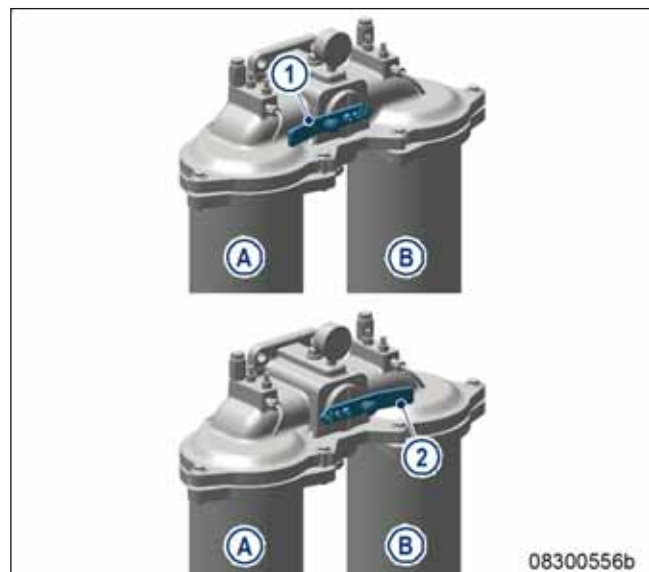
1. Stop engine (→ Page 76) and disable engine start.
2. Connect filling pump to filling connection (1) on intake side of filter.
3. Loosen threaded vent plugs (2) and fill with fuel until fuel emerges from vent pipe (3).
4. Close threaded vent plugs (2).
5. Open fuel shutoff valve.
6. Check differential pressure (→ Page 160).

Result: If flushing did not improve differential pressure, replace fuel prefilter element (→ Page 169).



Flushing fuel prefilter with switchable duplex filter

1. Cut out contaminated filter (A or B):
 - 1 Filter A switched off
 - 2 Filter B switched off



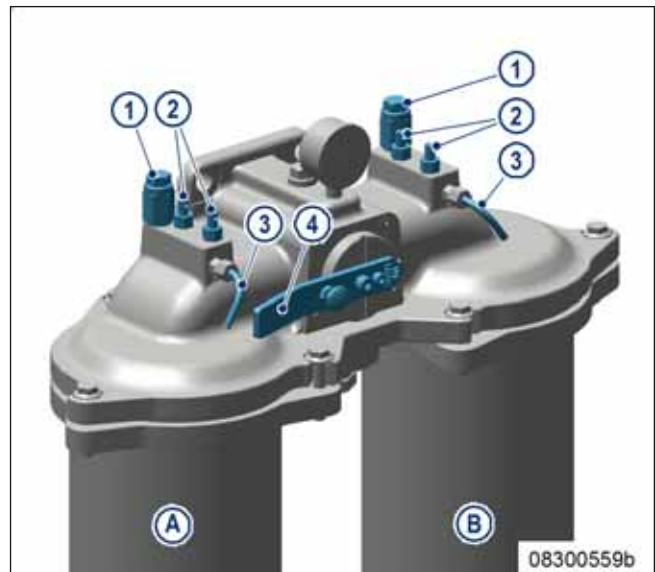
2. Open threaded vent plug (1) of filter to be flushed.
 3. Open drain valve (2) and drain fuel.
- Result: Fuel flows from filtered side back to unfiltered side, flushing filter deposits downwards out of the filter.
4. Close threaded vent plug (1) and drain valve (2).



Filling fuel prefilter with switchable duplex filter

1. Stop engine (→ Page 76) and disable engine start.

2. Connect filling pump to filling connection (1) on intake side of filter.
 3. Open vent valve (2) and fill with fuel until fuel emerges from vent pipe (3).
 4. Close vent valve (2).
 5. Open rotary slide valve (4) a little (by approx. 30°) and open vent valve(s) (2), until fuel emerges from vent pipe (3).
 6. Close vent valve(s) (2).
 7. Turn rotary slide valve (4) back to locked position.
 8. Check differential pressure (→ Page 160).
- Result: If flushing did not improve differential pressure, replace fuel prefilter element (→ Page 169).



9.10.5 Fuel prefilter – Filter element replacement

Preconditions

- ☑ Engine is stopped and starting disabled. (only with single-stage fuel prefilter)

Special tools, Material, Spare parts

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

DANGER



Components are moving or rotating.

Risk of crushing, danger of parts of the body being caught or pulled in!

- Operate the engine at low load only. Keep clear of the danger zone of the engine.

WARNING



Liquid or gaseous media, e.g. fuel, are poisonous.

Escaping vapors of highly volatile media, e.g. fuel or ether.

Risk of fatal injury through swallowing; risk of poisoning through inhalation; irritation to eyes and skin!

- Seek medical attention immediately; do not induce vomiting.
- Do not inhale vapors or smoke.
- Wear protective clothing, protective gloves, and safety glasses.
- If contact is made with skin, wash off with water and soap.
- Keep the engine room well ventilated at all times.

WARNING



A high level of noise is produced when the engine is running.

Risk of hearing loss!

- Wear suitable hearing protection.

WARNING



Fuels are combustible and explosive.

Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

NOTICE



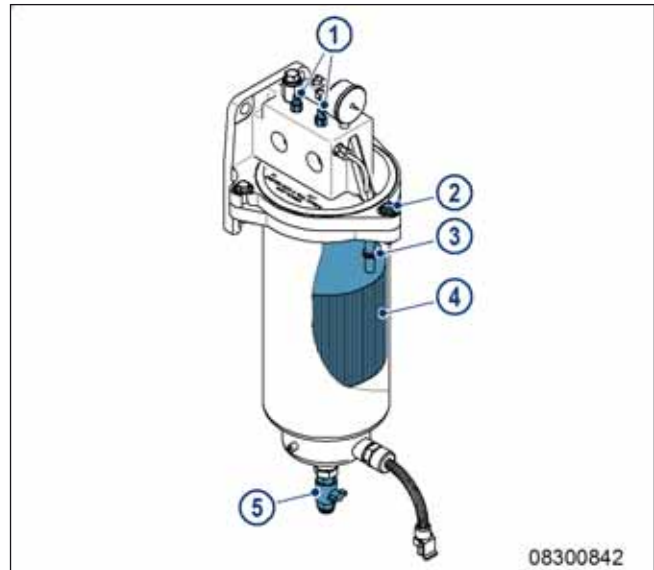
Damage to component!

Severe material damage!

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

Replacing filter element with single-stage filter

1. Close fuel shut-off valve.
2. Loosen threaded vent plugs (1) of contaminated filter.
3. Unlock drain valve (5) by pressing toggle and open it.
4. Drain fuel from filter.
5. Close drain valve (5).
6. Remove screws of securing cover (2) and open filter cartridge housing.
7. Remove level monitor (3) and filter cartridge (4).
8. Insert new level monitor (3) and new filter cartridge (4).
9. Place new gasket in filter cartridge housing.
10. Close filter cartridge housing and tighten screws (2).
11. Open fuel shut-off valve and fill filter with fuel.
12. Close threaded vent plugs (1) when fuel escapes.
13. Set differential pressure display instrument (→ Page 160).

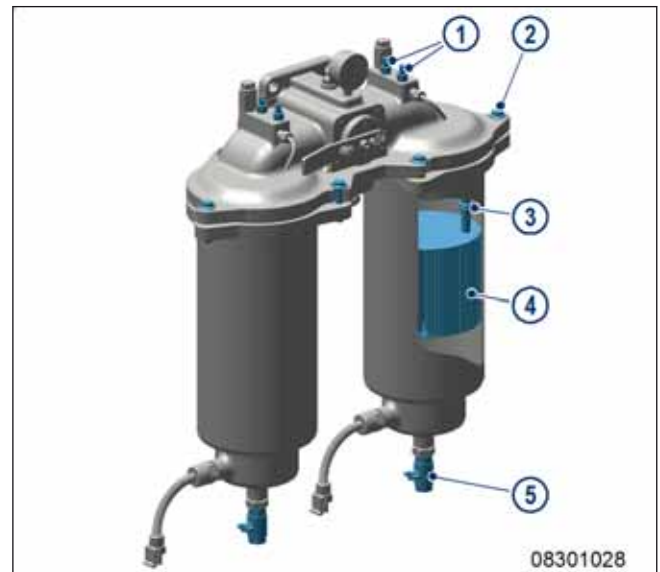


Replacing filter element with switchable duplex filter

1. Cut out filter to be replaced (A or B):
 - 1 Filter A cut out
 - 2 Filter B cut out



2. Release threaded vent plug (1) of contaminated filter.
3. Unlock drain valve (5) by pressing toggle and open it.
4. Drain water and contaminants from filter.
5. Close drain valve (5).
6. Remove screws of securing cover (2) and take off cover.
7. Remove spring cartridge (3) and filter element (4).
8. Insert new filter element (4) and spring cartridge (3).
9. Fill filter housing with clean fuel.
10. Place new gasket in cover.
11. Fit cover with gasket and secure it with screws (2).
12. Cut in cut-out filter again.
13. Close threaded vent plug (1) when fuel escapes.
14. Set differential pressure display instrument (→ Page 160).



9.11 Charge-Air Cooling

9.11.1.1 Intercooler - Checking condensate drain line for coolant discharge and obstruction

DANGER



Components are moving or rotating.

Risk of crushing, danger of parts of the body being caught or pulled in!

- Operate the engine at low load only. Keep clear of the danger zone of the engine.

WARNING



A high level of noise is produced when the engine is running.

Risk of hearing loss!

- Wear suitable hearing protection.

WARNING



Compressed air gun ejects a jet of pressurized air.

Risk of injury to eyes and damage to hearing, risk of rupturing internal organs!

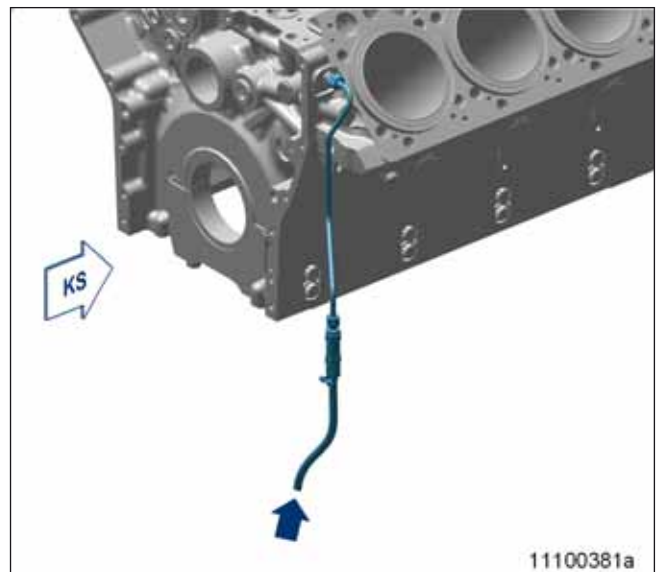
- Never direct air jet at people.
- Always wear safety goggles/face mask and hearing protection.

Checking drain line with small leak-fuel tank

1. Check condensate drain line for air discharge and obstruction when the engine is running idle.

Note: Valve closes at higher charge pressure.

2. If no air emerges, remove condensate drain line and blow out with compressed air.
3. Replace obstructed condensate drain line with a new line.
4. Install condensate drain line.
5. If a large amount of coolant is continuously discharged, the intercooler is leaking. Contact Service.

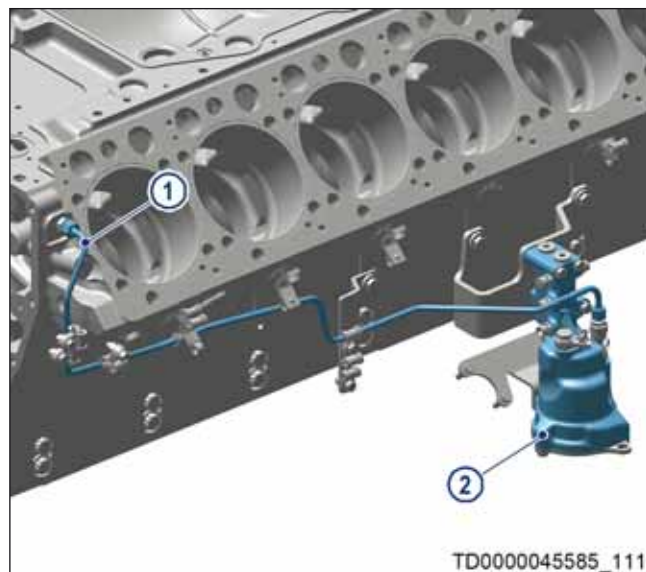


Checking drain line with large leak-fuel tank

1. Check condensate drain line for air discharge and obstruction when the engine is running idle.

Note: Valve closes at higher charge pressure.

2. If no air emerges, remove condensate drain line (1) at leak-fuel tank (2) and blow out with compressed air.
3. Replace obstructed condensate drain line with a new line.
4. Install condensate drain line.
5. If a large amount of coolant is continuously discharged, the intercooler is leaking. Contact Service.



Emergency measures prior to engine start with a leaking intercooler

1. Remove injectors (→ Page 148).
2. Crank engine manually (→ Page 135).
3. Crank engine on starting system to blow out combustion chambers (→ Page 136).
4. Install injectors (→ Page 149).

9.12 Air Filter

9.12.1 Air filter – Replacement

Preconditions

- ☒ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

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

Air filter – Replacement

1. Remove old air filter and install new air filter (→ Page 175).
2. Reset signal ring of contamination indicator (→ Page 176).

9.12.2 Air filter – Removal and installation

Preconditions

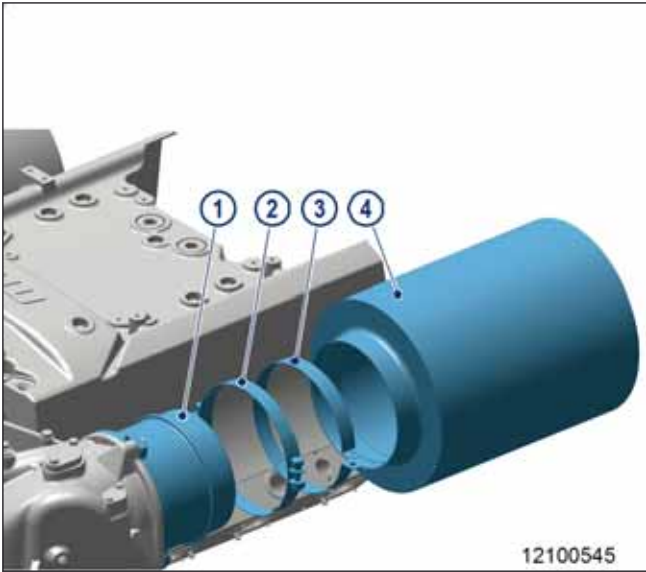
- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 8–40 Nm	F30043446	1

Removing air filter

1. Release screws from clamps (2) and (3).
2. Remove air filter (4) and clamps from connecting flange (1) of intake neck.



Installing air filter

1. Clean connecting flange (1) of intake neck and check for free passage.
2. Attach air filter (4) with clamps (2) and (3) on connecting flange (1) of intake neck.
3. Use a torque wrench to tighten screws on clamps (2) and (3) to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screws	M10	Tightening torque		15 +2 Nm

9.13 Air Intake

9.13.1 Service indicator – Signal ring position check

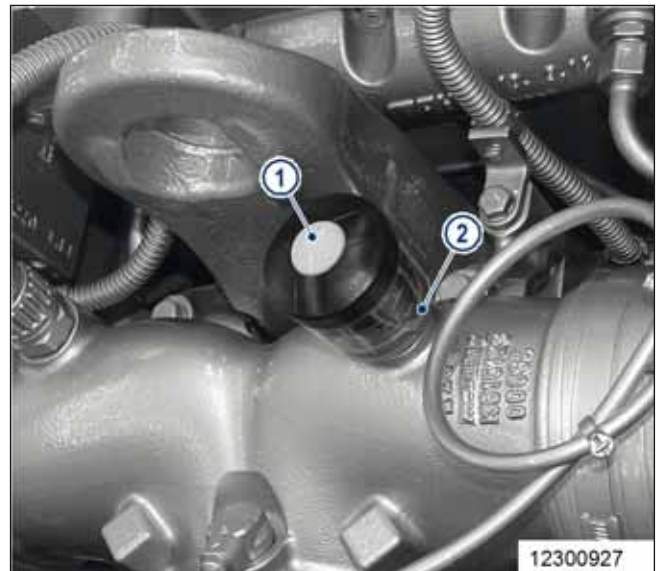
Preconditions

- ☑ Engine is stopped and starting disabled.

Checking signal ring position

1. When the yellow piston has reached the red shaded Service lettering (2), replace air filter (→ Page 174).
2. After installation of new filter, press reset button (1).

Result: Signal ring returns to initial position.



9.14 Lube Oil System, Lube Oil Circuit

9.14.1 Engine oil level – Check

Preconditions

- ☑ Engine is stopped and starting disabled

Checking oil level prior to engine start

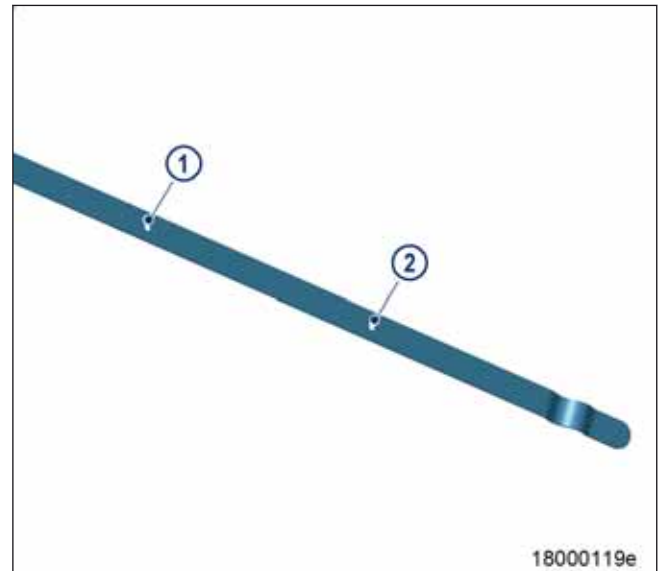
1. Pull out dipstick from guide tube and wipe it.
2. Insert oil dipstick into guide tube up to the stop, pull it out after approx. 10 seconds and check oil level.

Note: The oil level may be up to 2 cm above the mark (1) after extended out-of-service periods. The reason for this may be oil returning to the oil pan e.g. from oil filters and heat exchangers.

3. The oil level must reach the mark (2) or exceed the mark (1) by up to 2 cm.

Note: Topping up oil manually is not required on engines featuring automatic oil replenishment. On all other engines, oil must be topped up manually. The oil level check is only intended to confirm that the automatic oil replenishment feature works properly.

4. Insert oil dipstick into guide tube up to the stop.



Checking engine oil level after engine has stopped

1. 5 minutes after stopping the engine, pull out oil dipstick from guide tube and wipe it.
2. Insert oil dipstick into guide tube up to the stop, pull it out after approx. 10 seconds and check oil level.

Note: Topping up oil manually is not required on engines featuring automatic oil replenishment. On all other engines, oil must be topped up manually. The oil level check is only intended to confirm that the automatic oil replenishment feature works properly.

3. Oil level must be between marks (1) and (2).
4. Insert oil dipstick into guide tube up to the stop.

9.14.2 Engine oil - Change

Preconditions

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

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine oil		

WARNING



Oil is hot.

Oil can contain residue/substances which are harmful to health.

Risk of injury and poisoning!

- Allow the product to cool to below 50 °C before beginning work.
- Wear protective clothing, protective gloves and goggles/safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

Version with extraction equipment: Extracting engine oil

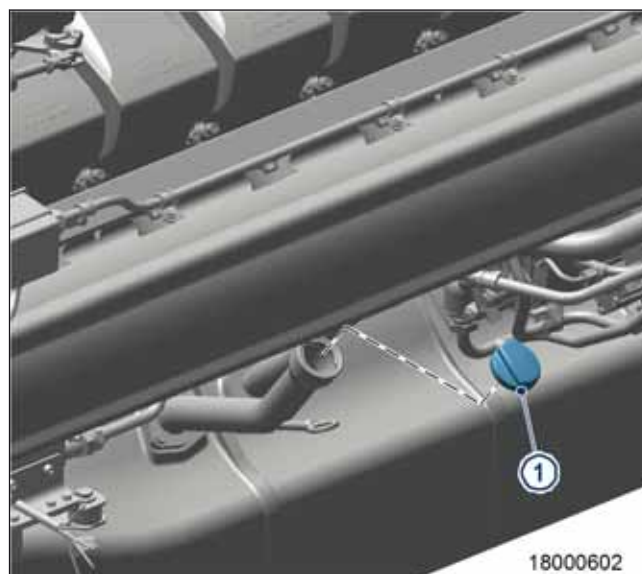
1. Position a suitable container to drain engine oil into.
2. Extract all engine oil from oil pan using the extraction equipment or drain via the oil drain screw.

Filling with new engine oil

1. Determine oil quantity for oil change:
 - For 12V (→ Page 58)
 - For 16V (→ Page 62)
2. Open cap (1) on filler neck.
3. Pour oil in at filler neck up to 'max.' mark at oil dipstick.
4. Close cap (1) on filler neck.
5. Check engine oil level (→ Page 177).

Note: Crank until engine oil pressure is indicated on pressure gauge.

6. Crank engine on starting system after oil change.



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9.15 Oil Filtration / Cooling

9.15.1 Engine oil filter – Replacement

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ Engine is at operating temperature.

Special tools, Material, Spare parts

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

DANGER



Components are moving or rotating.

Risk of crushing, danger of parts of the body being caught or pulled in!

- Operate the engine at low load only. Keep clear of the danger zone of the engine.

WARNING



A high level of noise is produced when the engine is running.

Risk of hearing loss!

- Wear suitable hearing protection.

WARNING



Oil is hot.

Oil can contain residue/substances which are harmful to health.

Risk of injury and poisoning!

- Allow the product to cool to below 50 °C before beginning work.
- Wear protective clothing, protective gloves and goggles/safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

NOTICE



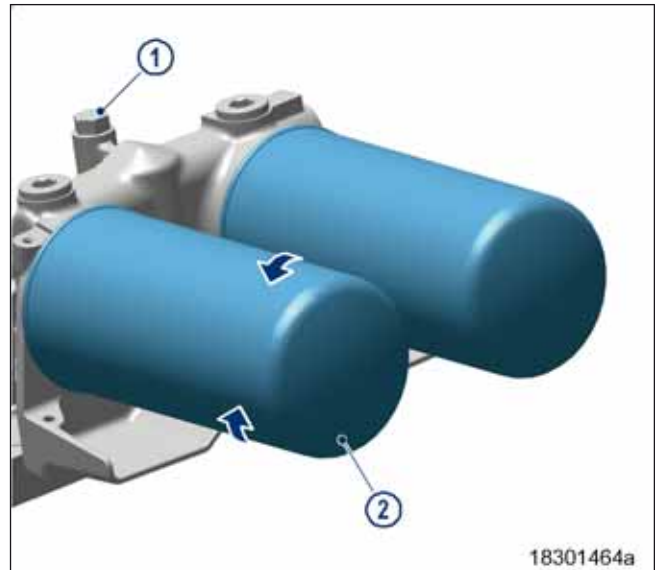
Damage to component!

Severe material damage!

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

Replacing non-switchable oil filters with engine at standstill

1. Stop engine (→ Page 76) and disable engine start.
2. Open screw (1) several rotations and wait until oil filter is empty.
3. Screw in screw (1) again.
4. Unscrew oil filter (2) using oil filter wrench.
5. Clean sealing surface on connecting piece.
6. Check sealing ring of new oil filter and coat it with oil.
7. Fit SOLAS shield.



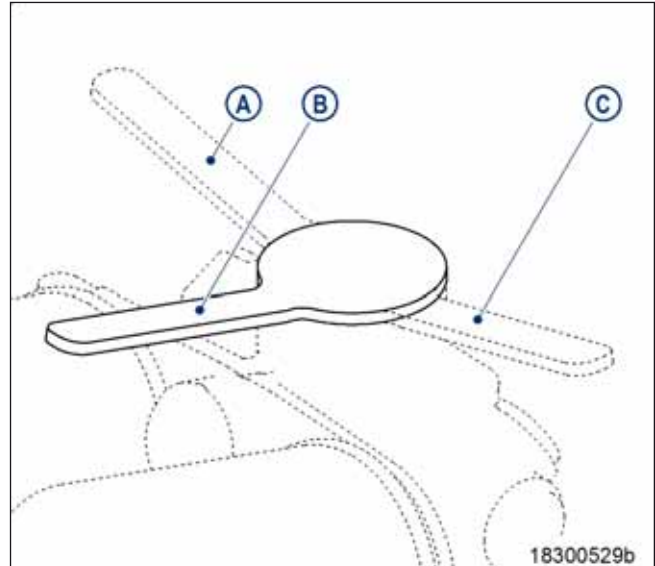
8. Insert oil filter and tighten to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Filter	–	Tightening torque		25 Nm

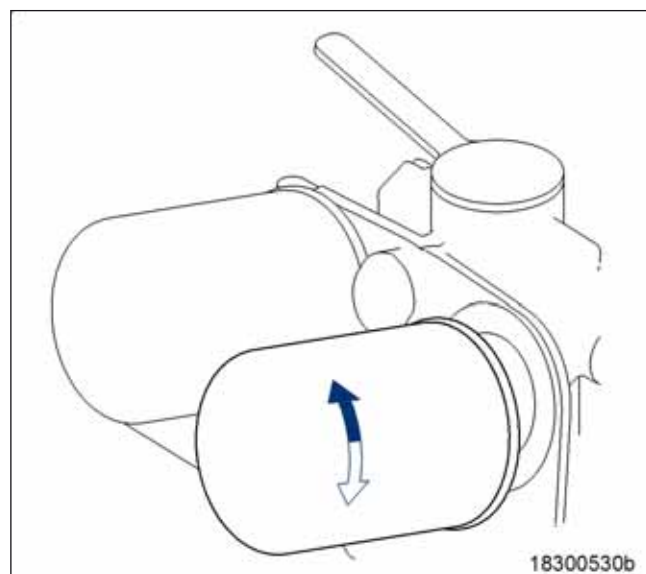
9. Replace other oil filters in the same way.
10. After each oil change and filter replacement, crank engine on starting system (→ Page 136).
11. Check oil level (→ Page 177).

Replacing switchable oil filters with engine at standstill

1. Stop engine (→ Page 76) and disable engine start.
2. Cut out filter to be replaced.
 - A Right filter cut out
 - B Both filters cut in (normal operating position)
 - C Left filter cut out



3. Wait until oil filter is empty.
4. Unscrew cut-out oil filter with oil filter wrench.
5. Clean sealing surface on connecting piece.
6. Check sealing ring of new oil filter and coat it with oil.
7. Fit SOLAS shield (→ Page 121).



8. Insert oil filter and tighten to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Filter	–	Tightening torque		25 Nm

9. Replace other oil filters in the same way.
10. Switch filter to normal position.
11. After each oil change and filter replacement, crank engine on starting system (→ Page 136).
12. Check oil level (→ Page 177).

Replacing switchable oil filters with engine running

1. Reduce engine speed to <1100 rpm.
2. Cut out oil filter and wait until oil filter is empty.
3. Unscrew cut-out oil filter with oil filter wrench.
4. Clean sealing surface on connecting piece.
5. Check sealing ring of new oil filter and coat it with oil.
6. Fit SOLAS shield (→ Page 121).
7. Insert oil filter and tighten to specified tightening torque.

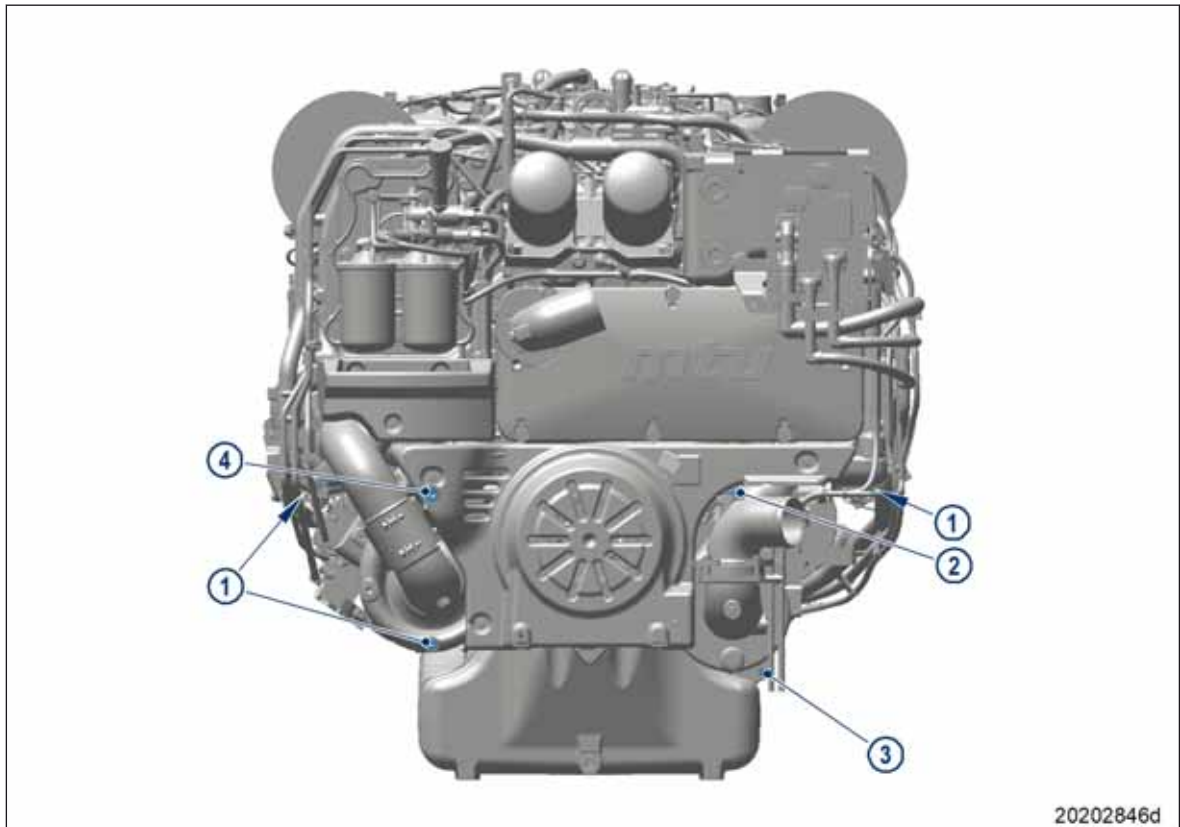
Name	Size	Type	Lubricant	Value/Standard
Filter	–	Tightening torque		25 Nm

8. Replace other oil filters in the same way.
9. Switch filter to normal position.
10. Check oil level (→ Page 177).

9.16 Coolant Circuit, General, High-Temperature Circuit

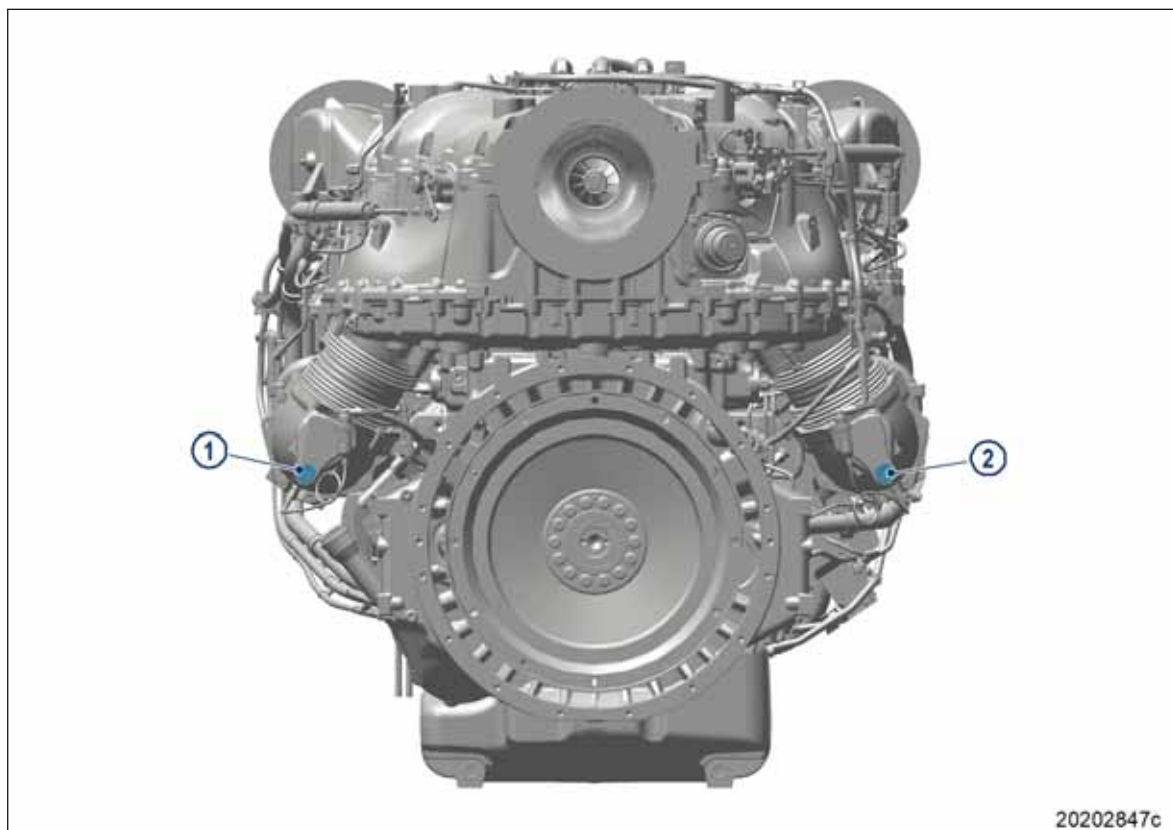
9.16.1 Engine coolant - Drain and venting points

Drain points, free end



- | | |
|-----------------------------------|-------------------------------------|
| 1 Engine coolant drain plug | 3 Raw-water pump drain |
| 2 Filling screw on raw-water pump | 4 Preheating line outlet connection |

Drain points, driving end

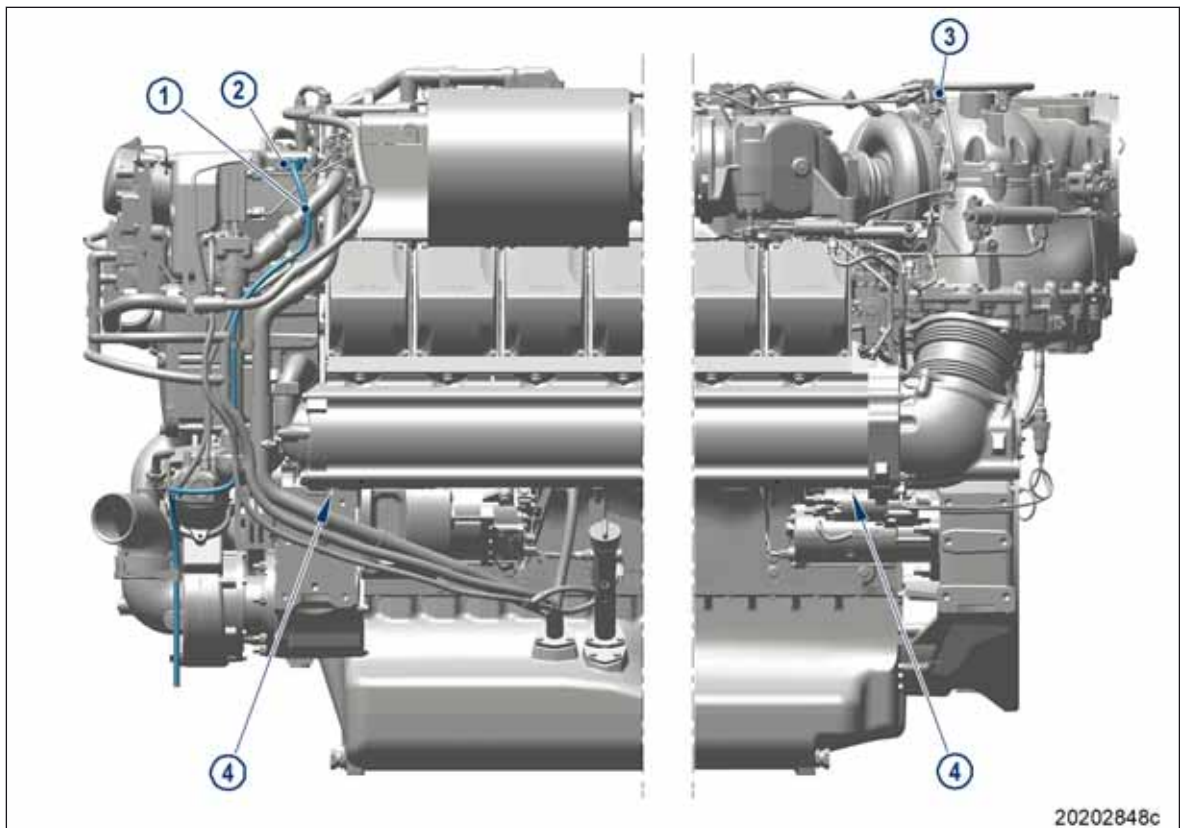


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1 Engine coolant drain plug

2 Engine coolant drain plug
Preheating line inlet connection

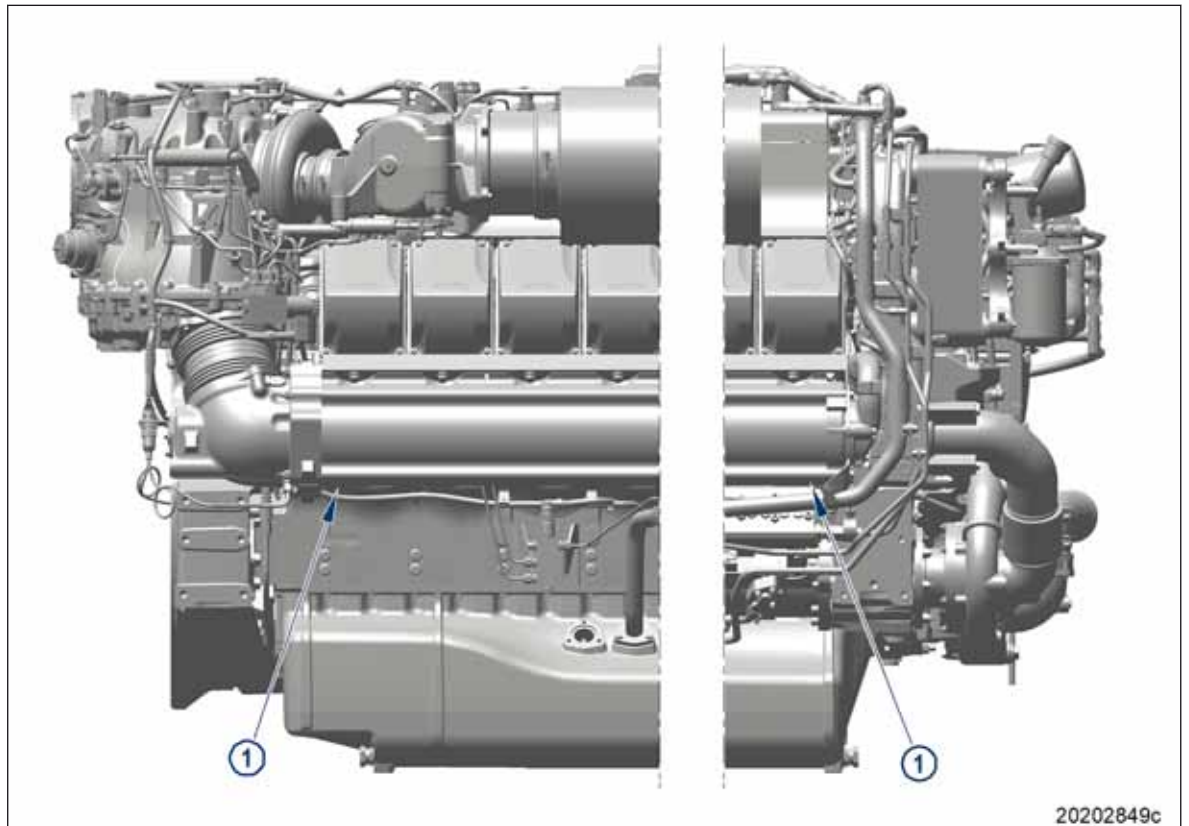
Drain points, left side



20202848c

- | | |
|----------------------------------|-----------------------------|
| 1 Engine coolant overflow line | 3 Vent valve |
| 2 Filler neck for engine coolant | 4 Engine coolant drain plug |

Drain points, right side



20202849c

1 Engine coolant drain plug

9.16.2 Engine coolant – Level check

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ 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.

NOTICE



Closing the cover on the coolant expansion tank when the engine is warm. After starting the engine, the necessary coolant pressure cannot be built up.

Risk of severe engine damage due to cavitation, especially with extended periods of operation!

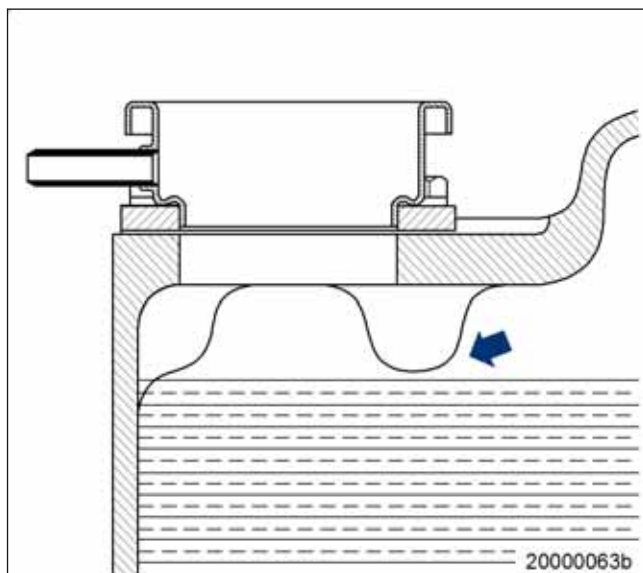
- Before closing the coolant expansion tank, make sure that the coolant has cooled down to below 40°C.

Checking coolant level at filler neck

1. Turn valve cover of coolant expansion tank (→ Page 44) counterclockwise until the first stop and allow pressure to escape.
2. Continue to turn valve cover counterclockwise and remove.

Note: Coolant must be visible at the lower edge of the cast-in eye of the filler neck (arrowed).

3. Check coolant level.
4. Top up with treated coolant as necessary (→ Page 189).



Checking coolant level by means of level sensor

Note: The engine control system monitors the minimum coolant level.

1. Switch on engine control system and check readings on display.
2. Top up with treated coolant as necessary (→ Page 189).

9.16.3 Engine coolant – Change

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Coolant		

Engine coolant change

- 1. Drain engine coolant (→ Page 188).
- 2. Fill with engine coolant (→ Page 189).

9.16.4 Engine coolant – Draining

Preconditions

- ☒ Engine is stopped and starting disabled

WARNING



Coolant is hot and under pressure.

Risk of injury and scalding!

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

Preparatory steps

1. Provide an appropriate container to collect the coolant or switch on the extraction device.
2. Switch off preheating unit.
3. Coolant temperature is below 50 °C.

Draining engine coolant

1. Turn breather valve of filler neck on coolant expansion tank (→ Page 182) counterclockwise to first stop and allow pressure to escape.
2. Continue to turn valve cover counterclockwise and remove.
3. Draw off separated corrosion inhibitor oil in expansion tank through the filler neck.
4. Open drain valves/plugs (→ Page 182) and drain or pump out engine coolant.
5. Close all open drain points.
6. Position breather valve on filler neck and close.




9.16.5 Engine coolant – Filling

Preconditions

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

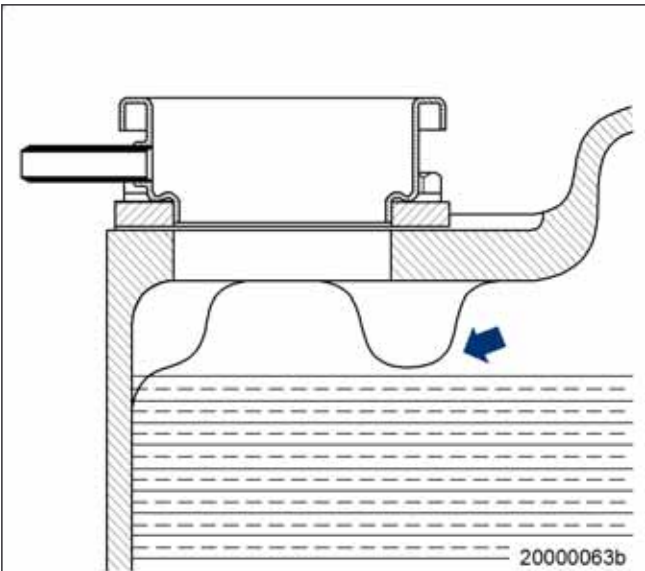
Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine coolant		

WARNING 	<p>Coolant is hot and under pressure.</p> <p>Risk of injury and scalding!</p> <ul style="list-style-type: none">• Let the engine cool down.• Wear protective clothing, gloves, and goggles / safety mask.
NOTICE 	<p>Cold coolant in hot engine can cause thermal stress.</p> <p>Possible formation of cracks in the engine!</p> <ul style="list-style-type: none">• Fill / top up coolant only into cold engine.
NOTICE 	<p>Closing the cover on the coolant expansion tank when the engine is warm. After starting the engine, the necessary coolant pressure cannot be built up.</p> <p>Risk of severe engine damage due to cavitation, especially with extended periods of operation!</p> <ul style="list-style-type: none">• Before closing the coolant expansion tank, make sure that the coolant has cooled down to below 40°C.

Engine coolant – Filling

1. Turn valve cover of coolant expansion tank (→ Page 44) counterclockwise until the first stop and allow pressure to escape.
2. Continue to turn valve cover counterclockwise and remove.
3. Pour coolant into engine until coolant level reaches bottom edge of cast-in eye of filler neck (arrowed).
4. Check satisfactory condition of valve cover and clean sealing faces.
5. Position valve cover on filler neck and close.
6. Start engine and operate it at idle speed for some minutes.
7. Vent coolant system as required (→ Page 190).
8. Check coolant level (→ Page 186).
9. Repeat steps until coolant no longer needs to be topped up.



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9.16.6 Engine coolant system – Venting

DANGER



Hazardous exhaust gases

Danger of suffocation and poisoning

- Ensure adequate ventilation.
- In case of nausea, dizziness or signs of tiredness, leave the room / danger zone immediately and shut down the plant.

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



Hot components/surfaces.

Risk of burns!

- Allow the engine to cool down to below 50 °C before beginning work.
- Wear suitable protective equipment/thermal gloves.
- Avoid unprotected contact with hot surfaces.

Preparatory steps

- Provide a suitable vessel to catch the coolant.

Venting coolant system

Note: The vent valve is located on top of the carrier housing.

1. Connect hose to nipple (arrow) of vent valve (1).
2. Guide hose into the provided container.
3. With the engine running (idle), open vent valve (1) until bubble-free coolant escapes.
4. Close vent valve (1).
5. Remove hose.



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9.16.7 HT coolant pump – Relief bore check

DANGER



Components are moving or rotating.

Risk of crushing, danger of parts of the body being caught or pulled in!

- Operate the engine at low load only. Keep clear of the danger zone of the engine.

WARNING



A high level of noise is produced when the engine is running.

Risk of hearing loss!

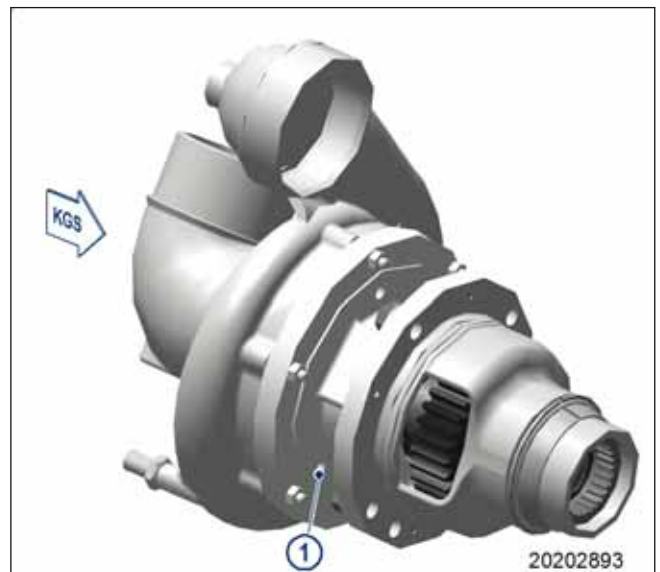
- Wear suitable hearing protection.

HT coolant pump – Relief bore check

1. Check relief bore (1) for oil and coolant discharge.

Result: No fluid should emerge.

2. If contaminated:
 - Stop engine (→ Page 76) and disable engine start.
 - Clean relief bore with a wire.
3. If liquid emerges, contact Service.



9.16.8 Engine coolant – Sample extraction and analysis

Preconditions

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

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
MTU test kit	F6798833	1

WARNING



Coolant is hot and under pressure.

Risk of injury and scalding!

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

NOTICE



Closing the cover on the coolant expansion tank when the engine is warm. After starting the engine, the necessary coolant pressure cannot be built up.

Risk of severe engine damage due to cavitation, especially with extended periods of operation!

- Before closing the coolant expansion tank, make sure that the coolant has cooled down to below 40°C.

Engine coolant – Sample extraction and analysis

1. Turn valve cover of coolant expansion tank (→ Page 182) counterclockwise until the first stop and allow pressure to escape.
2. Continue to turn valve cover counterclockwise and remove.
3. Draw off precipitated corrosion inhibitor oil from expansion tank and dispose of oil.
4. Draw off approx. 1 liter coolant and drain into a clean container.
5. Use equipment and chemicals from the MTU test kit to examine coolant for:
 - antifreeze concentration;
 - corrosion inhibitor concentration;
 - pH value.
6. Fit valve cover and close it.
7. Change engine coolant according to the change intervals specified in the (→ Fluids and Lubricants Specifications A001061/..) (→ Page 188).

9.16.9 Valve cover – Replacement

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Valve cover	(→ Spare Parts Catalog)	1

WARNING



Coolant is hot and under pressure.

Risk of injury and scalding!

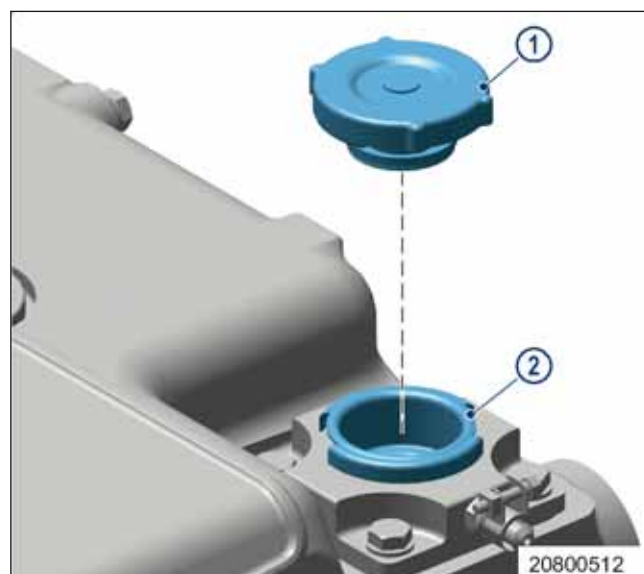
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Preparatory steps

- Switch off preheater.

Valve cover – Replacement

1. Turn valve cover (1) on coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
2. Continue to turn valve cover counterclockwise and remove.
3. Clean sealing face on filler neck (2).
4. Check coolant level and correct as necessary (→ Page 186).
5. Fit new valve cover and close it.



9.17 Preheater

9.17.1 Preheater – Thermostat replacement

Special tools, Material, Spare parts

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

DANGER



Symbol for electric voltage

Danger to life through electric shock

- Work is only permitted when the plant voltage is disconnected.

WARNING



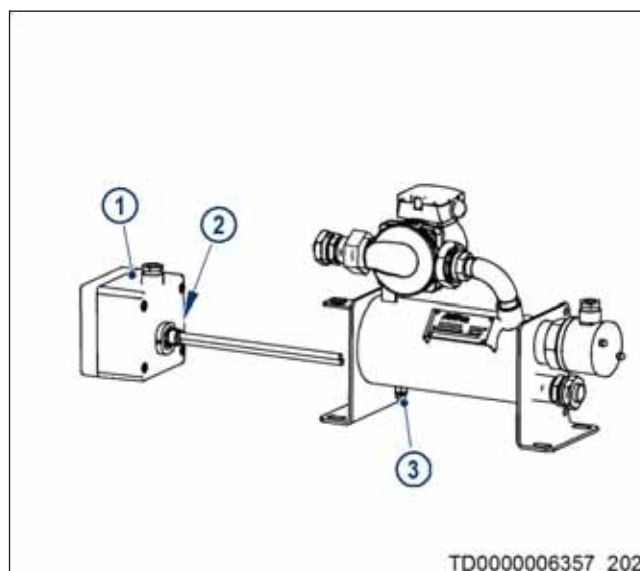
Coolant is hot and under pressure.

Risk of injury and scalding!

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

Thermostat – Removal

1. Switch off preheater.
2. Close shutoff valves in the supply and return line.
3. Disconnect preheater from power supply.
4. Provide a suitable container to catch the coolant.
5. Drain coolant by unscrewing drain screw (3) and collect discharged coolant in a suitable container.
6. Insert drain screw (3) and tighten.
7. Remove thermostat (1).
8. Remove gasket (2).



Thermostat – Installation

1. Clean mount for thermostat on housing.
2. Fit new gasket (2).
3. Install new thermostat (1).
4. Connect preheater unit to power supply.
5. Switch on preheating unit.
6. Check coolant level (→ Page 186).

9.17.2 Preheater – Function and leak check

Preconditions

- ☒ Preheating unit is switched on.

Function check

Note: The preheater operates properly if the measured value of the coolant temperature is within the control range of the thermostat.

1. Check coolant preheating temperature.
2. If the temperature is beyond the control range, set the thermostat to the desired values.

Leak check

1. Check unit for leaks at coolant inlet and coolant outlet.
2. Tighten leaky connections.

9.18 Raw Water Pump with Connections

9.18.1 Raw water pump – Relief bore check

DANGER



Components are moving or rotating.

Risk of crushing, danger of parts of the body being caught or pulled in!

- Operate the engine at low load only. Keep clear of the danger zone of the engine.

WARNING



A high level of noise is produced when the engine is running.

Risk of hearing loss!

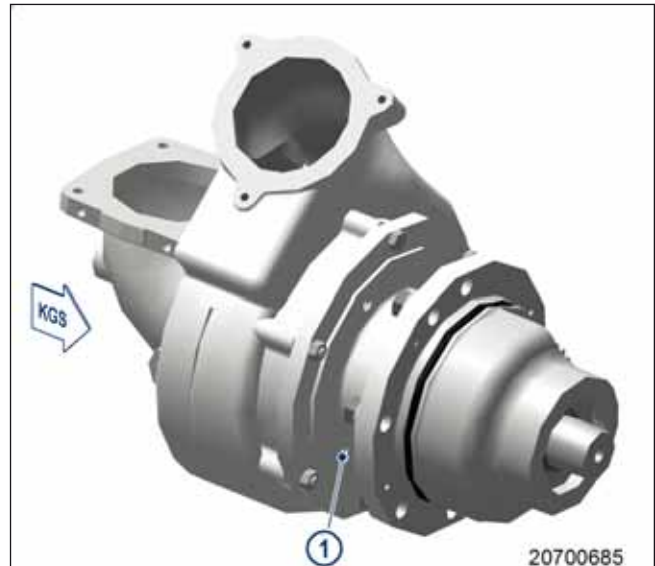
- Wear suitable hearing protection.

Checking relief bore of raw water pump

1. Check relief bore (1) for oil and raw water discharge.

Result: No fluid should emerge.

2. If contaminated:
 - Stop engine (→ Page 76) and disable engine start.
 - Clean relief bore with a wire.
3. If liquid emerges, contact Service.



9.19 Engine Mounting / Support

9.19.1 Engine mounting - Checking securing screws for firm seating

Preconditions

- ☒ Engine is stopped and starting disabled.

Engine mounting, checking securing screws for firm seating

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

9.19.2 Engine mounting – Checking condition of resilient mounts

Preconditions

- ☒ Engine is stopped and starting disabled.

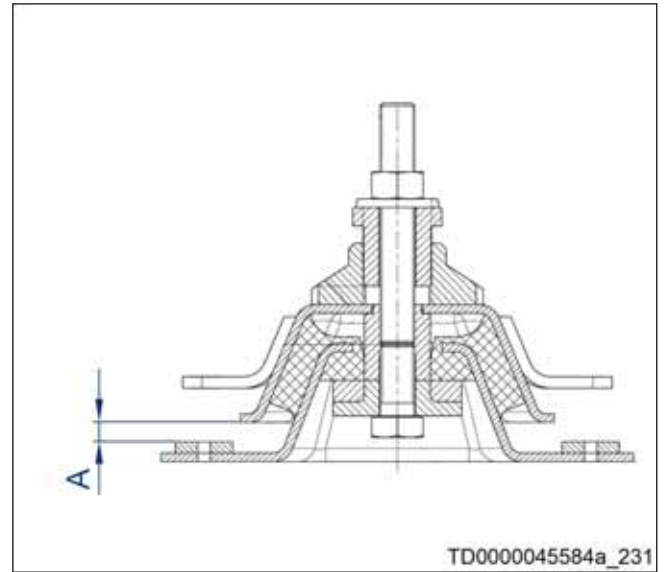
Engine mounting – Checking the condition of resilient mounts

1. Wipe rubber surface with dry cloth, do not use organic detergents.
2. Visually inspect resilient mounts for cracking and deformation.
3. Check rubber surfaces for swelling.
4. Have cracked or swollen mounts replaced, contact Service.

9.19.3 Engine mount – Measuring height of rubber element

Variant A

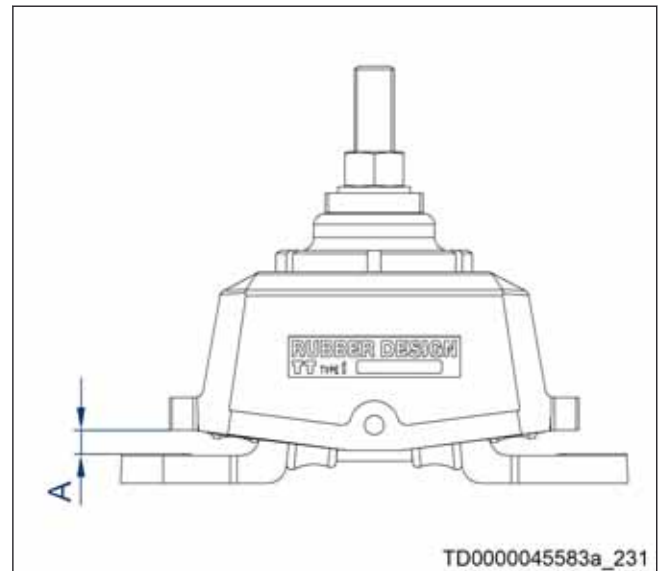
A Loaded 11 mm (free-standing gear-box)



1. Measure each resilient mount.
2. Measure height (A) of rubber element under load:
 - a) If height (A) of one rubber element is less than 7 mm: Replace relevant resilient mount.
 - b) If height (A) of all resilient mounts is not within a tolerance of ± 1 mm of the average value:
 - Compensate height difference with height adjustment.
 - If the height adjustment is no longer sufficient, place shims between affected resilient mounts and mating faces.

Variant B

A Loaded 11.5 mm (flange-mounted gearbox)



1. Measure each resilient mount.
2. Measure height (A) of rubber element under load:
 - a) If height (A) of one rubber element is less than 7 mm: Replace relevant resilient mount.
 - b) If height (A) of all resilient mounts is not within a tolerance of ± 1 mm of the average value:
 - Compensate height difference with height adjustment.
 - If the height adjustment is no longer sufficient, place shims between affected resilient mounts and mating faces.

9.20 Drive Systems, Driving End and Free End (Coupling)

9.20.1 Torsionally resilient coupling – Visual inspection

Preconditions

- ☑ Engine is stopped and starting disabled.

WARNING



Rotating parts.

Risk of injury!

- Disable engine start.

Checking coupling

Item	Findings	Action
Check coupling for contamination.	Contaminated	Remove loose dirt from coupling.
Check coupling for cracks, spalling or missing parts.	Cracks, defective or missing parts	Contact Service.
Check rubber elements for permanent deformation .	Permanent deformation of rubber elements	<ul style="list-style-type: none">• Document permanent deformation.• Check permissible value according to manufacturer's documentation.• If the maximum permissible deformation is exceeded, contact Service.
Check rubber elements for cracks.	Crack formation on rubber elements	<ul style="list-style-type: none">• Determine and document depth of cracks and check again after three months, at the latest.• Determine the cause of crack formation and rectify. If the root cause cannot be identified, inform manufacturer.• Check permissible value according to manufacturer's documentation.• If the maximum permissible crack depth is exceeded, contact Service.
If the coupling is pluggable, check the teeth on the rubber element for wear.	Wear-and-tear	<ul style="list-style-type: none">• Check permissible value according to manufacturer's documentation.• If the maximum permissible wear is exceeded, contact Service.
Check rubber/metal connection.	Detachment	<ul style="list-style-type: none">• Photograph and document the defective area.• Inform manufacturer immediately.

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9.21 Fuel Treatment System

9.21.1 Water drain valve - Check

Water drain valve – Check

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

9.21.2 Coalescer filter element – Replacement

Preconditions

- ☑ System is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 8–40 Nm	F30043446	1
Ratchet adapter	F30027340	1
Fuel		
Engine oil		
Coalescer filter element	(→ Spare Parts Catalog)	
Gasket	(→ Spare Parts Catalog)	

WARNING



Fuels are combustible and explosive.

Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

NOTICE



Contamination of components.

Damage to component!

- Observe manufacturer's instructions.
- Check components for special cleanliness.

NOTICE



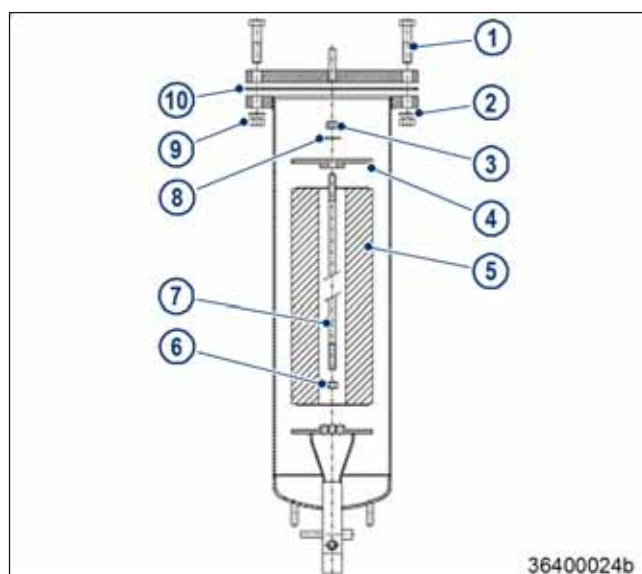
Incorrect installation of components and lines.

Damage to component!

- Ensure that components/lines are installed so that they are never under tension or strain.
- Ensure correct installation position of components.

Replacing coalescer filter element

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



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

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

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

Result: The fuel treatment system is ready for operation.

9.21.3 Differential pressure gage – Alarm function check

WARNING



Fuels are combustible and explosive.

Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

Checking differential pressure gage alarm function

1. Switch on fuel treatment system (→ Page 74).
2. Set the alarm points at the differential pressure gage to zero.

Result: Alarm is issued after preset time.

3. Reset alarm points at differential pressure gage.

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

Preconditions

- ☑ System is put out of service and emptied.

WARNING



Fuels are combustible and explosive.

Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

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

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.
 5. Switch on plant.
- Result: Water drain valve opens.
6. Leave water level probe in tank.
- Result: Alarm must be issued after the preset time.
7. Switch off the system.
 8. Disconnect plug from water level probe.
 9. Remove water level probe from tank.
 10. Screw in water level probe.
 11. Connect plug for water level probe.
 12. Fill system, vent and put into operation.

9.21.5 Pump capacity – Check

WARNING



Fuels are combustible and explosive.

Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

Checking pump capacity

1. Install suitable pressure gauge in the intake connection of the pump.
2. Check pump pressure.
 - a) Switch on fuel treatment system (→ Page 74).

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

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

Example:

Measured value (normal condition).	3 bar
Measured value (reduced suction condition).	2.6 bar

The wear limit has been reached when the measured value (reduced suction) is 10% lower than the measured pressure (normal). Repair pump (Contact Service).

9.22 Battery-Charging Generator

9.22.1 Battery-charging generator drive – Coupling condition check

Preconditions

- ☑ Engine is stopped and starting disabled

Special tools, Material, Spare parts

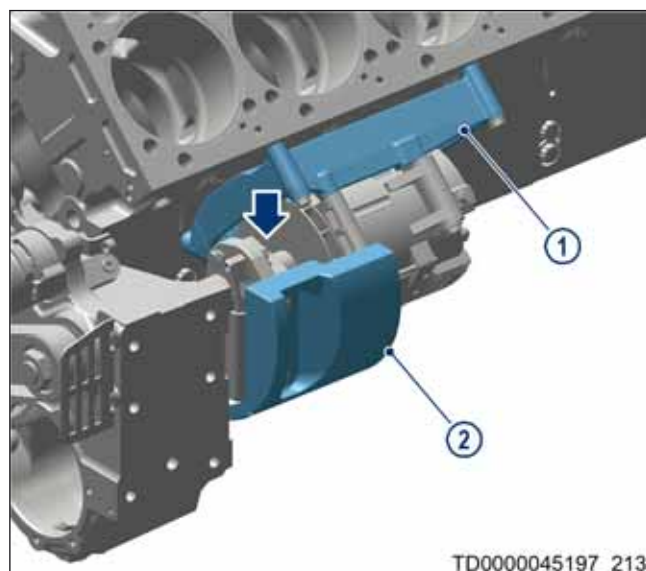
Designation / Use	Part No.	Qty.
Endoscope	Y20097353	1

Battery-charging generator drive, checking coupling condition

1. Install barring tool (→ Page 135).
2. Guide endoscope optics between guard plate (2) and battery-charging generator carrier (1) (arrowed).

Note: Seek the assistance of a second person

3. Bar engine slowly by hand.
4. Examine the resilient coupling over the entire circumference for plastic deformation and cracks.
5. If there is serious deformation or crack formation, contact Service.
6. Remove barring gear (→ Page 135).



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9.22.2 Battery-charging generator drive – Drive belt replacement

Preconditions

- ☒ Engine is stopped and starting disabled

Special tools, Material, Spare parts

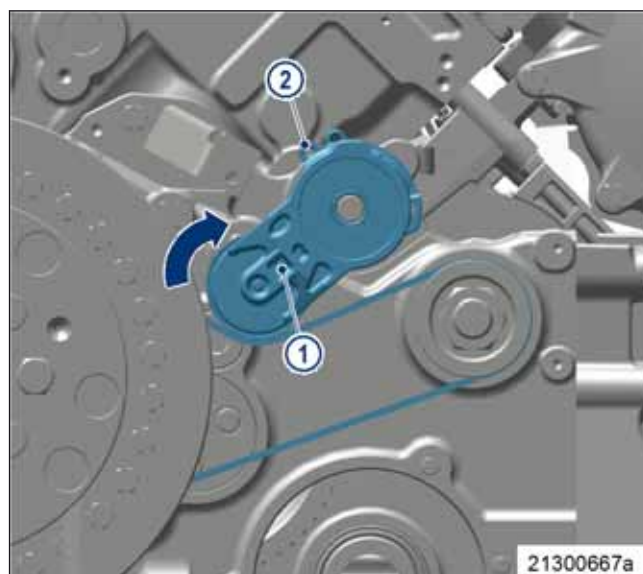
Designation / Use	Part No.	Qty.
Drive belt	(→ Spare Parts Catalog)	

Preparatory steps

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

Replacing drive belt

1. Using square (1), rotate adjusting lever clockwise until the drive belt is released.
2. Secure adjusting lever with locating pin or screwdriver (2).
3. Remove drive belt.
4. Check cleanness of belt pulleys.
5. Insert new drive belt.
6. Remove locating pin from adjusting lever.
7. Mount adjusting lever with square (1) slowly on drive belt.



Final steps

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

9.23 Wiring (General) for Engine/Gearbox/Unit

9.23.1 Engine cabling – Check

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Solvent (isopropyl alcohol)	X00058037	1

Engine cabling – Check

1. Check securing screws of cable clamps on engine and tighten loose screw connections.
2. Ensure that cables are securely seated in clamps and cannot move freely.
3. Check if all cable clips are closed and intact.
4. Replace faulty cable clips.
5. Check that cable ties are firmly seated, tighten loose cable ties.
6. Replace faulty cable ties.
7. Visually inspect the following electrical components for damage:
 - Connector housings
 - Contacts
 - Sockets
 - Cables and terminals
 - Plug-in contacts

Result: Contact Service if cable conductors are damaged.

Note: Close off disconnected connectors with protective caps provided.

8. Use isopropyl alcohol to clean dirty connector housings, sockets and contacts.
9. Ensure that all connecting plugs of the sensors are correctly engaged.

Important

Connecting connectors to sensors is only permitted when the engine is stopped.

9.24 Coupling

9.24.1 Universal shaft - Lubrication

Preconditions

- ☑ Engine is stopped and starting disabled

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Grease gun	F30006433	1
Lubricating grease		1

NOTICE



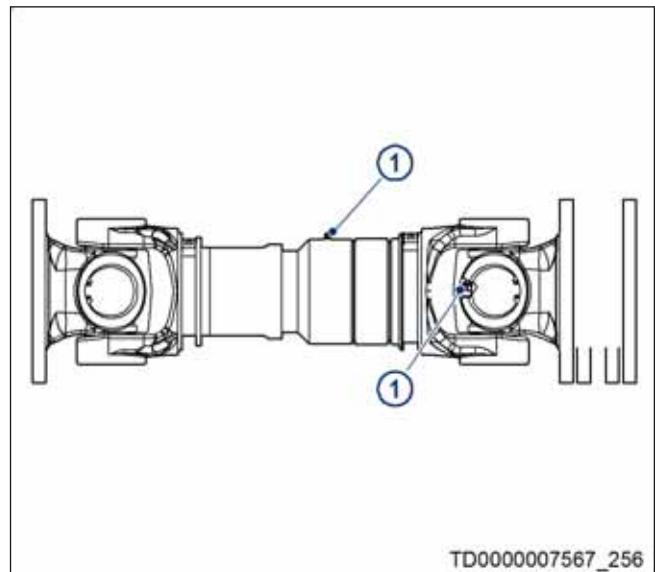
Damage to component.

Severe material damage!

- Do not press in grease at high pressure or with hard strokes.
- Permissible lubrication pressure max. 15 bar.

Lubricating universal shaft

1. Open protective caps.
2. Clean grease nipple (1) and lubricate.
3. Press lubricating grease into the lubricating points until it emerges at all the sealing lips.
4. Close protective caps.



9.25 Accessories for (Electronic) Engine Governor / Control System

9.25.1 Resetting CDC parameter and entering IIG with DiaSys®

Preconditions

- ☒ Engine is stopped and starting disabled.

Note: The engine will lose its emissions certification of the drift correction parameters (CDC) if not reset.

Parameters for drift correction (CDC) – Resetting with DiaSys®

1. Use DiaSys® to reset the CDC parameters (→ Dialog system DiaSys® E531920/..).
2. If no DiaSys® is available, contact Service.

Entering the codes for the injectors (IIG) with DiaSys®

1. Use DiaSys® to enter the IIG (→ Dialog system DiaSys® E531920/..).
2. If no DiaSys® is available, contact Service.

9.25.2 Engine governor and connectors – Cleaning

Preconditions

- ☒ Engine is stopped and starting disabled.
- ☒ Power supply to electronic engine management system is switched off.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Solvent (isopropyl alcohol)	X00058037	1

NOTICE



Insertion of unsuitable test probe, e.g. test prod.

The contacts in the plug connection can be bent!

- Carry out check of plug connection only with test connectors.

Engine governor and connectors – Cleaning

1. Use isopropyl alcohol to remove coarse dirt from housing surface.
2. Use isopropyl alcohol to remove dirt from the connector and cable surfaces.
3. Check legibility of cable labels. Clean or replace illegible labels.

Heavily contaminated connectors on engine governor – Cleaning

Note: Close off disconnected connectors with protective caps provided.

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

9.25.3 EMU and connectors – Cleaning

Preconditions

- ☒ Engine is stopped and starting disabled
- ☒ Power supply to electronic engine management system is switched off

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Solvent (isopropyl alcohol)	X00058037	1

NOTICE



Insertion of unsuitable test probe, e.g. test prod.

The contacts in the plug connection can be bent!

- Carry out check of plug connection only with test connectors.

Cleaning EMU and connectors

1. Use isopropyl alcohol to remove coarse dirt from housing surface.
2. Use isopropyl alcohol to remove dirt from the connector and cable surfaces.
3. Check legibility of cable labels. Clean or replace illegible labels.

Cleaning heavily soiled connectors on EMU

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

9.25.4 Engine governor plug connections – Check

Preconditions

- ☒ Engine stopped and starting disabled.
- ☒ Electronic engine management system is de-energized.

NOTICE



Insertion of unsuitable test probe, e.g. test prod.

The contacts in the plug connection can be bent!

- Carry out check of plug connection only with test connectors.

Checking plug connections at engine governor

1. Check all plug connections for secure seating.
2. Lock loose connectors.
3. Check dust cap on ECU and EXU connectors for damage and correct seating.

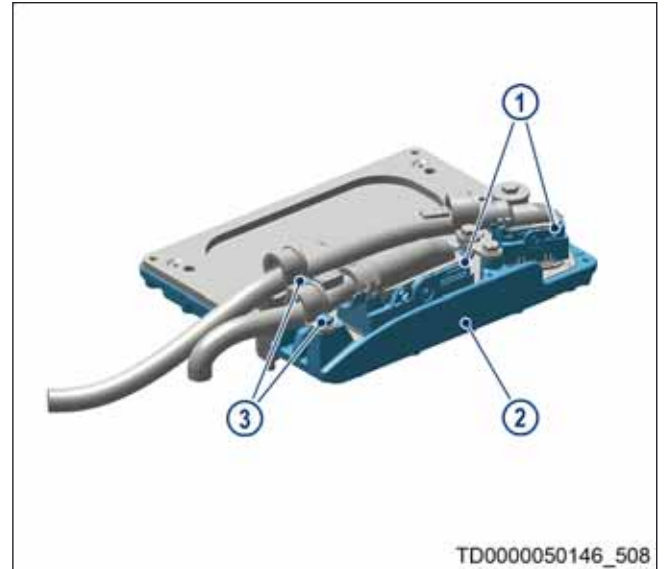
9.25.5 Engine Monitoring Unit EMU 8 – Plug connection check

Preconditions

- ☑ Engine is stopped and starting disabled
- ☑ Power supply to electronic engine management system is switched off

Checking plug connections on EMU

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



9.25.6 Interface module EIM plug connections - Check

Preconditions

- ☒ Engine is stopped and starting disabled.

Checking EIM plug connections

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



10 Appendix A

10.1 List of abbreviations

Abbreviation	Meaning	Explanation
ADEC	Advanced Diesel Engine Controller	Engine management system
AET	Außenerprobungsträger	Field Test Engine (FTE)
AL	Alarm	General Alarm
ANSI	American National Standards Institute	Association of American standardization organizations
BDM	Backup Data Module	-
BR	Baureihe	Series
BSP	British Standard Pipe	British Whitworth pipe threads
BV	Betriebsstoffvorschrift	Fluids and Lubricants Specifications (Publication No. A001061/..)
CAD	Computer-Aided Design	-
CAN	Controller Area Network	Data bus system, bus standard
CCS	Compatibility Check System	-
CPP	Controllable Pitch Propeller	-
cpsi	cells per square inch	-
CR	Common Rail	-
CSMF	Coated Sintered Metal Filter	-
DAS	Duty Alarm System	-
DIN	Deutsches Institut für Normung e. V.	German Standardization Organization, at the same time identifier of German standards ("Deutsche Industrie-Norm")
DIS	Display Unit	-
DL	Default Lost	Alarm: Default CAN bus failure
DOC	Diesel Oxidation Catalyst	-
DPF	Diesel Particulate Filter	-
ECS	Engine Control System	-
ECU	Engine Control Unit	Engine governor
EDM	Engine Data Module	Memory module for engine data
EGAT	Exhaust Gas Aftertreatment	-
EGR	Exhaust Gas Recirculation	-
EIL	Engine Ident Label	Electronic nameplate with specifications
EIM	Engine Interface Module	-
EMU	Engine Monitoring Unit	-
EPA	Environmental Protection Agency	US Environmental Protection Agency
ETC	Exhaust Turbocharger	-
ETK	Ersatzteilkatalog	Spare Parts Catalog (SPC)
FPP	Fixed Pitch Propeller	-
GCU	Gear Control Unit	-

Abbreviation	Meaning	Explanation
GMU	Gear Monitoring Unit	-
HI	High	Alarm: Measured value exceeds 1st maximum limit
HIHI	High High	Alarm: Measured value exceeds 2nd maximum limit value
HT	High Temperature	High temperature (HT)
ICFN	ISO - Continuous rating - Fuel stop power - Net	Power specification in accordance with DIN-ISO 3046-7
IDM	Interface Data Module	Memory module for interface data
IGI	Ignition Input	Binary input for ignition
IMO	International Maritime Organisation	-
ISO	International Organization for Standardization	International umbrella organization of all standardization institutes
KGS	Kupplungsgegenseite	Engine free end in accordance with DIN ISO 1204
KS	Kupplungsseite	Engine driving end in accordance with DIN ISO 1204
LCD	Liquid Crystal Display, Liquid Crystal Device	-
LCU	Local Control Unit	LOP subassembly
LED	Light Emitting Diode	-
LMU	Local Monitoring Unit	LOP subassembly
LO	Low	Alarm: Measured value lower than 1st minimum limit value
LOLO	Low Low	Alarm: Measured value lower than 2nd minimum limit value
LOP	Local Operating Panel	Control console, control panel
LOS	Local Operating Station	Local control unit
LPU	Lubricating Oil Pump Control Unit	-
MCS	Monitoring and Control System	-
MG	Message	-
MPU	Microprocessor Unit, Microprocessing Unit	Microprocessor unit
OPU	Operator Panel Unit	User interface panel
ORFS	O-Ring face seal	Flush seal design with O-ring fitted at the front face
OT	Oberer Totpunkt	Top Dead Center (TDC)
P-xyz	Pressure-xyz	Pressure measuring point xyz
PAN	Panel	Control panel
PAU	Power Automation Unit	Module for monitoring, control and plant-related system integration of peripheral components
PCD	Programmable Controller Device	-
PCU	Propeller Control Unit	-
PIM	Peripheral Interface Module	-
PLD	Pumpe Leitung Düse	Unit pump injection system
POM	Power Output Module	Module to control starter and battery-charging generator
PPC	Priming Pump Control	Oil priming pump
PTO	Power Take-Off	Main and auxiliary PTOs
RCS	Remote Control System	-

Abbreviation	Meaning	Explanation
RL	Redundancy Lost	Alarm: Redundant CAN bus failure
rpm	revolutions per minute	-
SAE	Society of Automotive Engineers	U.S. standardization organization
SD	Sensor Defect	Alarm: Sensor failure
SDAF	Shut Down Air Flaps	Emergency air shut-off flap(s)
SFB	Safety Function Box	Control unit
SFS	Safety Function System	Control system
SMF	Sintered Metal Filter	-
SS	Safety System	Safety system alarm
SUE-VSP	Steuerungs- und Überwachungseinrichtung Vorschmierpumpe	Control and Monitoring unit for oil priming pump
T-xyz	Temperature-xyz	Temperature measuring point xyz
TD	Transmitter Deviation	Alarm: Deviation in transmitter values
USV	Unterbrechungsfreie Stromversorgung	Uninterrupted Power Supply (UPS)
UT	Unterer Totpunkt	Bottom Dead Center (BDC)
UNF	Unified Fine Thread	-
VS	Voith Schneider	Voith-Schneider drive
VSP	Vorschmierpumpe	Oil priming pump
WJ	Water Jet	Waterjet drive
WZK	Werkzeugkatalog	Tool Catalog (TC)

10.2 Conversion tables

Length

Unit A	multiplied by factor	= Unit B
in	25.4	= mm
ft	0.3048	= m
yd	0.9144	= m
stat. mile	1.609	= km
Nm	1.852	= km
ft	3	= yd
in	36	= yd

Unit B	multiplied by factor	= Unit A
mm	0.03937	= in
m	3.281	= ft
km	0.6215	= stat. mile

Surface

Unit A	multiplied by factor	= Unit B
in ²	645.16	= mm ²
ft ²	0.0929	= m ²
yd ²	0.8361	= m ²
stat. mile ²	2.59	= km ²

Unit B	multiplied by factor	Unit A
mm ²	0.00155	= in ²
m ²	10.764	= ft ²
m ²	1.1960	= yd ²
km ²	0.3861	= stat. mile ²

Volume

Unit A	multiplied by factor	= Unit B
in ³	16387	= mm ³
ft ³	0.02832	= m ³
yd ³	0.7646	= m ³
gallon (U.S.)	3.785	= dm ³
gallon (brit.)	4.546	= dm ³

Unit B	multiplied by factor	= Unit A
cm ³	0.06102	= in ³
m ³	35.31	= ft ³
dm ³	0.2642	= gallon (U.S.)
dm ³	0.22	= gallon (brit.)

Volumetric flow

Unit A	multiplied by factor	= Unit B
gal/min (GPM, U.S.)	3.79	= l/min
gal/min (GPM, U.S.)	0.134	= ft ³ /min (cfm)
ft ³ /min (cfm)	1.70	= m ³ /h
Unit B	multiplied by factor	= Unit A
l/min	0.264	= gal/min (U.S.)
ft ³ /min (cfm)	7.48	= gal/min (U.S.)
m ³ /h	0.589	= ft ³ /min (cfm)

Velocity

Unit A	multiplied by factor	= Unit B
ft/s	0.3048	= m/s
stat. mile/h (mph)	1.609	= km/h
knot (brit.)	1.852	= km/h
Unit B	multiplied by factor	= Unit A
m/s	3.281	= ft/s
km/h	0.6214	= stat. mile/h (mph)
km/h	0.54	= knot (brit.)

Mass

Unit A	multiplied by factor	= Unit B
lb	0.4536	= kg
oz	28.35	= g
ton (imp.)	1.016	= t
Unit B	multiplied by factor	= Unit A
g	0.03527	= oz
kg	2.205	= lb
t	0.9842	= ton (imp.)

Force

Unit A	multiplied by factor	= Unit B
lbf	0.4536	= kp
lbf	4.4482	= N
kp	9.80665	= N
Unit B	multiplied by factor	= Unit A
kp	2.205	= lbf
N	0.10197	= kp
N	0.2248	= lbf

Density

Unit A	multiplied by factor	= Unit B
slug/ft ³	515.4	= kg/m ³
Unit B	multiplied by factor	= Unit A
kg/m ³	0.00194	= slug/ft ³

Torque

Unit A	multiplied by factor	= Unit B
lbf ft	1.3558	= Nm
Unit B	multiplied by factor	= Unit A
Nm	0.7376	= lbf ft

Pressure

Unit A	multiplied by factor	= Unit B
lbf/in ² (psi)	703.1	= kp/m ² (mmH ₂ O)
lbf/in ² (psi)	0.06895	= bar
lbf/ft ² (psf)	47.88	= Pa
inHg	0.03386	= bar
inHg	345.3	= kp/m ² (mmH ₂ O)
Unit B	multiplied by factor	= Unit A
atm	760	= mmHg
atm	1.0133	= bar
atm	10332	= kp/m ² (mmH ₂ O)
atm	1.0332	= kp/cm ² (at)
atm	14.696	= lbf/in ² (psi)
bar	14.504	= lbf/in ² (psi)
Pa	0.0209	= lbf/ft ² (psf)

2nd moment of mass

Unit A	multiplied by factor	= Unit B
slug ft ²	1.3558	= kg m ²
Unit B	multiplied by factor	= Unit A
kg m ²	0.7376	= slug ft ²

Energy

Unit A	multiplied by factor	= Unit B
lbf ft	1.356	= J
kcal	4186.8	= J
BTU	1055	= J
CHU	1899	= J

Unit B	multiplied by factor	= Unit A
J	0.7376	= lbf ft
J	0.0002388	= kcal
J	0.0009478	= BTU
J	0.00052656	= CHU

Power

Unit A	multiplied by factor	= Unit B
PS	0.7355	= kW
HP	0.7457	= kW
BTU/s	1.054	= kW
kcal/h	1.163	= W
HP	550	= lbf ft/s

Unit B	multiplied by factor	= Unit A
kW	1.36	= PS
kW	1.341	= HP
kW	0.9487	= BTU/s
W	0.8598	= kcal/h
lbf ft/s	0.0018	= HP

Temperature

	Celsius	Kelvin
x °C	-	= x + 273.15 K
x K	= x - 273.15 °C	-
x °F	= 5/9(x - 32) °C	= 5/9(x - 32) + 273.15 K
x °R	= 5/4x °C	= (5/4x) + 273.15 K

	Fahrenheit	Réaumur
x °C	= 9/5x + 32 °F	= (4/5x) °R
x K	= 9/5(x - 273.15) + 32 °F	= 4/5(x - 273.15) °R
x °F	-	= 4/9 (x - 32) °R
x °R	= (9/4x) + 32 °F	-

Fuel consumption

Unit A	multiplied by factor	= Unit B
mile/gal (US)	0.4251	= km/l
gal/mile (US)	2.3527	= l/km

Unit B	multiplied by factor	= Unit A
km/l	2.3527	= mile/gal (US)
l/km	0.4251	= gal/mile (US)

10.3 Contact person/Service partner

Service

The worldwide network of the sales organization with subsidiaries, sales offices, representatives and customer service centers ensure fast and direct support on site and ensure 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 Internet site: <http://www.mtu-solutions.com>

24-h Hotline

With our 24-h hotline and high flexibility, we are your contact around the clock: during each operating phase, preventive maintenance and corrective operations in case of a malfunction, for information on changes in conditions of use and for supplying spare parts.

Your contact person in our Customer Assistance Center:

Tel: +49 7541 9077777

Fax.: +49 7541 9077778

Asia/Pacific: +65 6860 9669

North and Latin America: +1 248 560 8888

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 parts logistics system, a central warehouse at headquarters and on-site stores at our subsidiary companies, representatives and contractual workshops.

Your contact person:

E-mail: Please contact your spare parts order manager

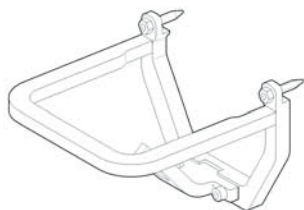
Tel: +49 7541 9077777

Fax.: +49 7541 9077778

11 Appendix B

11.1 Special Tools

Alignment jig

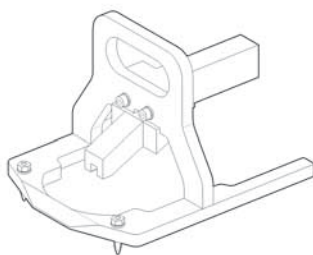


Part No.: F6795554

Qty.: 1

Used in: 9.8.2 Injector – Removal and installation (→ Page 149)

Alignment jig

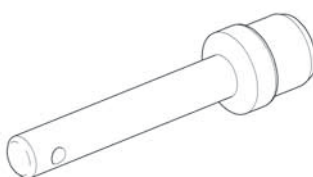


Part No.: F6795725

Qty.: 1

Used in: 9.8.2 Injector – Removal and installation (→ Page 149)

Alignment mandrel

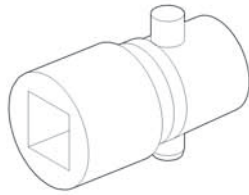


Part No.: F6795777

Qty.: 1

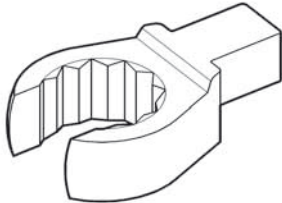
Used in: 9.8.2 Injector – Removal and installation (→ Page 149)

Barring tool



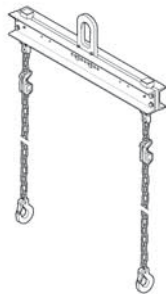
Part No.:	F6783914
Qty.:	1
Used in:	9.2.1 Engine – Cranking manually (→ Page 135)
Qty.:	1
Used in:	9.6.2 Valve clearance – Check and adjustment (→ Page 144)

Box wrench, 22 mm



Part No.:	F30038494
Qty.:	1
Used in:	9.9.1 Fuel system – Venting (→ Page 154)

Crossbeam



Part No.:	T80091731
Qty.:	1
Used in:	3.1 Transport (→ Page 22)

Double-head box wrench



Part No.:	F30002800
Qty.:	1
Used in:	9.6.2 Valve clearance – Check and adjustment (→ Page 144)

Endoscope



Part No.: Y20097353

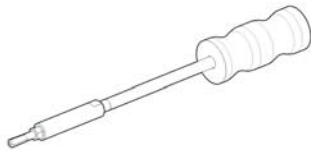
Qty.: 1

Used in: 9.3.2 Cylinder liner – Endoscopic examination
(→ Page 139)

Qty.: 1

Used in: 9.22.1 Battery-charging generator drive – Coupling condition check (→ Page 207)

Extraction device



Part No.: F6790992

Qty.: 1

Used in: 9.8.2 Injector – Removal and installation (→ Page 149)

Feeler gauge



Part No.: Y4345893

Qty.: 1

Used in: 9.6.2 Valve clearance – Check and adjustment
(→ Page 144)

Grease gun



Part No.: F30006433

Qty.: 1

Used in: 9.24.1 Universal shaft – Lubrication (→ Page 210)

High-pressure cleaner

Part No.:

Qty.:

1

Used in:

6.13 Plant – Cleaning (→ Page 80)

Insertion socket wrench, 17 mm

Part No.:

F30030450

Qty.:

1

Used in:

9.6.2 Valve clearance – Check and adjustment
(→ Page 144)



Measuring jig

Part No.:

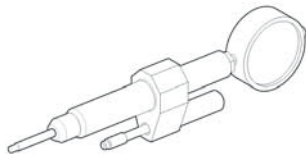
Y4348409

Qty.:

1

Used in:

9.6.2 Valve clearance – Check and adjustment
(→ Page 144)



Mounting sleeve

Part No.:

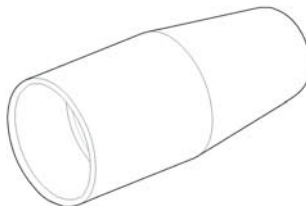
F30454554

Qty.:

1

Used in:

9.8.2 Injector – Removal and installation (→ Page 149)



MTU test kit

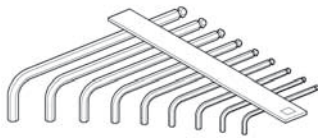


Part No.: F6798833

Qty.: 1

Used in: 9.16.8 Engine coolant – Sample extraction and analysis
(→ Page 192)

Offset screwdriver

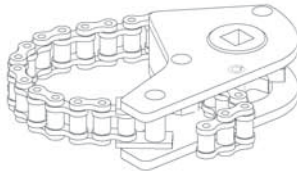


Part No.: F30453001

Qty.: 1

Used in: 9.6.2 Valve clearance – Check and adjustment
(→ Page 144)

Oil filter wrench



Part No.: F30379104

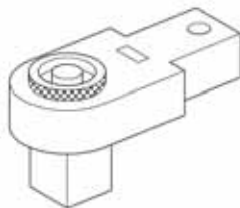
Qty.: 1

Used in: 9.10.1 Fuel filter – Replacement (→ Page 157)

Qty.: 1

Used in: 9.15.1 Engine oil filter – Replacement (→ Page 179)

Ratchet adapter

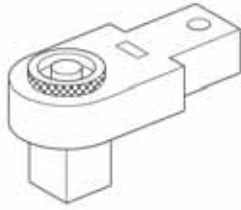


Part No.: F30027340

Qty.: 1

Used in: 9.21.2 Coalescer filter element – Replacement
(→ Page 202)

Ratchet bit



Part No.: F30027340

Qty.: 1

Used in: 9.6.2 Valve clearance – Check and adjustment
(→ Page 144)

Ratchet bit with extension



Part No.: F30006212

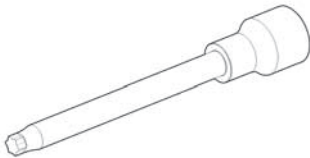
Qty.: 1

Used in: 9.2.1 Engine – Cranking manually (→ Page 135)

Qty.: 1

Used in: 9.6.2 Valve clearance – Check and adjustment
(→ Page 144)

Socket



Part No.: F30454548

Qty.: 1

Used in: 9.8.2 Injector – Removal and installation (→ Page 149)

Socket wrench



Part No.: F30452389

Qty.: 1

Used in: 9.8.2 Injector – Removal and installation (→ Page 149)

Torque wrench, 1–5 Nm

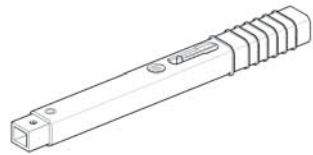


Part No.: F30452774

Qty.: 1

Used in: 9.8.2 Injector – Removal and installation (→ Page 149)

Torque wrench, 20–100 Nm



Part No.: F30026582

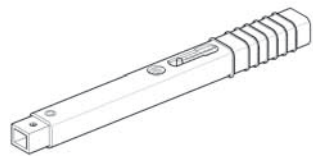
Qty.: 1

Used in: 9.6.2 Valve clearance – Check and adjustment (→ Page 144)

Qty.: 1

Used in: 9.8.2 Injector – Removal and installation (→ Page 149)

Torque wrench, 8–40 Nm



Part No.: F30043446

Qty.: 1

Used in: 9.6.1 Cylinder head cover – Removal and installation (→ Page 143)

Qty.: 1

Used in: 9.12.2 Air filter – Removal and installation (→ Page 175)

Qty.: 1

Used in: 9.21.2 Coalescer filter element – Replacement (→ Page 202)

Torque wrench, 8–40 Nm



Part No.: F30453004/21

Qty.: 1

Used in: 9.9.1 Fuel system – Venting (→ Page 154)

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12.1 Declaration of Conformity



MTU Friedrichshafen GmbH

Maybachplatz 1
88045 Friedrichshafen
Germany
T +49 7541 90-0

Declaration of Conformity for Recreational Craft Propulsion Engines with the exhaust emission requirements of Directive 2013/53/EU

Manufacturer: MTU Friedrichshafen GmbH
Maybachplatz 1, 88045 Friedrichshafen, Germany

Description: 4-stroke diesel inboard engine without integral exhaust

Engine family: MTU-V2000-01-RCD2

Engine types: Engine(s) covered by this Declaration:
10V 2000 M86 (1015 kW @ 2450 rpm) 12V 2000 M96L (1432 kW @ 2450 rpm)
10V 2000 M96 (1120 kW @ 2450 rpm) 12V 2000 M96X (1472 kW @ 2450 RPM)
10V 2000 M96L (1193 kW @ 2450 rpm) 16V 2000 M86 (1630 kW @ 2450 rpm)
12V 2000 M86 (1268 kW @ 2450 rpm) 16V 2000 M96 (1790 kW @ 2450 rpm)
12V 2000 M96 (1342 kW @ 2450 rpm) 16V 2000 M96L (1939 kW @ 2450 rpm)

Essential requirements

I.B.1. Engine identification	see technical documentation
I.B.2. Exhaust Emissions	acc. harmonized standard EN ISO 18854:2015
I.B.3. Durability	see technical documentation
I.B.4. Owner's manual	see technical documentation

Modules: Modules used for exhaust emission assessment:
☐ B+C ☒ B+D ☐ B+E ☐ B+F ☐ G ☐ H

Notified Body for exhaust emission assessment: DNV GL SE (Code-No. 0098)
Brooktorkai 18,
20457 Hamburg, Germany

EC Type examination certificate: RCDB000002F

This declaration of conformity is issued under the sole responsibility of the manufacturer. I declare on behalf of the engine manufacturer that the engine(s) will meet the requirements of above mentioned directives when installed in a recreational craft, in accordance with the engine manufacturer's supplied instructions and that this (these) engine(s) must not be put into service until the recreational craft into which it is (they are) to be installed has been declared in conformity with the relevant provisions of the above mentioned directives.

Friedrichshafen, 2020-09-17

MTU Friedrichshafen GmbH

Dr. Thorsten Kuhn
Director
Product Compliance

i.A. Stephan Fuss
Manager
Product Compliance

Board of Management: Andreas Schell (President and CEO), Louise Öfverström, Dr. Otto Preiss.
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