

Operating Instructions

Diesel engine
6R1600M20x

MS15029/01E



Power. Passion. Partnership.

Engine model	kW/cyl.	Hz	rpm	Application group
6R1600M20F	44.8 kW/cyl.	50 Hz	1500	3A, continuous operation, unrestricted
6R1600M20S	53.8 kW/cyl.	60 Hz	1800	3A, continuous operation, unrestricted

Table 1: Applicability

Table of Contents

1 Safety		5 Maintenance	
1.1 Important provisions for all products	5	5.1 Maintenance task reference table [QL1]	53
1.2 Personnel and organizational requirements	7	6 Troubleshooting	
1.3 Safety regulations for startup and operation	8	6.1 Troubleshooting	54
1.4 Safety regulations for maintenance and repair work	10	6.2 Engine governor ECU9 - Fault messages	57
1.5 Fire prevention and environmental protection, fluids and lubricants, auxiliary materials	13	7 Task Description	
1.6 Auxiliary materials, fire prevention and environmental protection	15	7.1 SOLAS	67
1.7 Standards for safety notices in the text	17	7.1.1 Installation locations for SOLAS shielding	67
1.8 Transport	18	7.1.2 SOLAS shielding as per MTN 5233 - Installation	69
2 General Information		7.1.3 Adhesive tape for SOLAS shielding - Application	70
2.1 Engine side and cylinder designations	19	7.2 Engine	71
2.2 Product description	20	7.2.1 Engine - Barring manually	71
2.3 Engine overview	23	7.2.2 Engine - Barring with starting system	73
2.4 Sensors and actuators - Overview	25	7.2.3 Engine - Test run	74
3 Technical Data		7.3 Crankcase Breather	75
3.1 Engine data 6R1600M20F, 6R1600M20S, engine-mounted heat exchanger, IMO Tier 2	29	7.3.1 Crankcase breather - Fine oil mist separator replacement	75
3.2 Engine data 6R1600M20F, 6R1600M20S, remote heat exchanger, IMO Tier 2	33	7.4 Valve Drive	77
3.3 Engine data 6R1600M20S, engine-mounted heat exchanger, EPA Tier 3	36	7.4.1 Valve clearance - Check and adjustment	77
3.4 Engine data 6R1600M20S, remote heat exchanger, EPA Tier 3	39	7.4.2 Cylinder head cover - Removal and installation	79
3.5 Firing order	42	7.5 Injector	82
3.6 Engine - Main dimensions	43	7.5.1 Injector - Replacement	82
4 Operation		7.5.2 Injector - Removal and installation	83
4.1 Putting the engine into operation after extended out-of-service periods (>3 months)	44	7.6 Fuel System	88
4.2 Putting the engine into operation after scheduled out-of-service-period	45	7.6.1 Fuel system - Venting	88
4.3 Engine start in manual operation (trials)	46	7.7 Fuel Filter	89
4.4 Safety system - Override	47	7.7.1 Fuel filter - Replacement	89
4.5 Operational checks	48	7.8 Air Filter	92
4.6 Engine stop in manual operation (trials)	49	7.8.1 Air filter - Replacement	92
4.7 Emergency stop	50	7.8.2 Air filter - Removal and installation	93
4.8 After stopping the engine - Engine remains ready for operation	51	7.9 Air Intake	94
4.9 After stopping engine - Putting engine out of operation	52	7.9.1 Service indicator - Signal ring position check	94
		7.10 Lube Oil System, Lube Oil Circuit	95
		7.10.1 Engine oil - Level check	95
		7.10.2 Engine oil - Change	97
		7.11 Oil Filtration / Cooling	98
		7.11.1 Engine oil filter - Replacement	98
		7.12 Coolant System, General, High-Temperature Circuit	102
		7.12.1 Engine coolant - Level check	102

7.12.2	Engine coolant - Change	103	7.16.1	Engine governor and connector - Cleaning	117
7.12.3	Engine coolant - Draining	104	7.16.2	Engine governor - Checking plug-in connections	118
7.12.4	Engine coolant - Filling	105			
7.12.5	Engine coolant pump - Relief bore check	107	7.17	Engine Mounting / Support	119
7.13	Low-Temperature Circuit	108	7.17.1	Engine mounting - Check	119
7.13.1	Charge-air coolant pump - Relief bore check	108			
7.14	Belt Drive	109	8	Appendix A	
7.14.1	Drive belt - Condition check	109	8.1	Abbreviations	121
7.14.2	Belt tensioner - Check	110	8.2	MTU contact persons/service partners	123
7.14.3	Drive belt - Replacement	111			
7.14.4	Belt tensioner - Tensioning element and tensioning roller replacement	113	9	Appendix B	
7.15	Wiring (General) for Engine/Gearbox/Unit	116	9.1	Special Tools	124
7.15.1	Engine cabling - Check	116	9.2	Index	131
7.16	Accessories for (Electronic) Engine Governor / Control System	117			

1 Safety

1.1 Important provisions for all products

Nameplate

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

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

All EU-certified engines delivered by MTU come with a second nameplate. When operating the machine in the EU: The second nameplate must be affixed in a prominent position as described in the accompanying specifications.

General information

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

- Incorrect use
- Operation, maintenance and repair by unqualified personnel
- Modifications or conversions
- Noncompliance with the safety instructions and warning notices

Correct use

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

Intended use entails operation:

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

Any other use is considered improper use. 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.

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.

Emission regulations and emission labels

Responsibility for compliance with emission 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 emission characteristics of the product are prohibited by emission regulations. Emission control units/systems may only be maintained, exchanged or repaired if the components used for this purpose are approved by the manufacturer.

Noncompliance with these regulations will invalidate the design type approval issued by the emissions regulation authorities. The manufacturer does not accept any liability for violations of the emission regulations. The maintenance schedules of the manufacturer must be observed over the entire life cycle of the product.

Replacing components with emission labels

Emission labels are attached to all MTU engines. These must remain on the engine throughout its operational life.

Engines used exclusively in land-based, military applications other than by US government agencies are excepted from this proviso.

Please note the following when replacing components with emission labels:

- Appropriate emission labels must be affixed on spare parts.
- Emission labels may not be transferred from old components to new ones.
- Emission labels on old components must be removed and destroyed.

1.2 Personnel and organizational requirements

Organizational measures of the user/manufacturer

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

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

Personnel must receive instruction on product handling and maintenance on the basis of this manual with a special emphasis on safety requirements and warnings.

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

Personnel requirements

All work on the product shall be carried out by trained and qualified personnel only:

- Training at the Training Center of the manufacturer
- Technical personnel from the areas mechanical engineering, plant construction and electrical engineering

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

Personnel must not be under the influence of alcohol, drugs or strong medication.

Work clothing and personal protective equipment

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

1.3 Safety regulations for startup and operation

Safety regulations for startup

Install the product correctly and carry out acceptance in accordance 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.

When putting the product into operation, always 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 safety equipment is in place.
- No persons wearing pacemakers or any other technical body aids are present.
- The service room is adequately ventilated.
- Keep clear of the service room during the first operating hours. Hazardous gases may occur as a result of the combustion of paints or oils.
- The exhaust system is leak-tight and that the gases are vented to atmosphere.
- Protect battery terminals, generator terminals or cables against accidental contact.
- Check that all connections have been correctly allocated (e.g. +/- polarity, direction).

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

Smoking is prohibited in the area of the product.

Safety regulations during operation

The operator must be familiar with the controls and displays.

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

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

Malfunctions and emergency stop

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

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

- Inform supervisor(s) in charge.
- Analyze the message.
- Respond to the emergency appropriately, e.g. execute an emergency stop.

Operation

Do not remain in the operating room when the product is running for any longer than absolutely necessary.

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 ear protectors.
- Mop up any leaked or spilled fluids and lubricants immediately or soak up with a suitable binder agent.

Operation of electrical equipment

During operation of electrical devices, certain elements of these devices are live/under high voltage.

Observe the warning information applicable to the devices.

1.4 Safety regulations for maintenance and repair work

Safety regulations prior to maintenance and repair work

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

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

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

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

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

- It is expressly permitted to do so following a written procedure.
- The product is running in the low load range and only for as long as absolutely necessary.

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

- Start interlock
- Key switch
- With hydraulic starting system: shut off supply line.

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

Disconnect the battery. Lock out circuit breakers.

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

Disconnect the control equipment from the product.

Use special tools if they are specified for the relevant work.

Elastomer components (e.g. engine mounts, damping elements, couplings and V-belts) must not be painted. They may only be installed after painting the engine or must be covered before painting work is carried out.

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 during maintenance and repair work

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

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

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

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

Make sure components or assemblies are placed on stable surfaces. Adopt suitable measures to avoid that components/tools fall down. Use the specified lifting equipment for all components.

Never use the product as a climbing aid.

When working high on the equipment, always use suitable ladders and work platforms. Never work on engines or components that are held in place by lifting equipment.

Keep fuel injection lines and connections clean.

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

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 retainers and dampers are installed correctly.

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

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

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

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

Pay particular attention to cleanliness at all times.

Remove any condensate from components which were chilled before assembly. If necessary, coat the components with a suitable corrosion inhibitor.

Safety regulations following maintenance and repair work

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

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

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

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

Welding work

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

Before starting welding work:

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

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

Do not use product as ground terminal.

Never position the welding power supply cable adjacent to, or crossing wiring harnesses of the product. The welding current may otherwise induce an interference voltage in the wiring harnesses which could conceivably damage the electrical system.

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

Hydraulic installation and removal

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

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

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

Before starting work, pay attention to the following:

- Vent the installation/removal device, the pumps and the pipework at the relevant designated points.
- During the installation procedure, screw on device with plunger extended.
- During the removal procedure, screw on device with plunger retracted.

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

During hydraulic installation/removal of components, ensure that no persons are in the direct vicinity of the component being pressed on.

Working with batteries

Observe the safety instructions of the battery manufacturer when working with 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 tools on the battery.

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

Working on electrical and electronic assemblies

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

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

Do not damage cabling during removal work. When 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 straps to secure cables.

Always use connector pliers to tighten union nuts on connectors.

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

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

- Moisture-proof
- Shock-proof
- Wrapped in antistatic foil if necessary.

Working with laser devices

Laser work must only be performed by authorized and trained personnel. When working with laser equipment, always observe the safety instructions in the manufacturer's Operating Instructions.

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

Laser devices must be equipped with protective devices in accordance with their class and usage to ensure safe operation.

Measuring deviations on components

At a reference temperature of 20 °C, workpieces, components and measuring instrument are within the specified tolerances.

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

Fire prevention

Flames, naked light and smoking are prohibited.

When working with combustible indirect materials, e.g. cleaning agent, ensure area is well ventilated. The resultant steam/air mixture must be sufficiently diluted to prevent a potentially explosive atmosphere.

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

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

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

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

Noise

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

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

Environmental protection and disposal

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

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

Fluids and lubricants, auxiliary materials

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

Process materials may also be hazardous or toxic. When using consumables and auxiliary materials as well as other chemical substances, observe the information contained in the safety data sheet for the product. The safety data sheet may be obtained from the relevant manufacturer or from MTU.

Take special care when using hot, chilled or caustic materials.

Used oil

Used oil contains combustion residues that are harmful to health.

Wear protective gloves!

Wash relevant areas after contact with used oil.

Lead

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

Compressed air

Observe special safety precautions when working with compressed air:

- Unauthorized use of compressed air, e.g. forcing flammable liquids (hazard class A1, A2 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).
- First shut off compressed air lines before compressed air device is disconnected from the supply line, or before device or tool is to be replaced.
- Carry out leak test in accordance with the specifications.

Painting

- 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 working area is well ventilated.
- Avoid knocking or jolting the containers, valves and fittings or workpieces in any way.

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

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

1.6 Auxiliary materials, fire prevention and environmental protection

Fire prevention

Correct fuel or oil leaks immediately. Quantities of oil or fuel on hot components can cause fires – therefore always keep the engine in a clean condition. Do not leave cloths soaked with fluids and lubricants lying on or near the assembly or plant. Do not store flammable material near the assembly or plant.

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

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

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

SOLAS classification

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

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

Noise

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

At all workplaces with a sound pressure level over 85 dB(A), always wear ear protectors.

Environmental protection and disposal

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

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

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

Batteries can be returned within the EU to MTU FN / MTU Onsite Energy free of charge for correct recycling/disposal.

Auxiliary materials

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

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

Used oil

Used oil contains combustion residue harmful to health.

Rub your hands with skin protection cream.

Wash your hands after contact with used oil.

Lead

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

Compressed air

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

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

Painting

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





Liquid nitrogen

- Store liquid nitrogen only in small quantities and always in specified containers without fixed covers.
- Avoid body contact (eyes, hands).
- Wear protective clothing, protective gloves, closed shoes and protective goggles / safety mask!
- Make sure that working area is well ventilated.
- Take great care not to subject containers, fittings and tools to impact or shock.

Acids/alkaline solutions

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

1.7 Standards for safety notices in the text

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.

Safety notices

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

1.8 Transport

Taking the engine's center of gravity into account

For information regarding the center of gravity of the engine, refer to the installation/arrangement drawing of the engine.

Transport

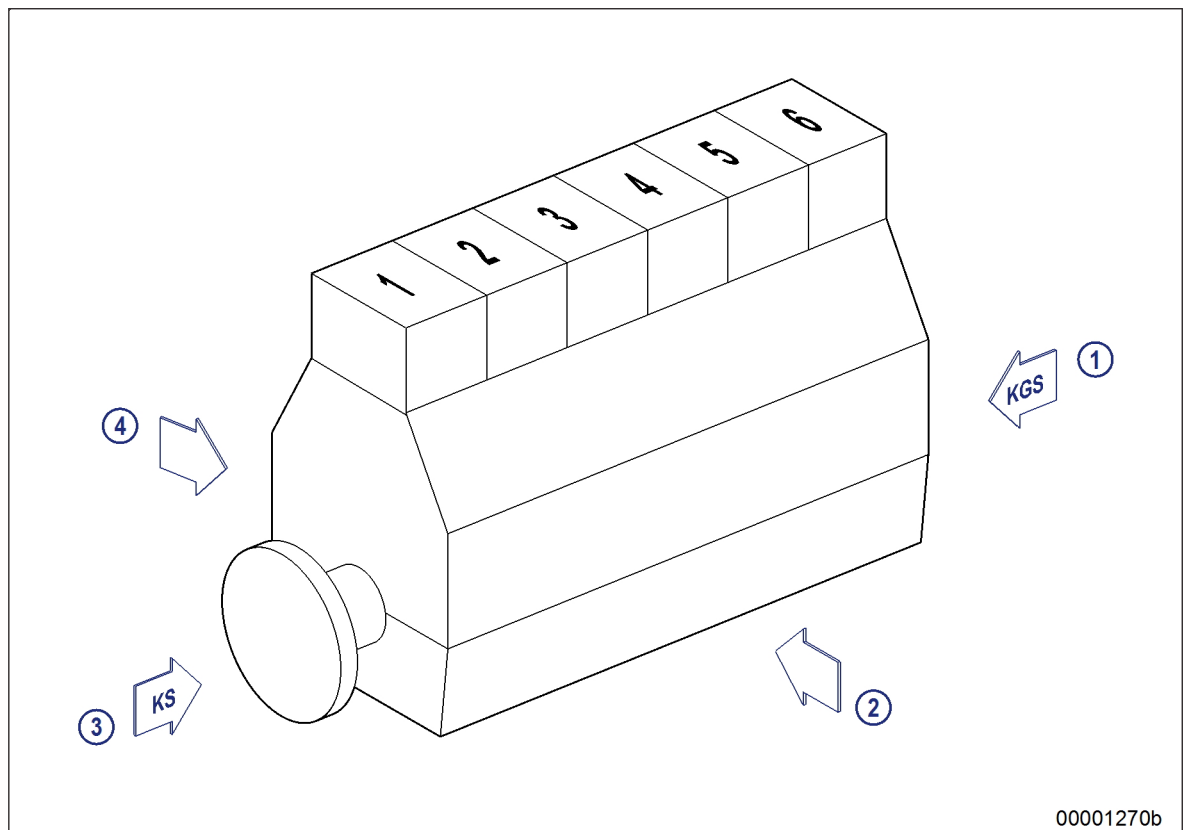
- Lift the engine only with the lifting eyes provided.
- Only use transport and lifting devices approved by MTU.
- Always transport the engine in installation position, observe the max. permissible diagonal pull:
 - Max. permissible diagonal pull in longitudinal direction is 10 degrees; with no diagonal pull in transverse direction permitted.
 - Max. permissible diagonal pull in longitudinal direction is 3 degrees; with no diagonal pull in longitudinal direction permitted.
- Lift engine by approx. 10 mm and verify that the lifting ropes / chains between engine and lifting equipment run vertically or in accordance with the specifications on the installation drawing. If this is not the case, the lifting equipment must be re-adjusted.
- If the engine is supplied with special aluminum foil packing, lift the engine at the lifting eyes of the bearing pedestal or use a means of transportation which is appropriate for the given weight (forklift truck).
- Secure the engine against tilting during transport.
- Secure such as to preclude slipping and tipping when driving up or down inclines and ramps.

Setting the engine down after transport

- Make sure that the consistency and load-bearing capacity of the ground or support surface is adequate.
- Never set down engine onto the oil pan unless expressly permitted by MTU on an engine-specific base.
- Only set down engine on a firm, level surface.

2 General Information

2.1 Engine side and cylinder designations



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

For engine side designation (acc. to DIN ISO 1204), the engine is viewed on driving end (3).

For cylinder designation (acc. to DIN ISO 12041), cylinders are numbered consecutively from engine driving end (3) starting with No. 1.

The numbering of other engine components is also from the driving end (3), starting with No. 1.

2.2 Product description

Description of the engine

Engine

The engine is a liquid-cooled four-stroke diesel engine, rotating counter-clockwise (viewed on driving end), with direct injection and charge air cooling.

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

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

Fuel system

Electronically controlled unit injection pumps with double-walled HP lines.

The electronic control unit controls

- Injection start
- Injection quantity

Fuel leaks are prevented by the following design measures:

1. Special unions on high-pressure fuel lines
2. Double-walled high-pressure fuel lines

The design of the fuel system complies with the SOLAS requirements.

Exhaust system

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

The triple-walled design permits

- low surface temperature,
- reduced amount of heat to be dissipated by the coolant,
- absolute gas-tightness.

Supercharging

Exhaust turbocharger with charge-air cooling.

Cooling system

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

Seawater only circulates in the engine coolant cooler and raw water pump.

Service block

The service components are mounted at the auxiliary PTO end.

The layout permits easy access for maintenance.

Service components:

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

Electronic engine control unit (ECU)

Functions:

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

SOLAS – Fire safety requirements

Fuel system, fuel lines with fuel pressure >1.8 bar

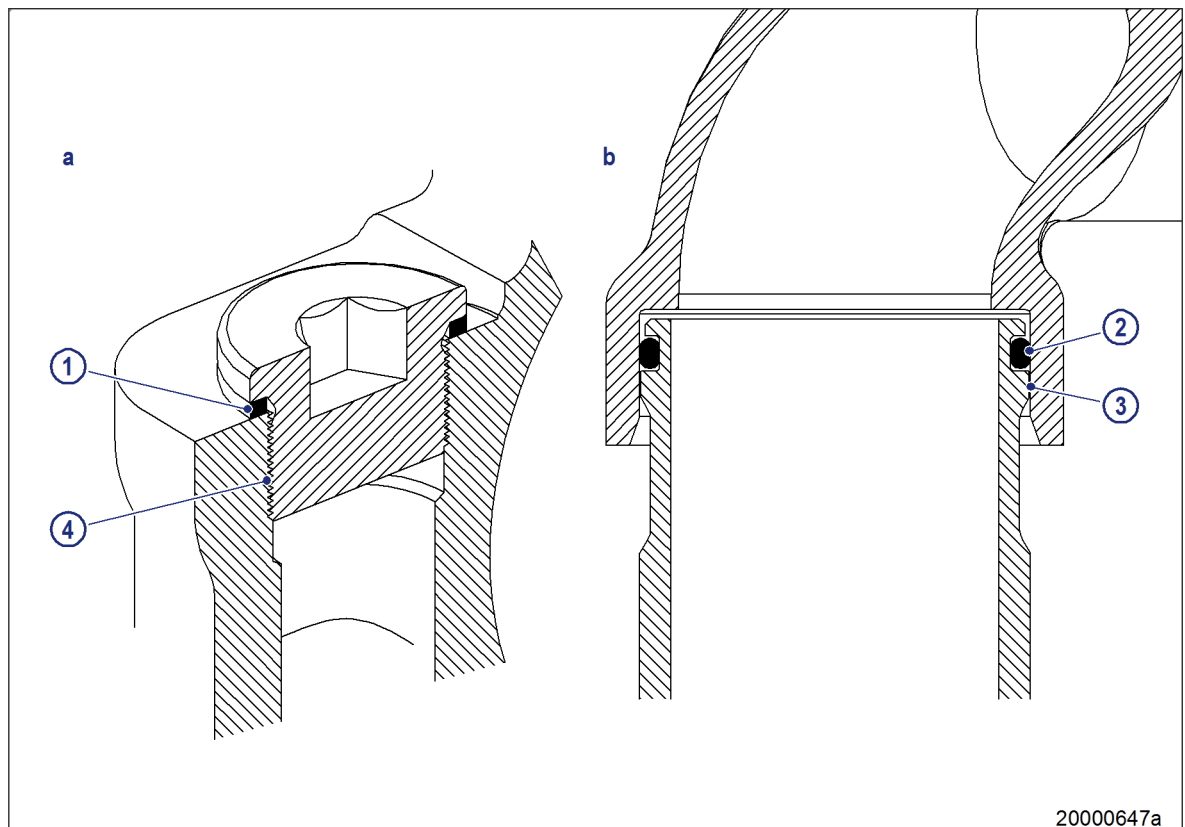
SOLAS-compliant covers must be fitted to pipe joints according to MTU standard MTN5233 (→ Page 67).

Lube oil system, oil lines with oil pressure >1.8 bar

SOLAS-compliant covers must be fitted to pipe joints according to MTU standard MTN5233 (→ Page 67).

Special connections

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



a) 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 defective 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.

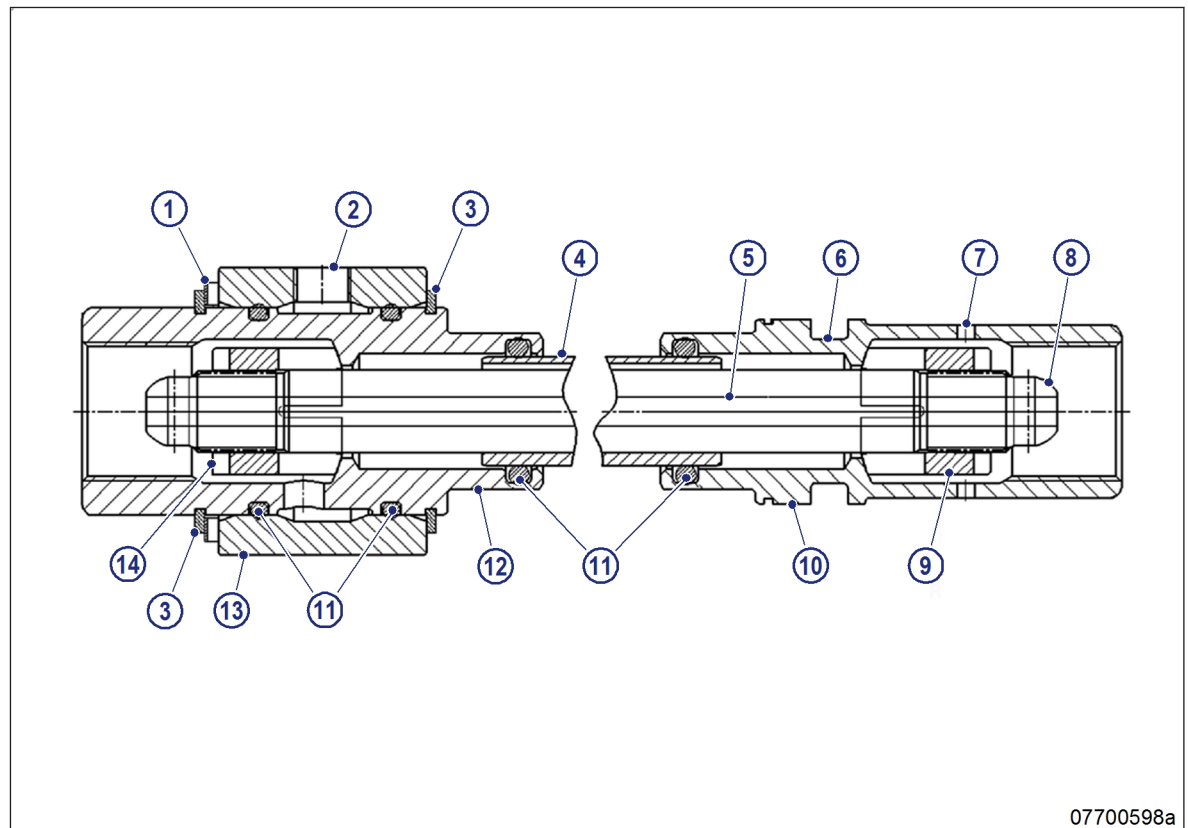
b) Plug-in pipe connection

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

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

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

HP connections



07700598a

- | | | |
|------------------------|-----------------------|---------------------|
| 1 Compensating disks | 6 Not applicable | 11 O-ring |
| 2 Leak fuel connection | 7 Not applicable | 12 Union nut |
| 3 Snap ring | 8 Ball-type seal area | 13 Connecting piece |
| 4 HP line outer pipe | 9 Thrust ring | 14 Thrust ring |
| 5 HP line inner pipe | 10 Union nut | |

The HP fuel line is sealed by the thrust ring (14).

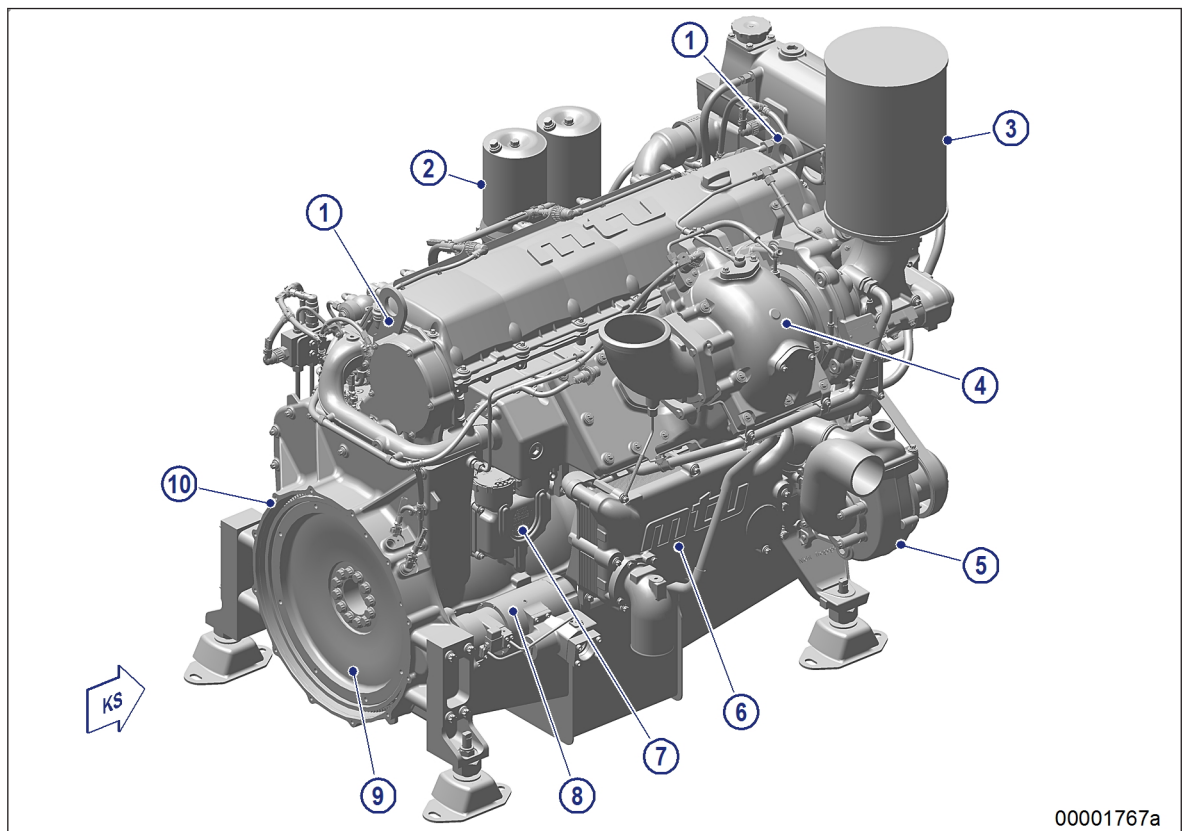
If leaks occur in the area of the thrust ring (14) or the HP line, the emerging fuel is routed to the leak-age chamber.

The fuel is depressurized and discharged via the connection (2). The leakage chamber is sealed toward the outside by the O-rings (11).

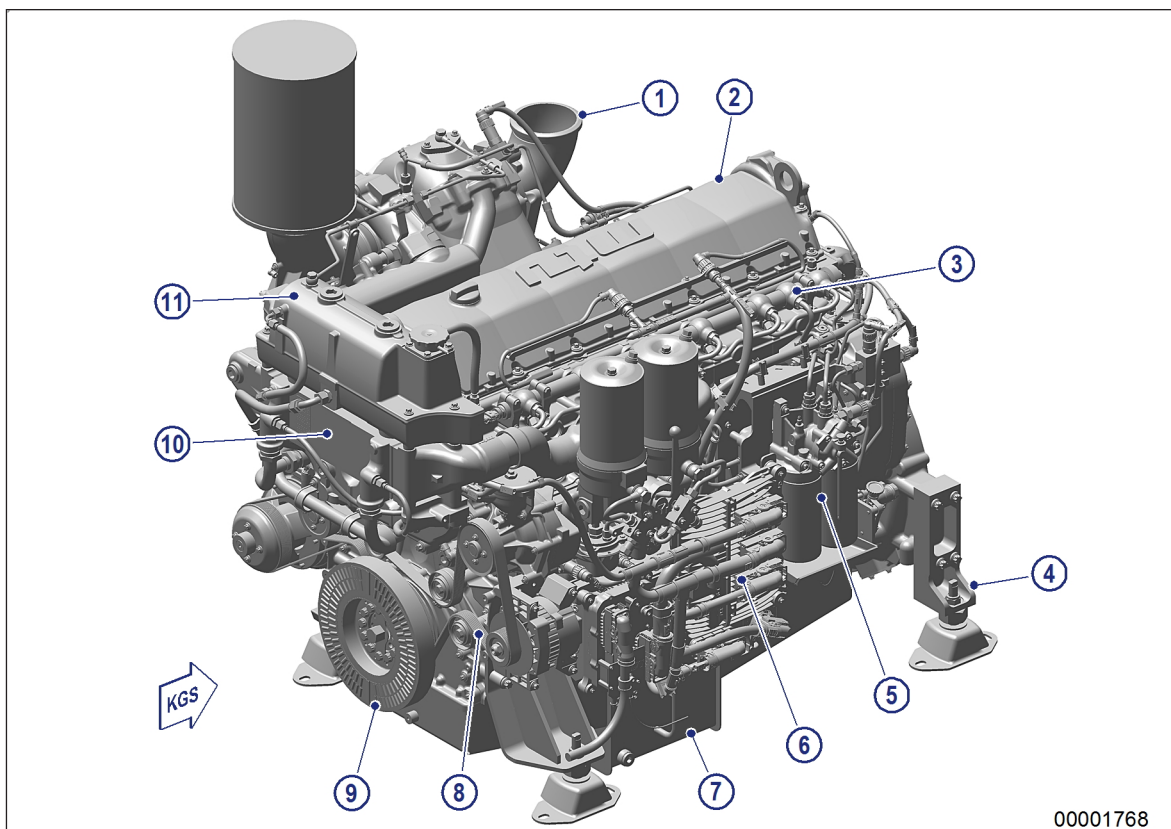
This prevents leaking fuel from escaping.

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

2.3 Engine overview



- | | | |
|------------------------|--------------------------------|---------------------|
| 1 Engine lifting eyes | 5 Raw water pump | 9 Flywheel |
| 2 Engine oil filter | 6 Plate-core heat exchanger | 10 Flywheel housing |
| 3 Air filter | 7 Crankcase breather | KS Driving end |
| 4 Exhaust turbocharger | 8 Starter (pneumatic/electric) | |



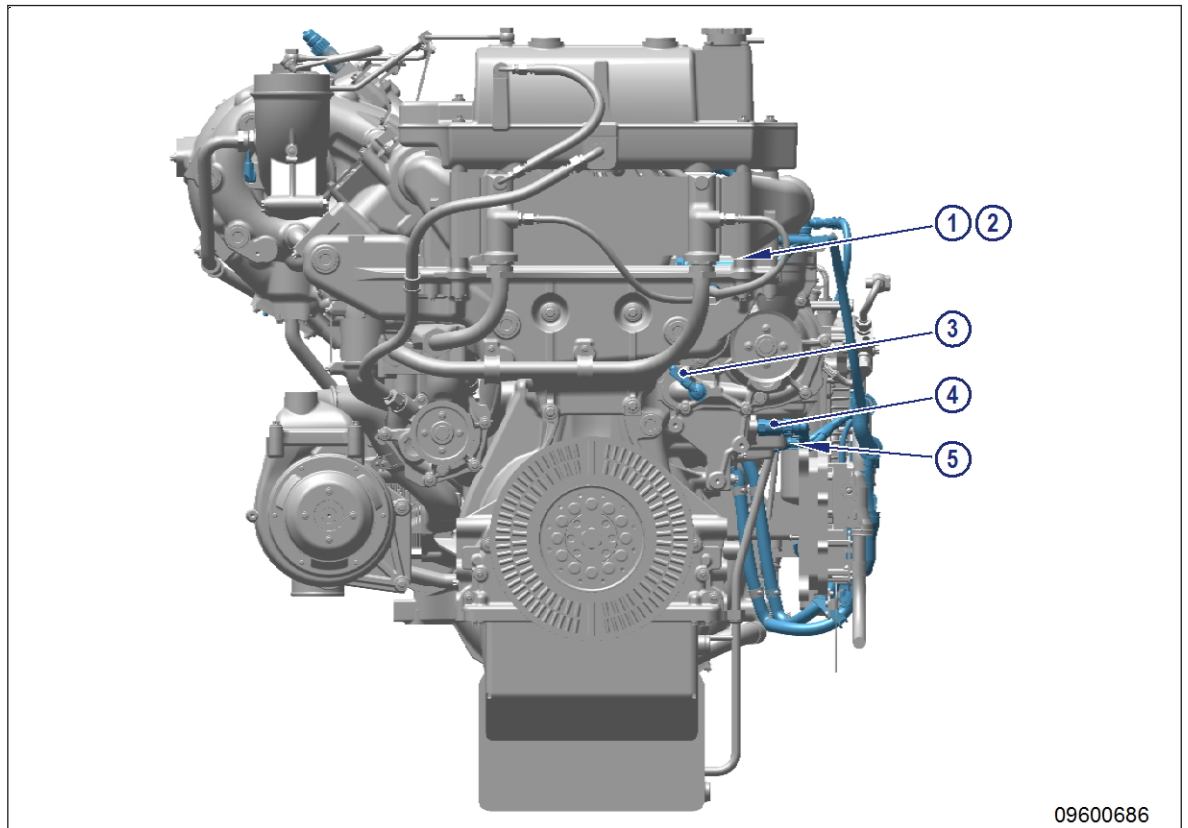
- | | | |
|-----------------------|----------------------|---------------------------|
| 1 Exhaust elbow | 5 Fuel duplex filter | 9 Vibration damper |
| 2 Cylinder head | 6 Engine governor | 10 Intercooler |
| 3 HP fuel accumulator | 7 Oil pan | 11 Coolant expansion tank |
| 4 Engine mounting | 8 Belt drive | KGS Free end |

Engine model designation

Key to the engine model designation 6R1600M20x

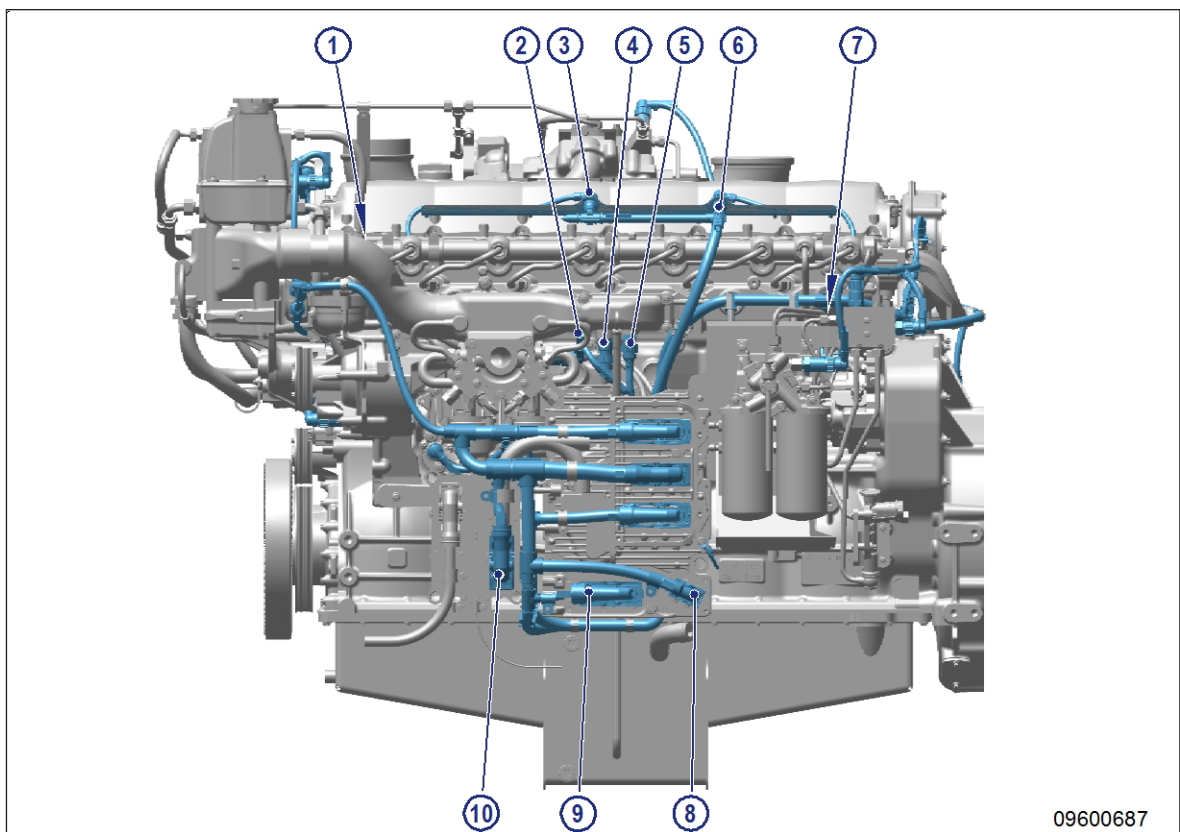
6	Number of cylinders
R	Cylinder arrangement: In-line engine
1600	Series
M	Application (M = Marine)
2	Application segment (1, 2, 4, 5, 7, 8)
0	Design index
x	Frequency code (F = 50 Hz, S = 60 Hz)

2.4 Sensors and actuators - Overview

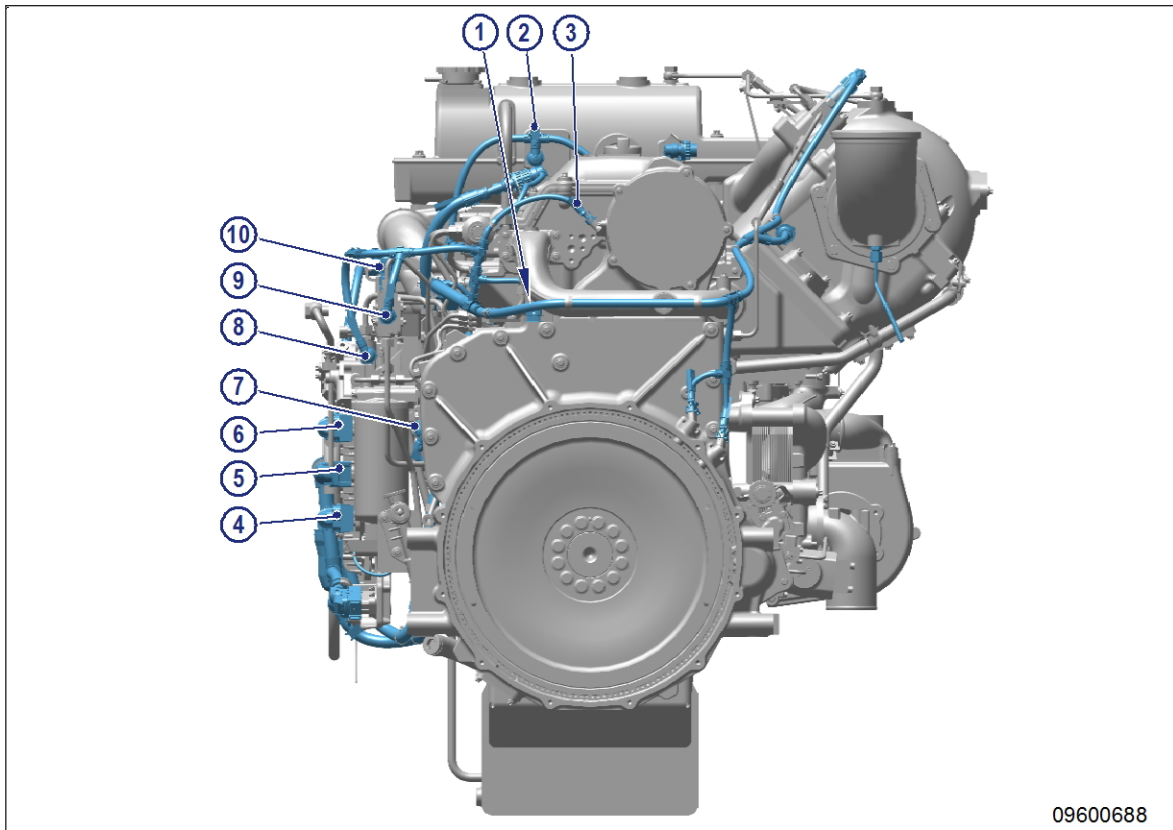


09600686

No.	Description	Monitoring of
1	B6.1	Engine coolant temperature at engine outlet
2	B6.2	Coolant temperature at engine outlet for EMU
3	B16	Engine coolant pressure
4	B5.1	Lube oil pressure after filter
5	B7	Lube oil temperature

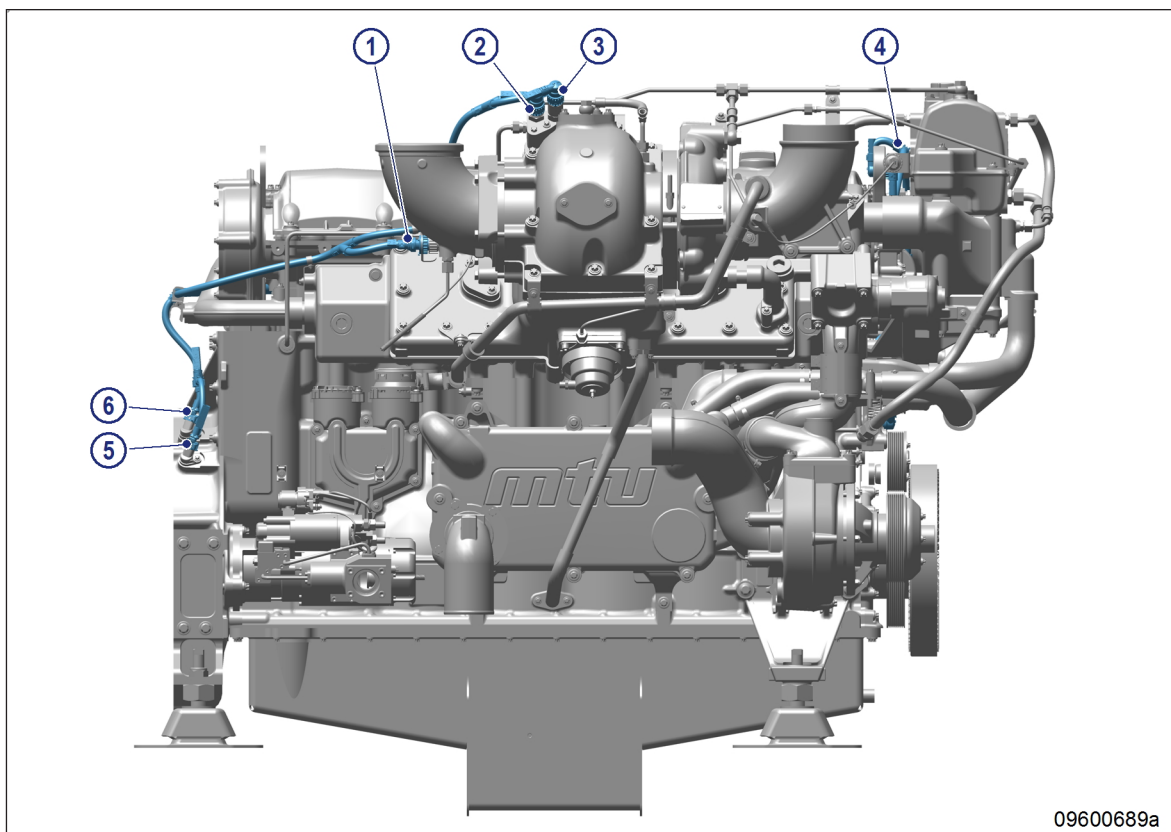


No.	Description	Monitoring of
1	B48.1	Fuel high pressure
2	B5.2	Lube oil pressure, redundant
3	XY39.A2	Injector A2
4	B10	Charge-air pressure
5	B9	Charge-air temperature
6	XY39.A1	Injector A1
7	M8	Fuel pump (HP)
8	X11	EMU - EIM connection
9	X12	Sensor connection to EMU
10	X52	EIM connection



09600688

No.	Description	Monitoring of
1	A19	Engine identification (Engine Ident Label EIL)
2	F33	Engine coolant level
3	B1	Camshaft speed
4	X3	Injector connection to governor ECU9
5	X1	Connection to governor ECU9
6	X2	Sensor connection to governor ECU9
7	B5.3	Lube oil pressure before filter
8	B34.1	Fuel pressure after filter
9	B33	Fuel temperature
10	F46	Leak fuel level



09600689a

No.	Description	Monitoring of
1	B4	Exhaust gas temperature
2	B7.3	Lube oil temperature before turbocharger
3	B5.8	Lube oil pressure before turbocharger
4	B44	Turbocharger speed
5	B13.1	Crankshaft speed
6	B13.2	Crankshaft speed for EMU

3 Technical Data

3.1 Engine data 6R1600M20F, 6R1600M20S, engine-mounted heat exchanger, IMO Tier 2

Explanation

Abbr.	Meaning
DL	Ref. value: Continuous power. Continuously available power under standard conditions
BL	Ref. value: Fuel stop power. Maximum engine power. Not available continuously in some applications (reserve for stabilization)
A	Design value. Value is required to design an external system (plant)
R	Guideline value. Typical average value for purposes of information, not entirely suitable for purposes of design
L	Limit value up to which the engine can be operated without change (e.g. of power setting)
N	Not yet defined value. Value as yet undefined or not to be defined
-	Not applicable. Module not applicable to this type of product
X	Applicable. Module applicable to this type of product
>	Actual value must be greater than specified value.
<	Actual value must be less than specified value.
*	Insufficiently secured value (tolerance +/- 10%).
**	Insufficiently secured value (tolerance +/- 5%).

ID	Product type	Application	Engine speed	List power	
1	6R1600M20F	Marine / onboard power generator 3A continuous operation, unrestricted	1500 1 50 Hz	269 kW 361 bhp	25°C/25°C; Engine-mounted heat exchanger IMO Tier II (Marpol convention)
2	6R1600M20F	Marine / onboard power generator 3A continuous operation, unrestricted	1500 1 50 Hz	269 kW 361 bhp	45°C/32°C; Engine-mounted heat exchanger IMO Tier II (Marpol convention)
3	6R1600M20S	Marine / onboard power generator 3A continuous operation, unrestricted	1800 rpm 60 Hz	323 kW 433 bhp	25°C/25°C; Engine-mounted heat exchanger IMO Tier II (Marpol convention)
4	6R1600M20S	Marine / onboard power generator 3A continuous operation, unrestricted	1800 rpm 60 Hz	323 kW 433 bhp	45°C/32°C; Engine-mounted heat exchanger IMO Tier II (Marpol convention)

Reference conditions

ID			1	2	3	4
Intake air temperature		°C	25	45	25	45
Barometric pressure		mbar	1000	1000	1000	1000
Site altitude above sea level		m	100	100	100	100
Raw water inlet temperature		°C	25	32	25	32

Performance data

ID			1	2	3	4
Rated engine speed	A	rpm	1500	1500	1800	1800
Continuous power ISO 3046 (10% overload possible) (power range DIN 6280, ISO 8528)	A	kW	269	269	323	323

General 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

Model related data (basic design)

ID			1	2	3	4
Cylinder arrangement: V-angle		Degrees (°)	-	-	-	-
Bore		mm	122	122	122	122
Stroke		mm	150	150	150	150
Displacement, cylinder		Liters	1.75	1.75	1.75	1.75
Displacement, total		Liters	10.5	10.5	10.5	10.5
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 pump: Inlet pressure, min.	L	bar	-0.3	-0.3	-0.3	-0.3
Raw water pump: Inlet pressure, max.	L	bar	0.7	X 0.7	0.7	0.7
Pressure loss in off-engine raw water system, max.	L	bar	1	1	1.37	1.37

Lube oil system

ID			1	2	3	4
Lube oil operating temperature before engine, from	R	°C	93.9	93.9	96.5	96.5
Lube oil operating temperature before engine, to	R	°C	96.1	96.1	97.5	97.5

TIM-ID: 0000062400 - 001

ID			1	2	3	4
Lube oil operating pressure upstream of engine, from	R	bar	5.3	5.3	5.3	5.3
Lube oil operating pressure before engine, to	R	bar	6.1	6.1	6.1	6.1

Fuel system

ID			1	2	3	4
Fuel pressure at engine inlet connection, min. (when engine is starting)	L	bar	-0.5	-0.5	-0.5	-0.5
Fuel pressure at engine inlet connection, min. (when engine is running)	L	bar	-0.5	-0.5	-0.5	-0.5
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	80	80	80	80
Firing speed, to	R	rpm	120	120	120	120

Starting (electrical)

ID			1	2	3	4
Nominal starter voltage	R	V=	24	24	24	24

Starting (with compressed-air/hydraulic starter motor)

ID			1	2	3	4
Starting-air pressure before starter motor, min.	R	bar	3	3	3	3
Starting-air pressure before starter motor, max.	R	bar	4	4	4	4

Oil and coolant capacity

ID			1	2	3	4
Engine coolant capacity, engine side (with cooling equipment)	R	Liters	52	52	52	52
Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	R	Liters	52	52	52	52

Weights / main dimensions

ID			1	2	3	4
Engine dry weight (with standard accessories installed, w/o coupling)	R	kg	1473	1473	1473	1473

Noise

ID			1	2	3	4
Exhaust noise, unsilenced - BL (free-field sound-pressure level L _p , 1m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	109	109	110	110
Engine surface noise, without intake noise - DL (free-field sound-pressure level L _p , 1m distance, ISO 6798, +2dB(A) tolerance)	R	dB(A)	110	110	102	102

3.2 Engine data 6R1600M20F, 6R1600M20S, remote heat exchanger, IMO Tier 2

Explanation

Abbr.	Meaning
DL	Ref. value: Continuous power. Continuously available power under standard conditions
BL	Ref. value: Fuel stop power. Maximum engine power. Not available continuously in some applications (reserve for stabilization)
A	Design value. Value is required to design an external system (plant)
R	Guideline value. Typical average value for purposes of information, not entirely suitable for purposes of design
L	Limit value up to which the engine can be operated without change (e.g. of power setting)
N	Not yet defined value. Value as yet undefined or not to be defined
-	Not applicable. Module not applicable to this type of product
X	Applicable. Module applicable to this type of product
>	Actual value must be greater than specified value.
<	Actual value must be less than specified value.
*	Insufficiently secured value (tolerance +/- 10%).
**	Insufficiently secured value (tolerance +/- 5%).

ID	Product type	Application	Engine speed	List power	
1	6R1600M20F	Marine / onboard power generator 3A continuous operation, unrestricted	1500 1 50 Hz	269 kW 361 bhp	25°C/25°C; Remote heat exchanger IMO Tier II (Marpol convention)
2	6R1600M20F	Marine / onboard power generator 3A continuous operation, unrestricted	1500 1 50 Hz	269 kW 361 bhp	45°C/32°C; Remote heat exchanger IMO Tier II (Marpol convention)
3	6R1600M20S	Marine / onboard power generator 3A continuous operation, unrestricted	1800 rpm 60 Hz	323 kW 433 bhp	25°C/25°C; Remote heat exchanger IMO Tier II (Marpol convention)
4	6R1600M20S	Marine / onboard power generator 3A continuous operation, unrestricted	1800 rpm 60 Hz	323 kW 433 bhp	45°C/32°C; Remote heat exchanger IMO Tier II (Marpol convention)

Reference conditions

ID		1	2	3	4
Intake air temperature	°C	25	45	25	45
Barometric pressure	mbar	1000	1000	1000	1000
Site altitude above sea level	m	100	100	100	100
Raw water inlet temperature	°C	25	32	25	32

Performance data

ID			1	2	3	4
Rated engine speed	A	rpm	1500	1500	1800	1800
Continuous power ISO 3046 (10% overload possible) (power range DIN 6280, ISO 8528)	A	kW	269	269	323	323

General 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

Model related data (basic design)

ID			1	2	3	4
Cylinder arrangement: V-angle		Degrees (°)	-	-	-	-
Bore		mm	122	122	122	122
Stroke		mm	150	150	150	150
Displacement, cylinder		Liters	1.75	1.75	1.75	1.75
Displacement, total		Liters	10.5	10.5	10.5	10.5
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 pump: Inlet pressure, min.	L	bar	-	-	-0.3	-
Raw water pump: Inlet pressure, max.	L	bar	-	-	0.7	-
Pressure loss in off-engine raw water system, max.	L	bar	-	-	1.37	-

Lube oil system

ID			1	2	3	4
Lube oil operating temperature before engine, from	R	°C	93.9	93.9	96.5	96.5
Lube oil operating temperature before engine, to	R	°C	96.1	96.1	97.5	97.5
Lube oil operating pressure upstream of engine, from	R	bar	5.3	5.3	5.3	5.3
Lube oil operating pressure before engine, to	R	bar	6.1	6.1	6.1	6.1

TIM-ID: 0000062401 - 001

Fuel system

ID			1	2	3	4
Fuel pressure at engine inlet connection, min. (when engine is starting)	L	bar	-0.5	-0.5	-0.5	-0.5
Fuel pressure at engine inlet connection, min. (when engine is running)	L	bar	-0.5	-0.5	-0.5	-0.5
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	80	80	80	80
Firing speed, to	R	rpm	120	120	120	120

Starting (electrical)

ID			1	2	3	4
Nominal starter voltage	R	V=	24	24	24	24

Starting (with compressed-air/hydraulic starter motor)

ID			1	2	3	4
Starting-air pressure before starter motor, min.	R	bar	3	3	3	3
Starting-air pressure before starter motor, max.	R	bar	4	4	4	4

Oil and coolant capacity

ID			1	2	3	4
Engine coolant capacity, engine side (with cooling equipment)	R	Liters	-	52	52	52
Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	R	Liters	52	52	52	52

Weights / main dimensions

ID			1	2	3	4
Engine dry weight (with standard accessories installed, w/o coupling)	R	kg	1473	1473	1473	1473

Noise

ID			1	2	3	4
Exhaust noise, unsilenced - BL (free-field sound-pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	109	109	110	110
Engine surface noise, without intake noise - DL (free-field sound-pressure level Lp, 1m distance, ISO 6798, +2dB(A) tolerance)	R	dB(A)	110	110	102	102

3.3 Engine data 6R1600M20S, engine-mounted heat exchanger, EPA Tier 3

Explanation

Abbr.	Meaning
DL	Ref. value: Continuous power. Continuously available power under standard conditions
BL	Ref. value: Fuel stop power. Maximum engine power. Not available continuously in some applications (reserve for stabilization)
A	Design value. Value is required to design an external system (plant)
R	Guideline value. Typical average value for purposes of information, not entirely suitable for purposes of design
L	Limit value up to which the engine can be operated without change (e.g. of power setting)
N	Not yet defined value. Value as yet undefined or not to be defined
-	Not applicable. Module not applicable to this type of product
X	Applicable. Module applicable to this type of product
>	Actual value must be greater than specified value.
<	Actual value must be less than specified value.
*	Insufficiently secured value (tolerance +/- 10%).
**	Insufficiently secured value (tolerance +/- 5%).

ID	Product type	Application	Engine speed	List power	
1	6R1600M20S	Marine / onboard power generator 3A continuous operation, unrestricted	1800 rpm 60 Hz	323 kW 433 bhp	25°C/25°C; Engine-mounted heat exchanger EPA Marine T3 (40CFR1042)
2	6R1600M20S	Marine / onboard power generator 3A continuous operation, unrestricted	1800 rpm 60 Hz	323 kW 433 bhp	45°C/32°C; Engine-mounted heat exchanger EPA Marine T3 (40CFR1042)

Reference conditions

ID			1	2
Intake air temperature		°C	25	45
Barometric pressure		mbar	1000	1000
Site altitude above sea level		m	100	100
Raw water inlet temperature		°C	25	32

Performance data

ID			1	2
Rated engine speed	A	rpm	1800	1800
Continuous power ISO 3046 (10% overload possible) (power range DIN 6280, ISO 8528)	A	kW	355	355

TIM-ID: 0000062402 - 001

General conditions (for maximum power)

ID			1	2
Intake depression (new filter)	A	mbar	15	15
Intake depression, max.	L	mbar	30	30

Model related data (basic design)

ID			1	2
Cylinder arrangement: V-angle		Degrees (°)	-	-
Bore		mm	122	122
Stroke		mm	150	150
Displacement, cylinder		Liters	1.75	1.75
Displacement, total		Liters	10.5	10.5
Number of inlet valves per cylinder		-	2	2
Number of exhaust valves per cylinder		-	2	2

Raw water circuit (open circuit)

ID			1	2
Raw water pump: Inlet pressure, min.	L	bar	-0.3	-0.3
Raw water pump: Inlet pressure, max.	L	bar	0.7	0.7
Pressure loss in off-engine raw water system, max.	L	bar	1.37	1.37

Lube oil system

ID			1	2
Lube oil operating temperature before engine, from	R	°C	97.3	97.3
Lube oil operating temperature before engine, to	R	°C	97.9	97.9
Lube oil operating pressure upstream of engine, from	R	bar	5.3	5.3
Lube oil operating pressure before engine, to	R	bar	6.1	6.1

Fuel system

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

General operating data

ID			1	2
Firing speed, from	R	rpm	80	80
Firing speed, to	R	rpm	120	120

Starting (electrical)

ID			1	2
Nominal starter voltage	R	V=	24	24

Starting (with compressed-air/hydraulic starter motor)

ID			1	2
Starting-air pressure before starter motor, min.	R	bar	3	3
Starting-air pressure before starter motor, max.	R	bar	4	4

Oil and coolant capacity

ID			1	2
Engine coolant capacity, engine side (with cooling equipment)	R	Liters	52	52
Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	R	Liters	52	52

Weights / main dimensions

ID			1	2
Engine dry weight (with standard accessories installed, w/o coupling)	R	kg	1473	1473

Noise

ID			1	2
Exhaust noise, unsilenced - BL (free-field sound-pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	110	110
Engine surface noise, without intake noise - DL (free-field sound-pressure level Lp, 1m distance, ISO 6798, +2dB(A) tolerance)	R	dB(A)	102	102

3.4 Engine data 6R1600M20S, remote heat exchanger, EPA Tier 3

Explanation

Abbr.	Meaning
DL	Ref. value: Continuous power. Continuously available power under standard conditions
BL	Ref. value: Fuel stop power. Maximum engine power. Not available continuously in some applications (reserve for stabilization)
A	Design value. Value is required to design an external system (plant)
R	Guideline value. Typical average value for purposes of information, not entirely suitable for purposes of design
L	Limit value up to which the engine can be operated without change (e.g. of power setting)
N	Not yet defined value. Value as yet undefined or not to be defined
-	Not applicable. Module not applicable to this type of product
X	Applicable. Module applicable to this type of product
>	Actual value must be greater than specified value.
<	Actual value must be less than specified value.
*	Insufficiently secured value (tolerance +/- 10%).
**	Insufficiently secured value (tolerance +/- 5%).

ID	Product type	Application	Engine speed	List power	
1	6R1600M20S	Marine / onboard power generator 3A continuous operation, unrestricted	1800 rpm 60 Hz	323 kW 433 bhp	25°C/25°C; Remote heat exchanger EPA Marine T3 (40CFR1042)
2	6R1600M20S	Marine / onboard power generator 3A continuous operation, unrestricted	1800 rpm 60 Hz	323 kW 433 bhp	45°C/32°C; Remote heat exchanger EPA Marine T3 (40CFR1042)

Reference conditions

ID			1	2
Intake air temperature		°C	25	45
Barometric pressure		mbar	1000	1000
Site altitude above sea level		m	100	100
Raw water inlet temperature		°C	25	32

Performance data

ID			1	2
Rated engine speed	A	rpm	1800	1800
Continuous power ISO 3046 (10% overload possible) (power range DIN 6280, ISO 8528)	A	kW	355	355

General conditions (for maximum power)

ID			1	2
Intake depression (new filter)	A	mbar	15	15
Intake depression, max.	L	mbar	30	30

Model related data (basic design)

ID			1	2
Cylinder arrangement: V-angle		Degrees (°)	-	-
Bore		mm	122	122
Stroke		mm	150	150
Displacement, cylinder		Liters	1.75	1.75
Displacement, total		Liters	10.5	10.5
Number of inlet valves per cylinder		-	2	2
Number of exhaust valves per cylinder		-	2	2

Raw water circuit (open circuit)

ID			1	2
Raw water pump: Inlet pressure, min.	L	bar	-	-
Raw water pump: Inlet pressure, max.	L	bar	-	-
Pressure loss in off-engine raw water system, max.	L	bar	-	-

Lube oil system

ID			1	2
Lube oil operating temperature before engine, from	R	°C	97.3	97.3
Lube oil operating temperature before engine, to	R	°C	97.9	97.9
Lube oil operating pressure upstream of engine, from	R	bar	5.3	5.3
Lube oil operating pressure before engine, to	R	bar	6.1	6.1

Fuel system

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

General operating data

ID			1	2
Firing speed, from	R	rpm	80	80
Firing speed, to	R	rpm	120	120

Starting (electrical)

ID			1	2
Nominal starter voltage	R	V=	24	24

Starting (with compressed-air/hydraulic starter motor)

ID			1	2
Starting-air pressure before starter motor, min.	R	bar	3	3
Starting-air pressure before starter motor, max.	R	bar	4	4

Oil and coolant capacity

ID			1	2
Engine coolant capacity, engine side (with cooling equipment)	R	Liters	52	52
Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	R	Liters	52	52

Weights / main dimensions

ID			1	2
Engine dry weight (with standard accessories installed, w/o coupling)	R	kg	1473	1473

Noise

ID			1	2
Exhaust noise, unsilenced - BL (free-field sound-pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	110	110
Engine surface noise, without intake noise - DL (free-field sound-pressure level Lp, 1m distance, ISO 6798, +2dB(A) tolerance)	R	dB(A)	102	102

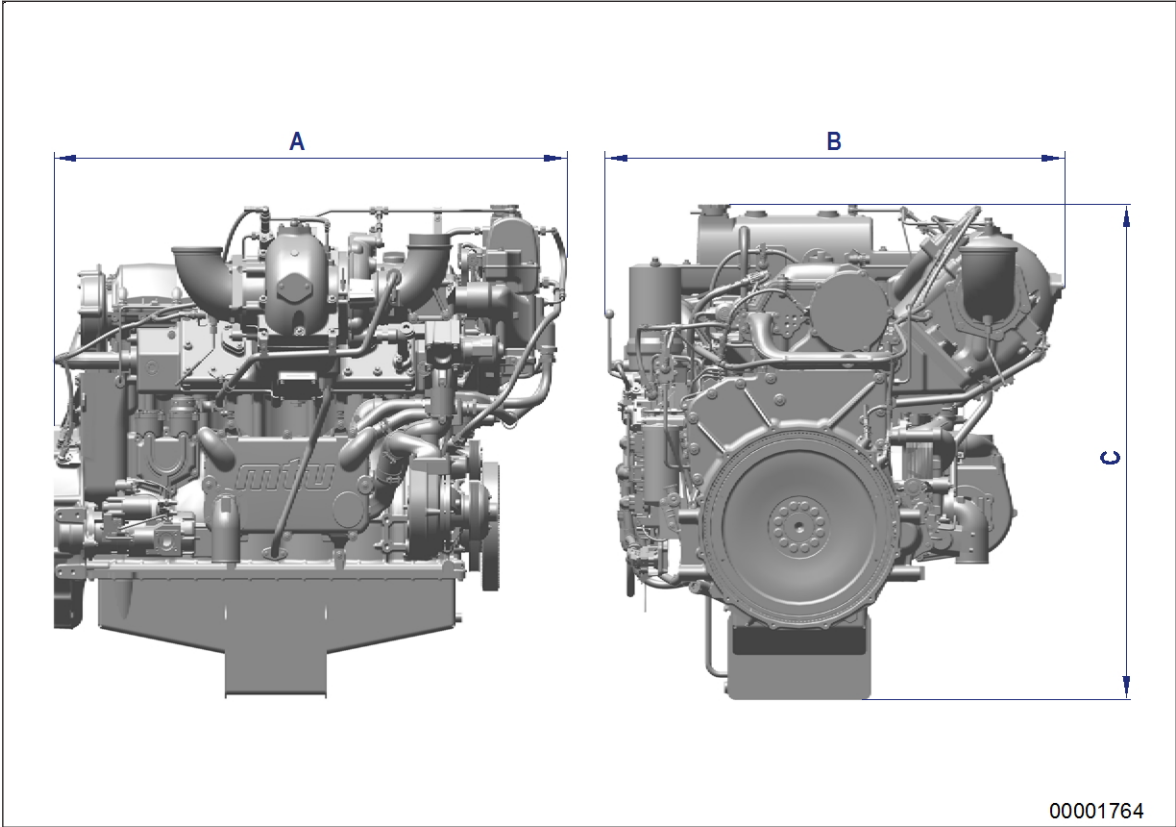
3.5 Firing order

Firing order

Number of cylinders	Firing order
6 R	2-4-1-5-3-6

3.6 Engine - Main dimensions

Engine - Main dimensions



Engine model	Length (A)	Width (B)	Height (C)
6R1600M20x	approx. 1554 mm	approx. 1193 mm	approx. 1297 mm

4 Operation

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

Preconditions

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

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

Item	Action
Engine	Depreserve (→ MTU Preservation and Represervation Specifications A001070/..).
Lube oil system	Check engine oil level (→ Page 95).
Fuel system	Vent (→ Page 88).
Raw-water pump (if located above waterline)	Prime (approx. 3 to 4 liters).
Engine coolant circuit	If engine is out of service for more than one year, change engine coolant (→ Page 103).
Engine coolant circuit	Check engine coolant level (→ Page 102).
Engine governor	Check plug connections (→ Page 118).
Monitoring system	Carry out lamp test (see manufacturer's documentation).
Engine/generator control system	Switch ON; select operating mode, e.g. MANUAL, AUTOMATIC OPERATION.

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

Preconditions

☑ Engine is stopped and starting disabled.


Putting into operation

Item	Action
Lube oil system	Check engine oil level (→ Page 95);
Coolant circuit	Check engine coolant level (→ Page 102).
Monitoring system	Carry out lamp test (see manufacturer's documentation).
Belt drive	Check condition of drive belt (→ Page 109).
Engine/generator control system	Switch ON; Select operating mode, e.g. MANUAL OPERATION, AUTOMATIC OPERATION.

4.3 Engine start in manual operation (trials)


Preconditions

- ☒ Generator is not connected to network.
- ☒ External start interlock is not active.

DANGER


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

- Before cranking the engine with starter system, make sure that there are no persons in the engine's danger zone.

WARNING


High level of engine noise when the engine is running.
Risk of damage to hearing!

- Wear ear protectors.

Preparation

Item	Action
Operating mode switch (if fitted)	Change to manual mode.

Starting the engine

Item	Action
Switchgear cabinet, control panel etc. (depending on manufacturer)	Press start button. <ul style="list-style-type: none">Automatic starting sequence is performed;Engine speed display instrument indicates increasing speed;After the starting sequence is completed, engine is running at rated speed.

Connecting the generator to network, running the engine to reach operating temperature

Item	Action
Switchgear cabinet, control panel etc. (depending on manufacturer)	Close the generator circuit breaker.
Engine	Apply full load only after engine has reached operating temperature (coolant temperature approx. 60 °C).

4.4 Safety system – Override

NOTICE



Safety functions and engine shutdown alarms will be disregarded.

Severe material damage!

- Initiate emergency start only in emergency situations.

NOTICE



Inadmissible operating status.

Severe damage to property!

- Use override function only in hazardous situations to ensure full capability in the event of engine faults.

Preparation

Note: This function is only available when a pushbutton is provided.

Safety system – Override

Item	Action
Switchgear cabinet, control panel etc. (depending on manufacturer)	Activate pushbutton for Override input of the ECU. <ul style="list-style-type: none">• Certain shutdown criteria and/or starting prerequisites are ignored.
Switchgear cabinet, control panel etc. (depending on manufacturer)	Actuate start button, for further starting sequence, refer to engine start (→ Page 46).
Control and display panels	During operation, check the displayed operational data (speed, temperature, pressures). Constantly monitor plant limit values.

4.5 Operational checks

DANGER



Rotating and moving engine parts.

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

- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING



High level of engine noise when the engine is running.

Risk of damage to hearing!

- Wear ear protectors.

Operational checks

Item	Action
Engine operation	Visually inspect engine for leaks and general condition. Check overflow line on expansion tank for coolant discharge , contact Service in case of severe coolant discharge.
Engine oil	Check engine oil level (→ Page 95).
Air filter	Check signal ring position of service indicator on air filter (if fitted) (→ Page 94).
Engine coolant pump	Check relief bore (→ Page 107).
Charge-air coolant pump	Check relief bore (→ Page 108).
Fuel prefilter	Drain water and contaminants from fuel prefilter (if fitted).
Raw water pump	Check relief bore for oil and water discharge and dirt.

4.6 Engine stop in manual operation (trials)

Preconditions

- ☒ Generator is not connected to network.
- ☒ Engine is running in manual mode.

Preparation

Item	Task
Engine	After the generator breaker has been opened, allow the engine to cool down by running it idle for approx. 5 minutes.

Stop engine

Item	Task
Switchgear cabinet, control panel etc. (depending on manufacturer)	Press stop button. <ul style="list-style-type: none">• Automatic stopping sequence is performed;• engine is stopped.

4.7 Emergency stop

NOTICE



An emergency stop causes extreme stress to the engine plant.

Risk of overheating, damage to components!

- Initiate emergency stop only in emergency situations.

Emergency stop

Item	Action
Emergency stop pushbutton	Press pushbutton. <ul style="list-style-type: none">• Engine is stopped by disconnecting the power supply to the ECU;• signalization (e.g. by horn, flashing lamp) is released.

After emergency stop

Item	Action
Switchgear cabinet, control panel etc. (depending on manufacturer)	Press pushbutton for alarm acknowledgment. <ul style="list-style-type: none">• Audible and visual alarm signaling stops.

4.8 After stopping the engine – Engine remains ready for operation

After stopping the engine

Item	Action
Engine/generator/pump control	Select operating mode, e.g. MANUAL, AUTOMATIC OPERATION.

4.9 After stopping engine – Putting engine out of operation

Preconditions

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

After stopping engine

Item	Action
Coolant circuit	Drain engine coolant (→ Page 104) if: <ul style="list-style-type: none">• engine room is not heated;• coolant is not kept at a suitable temperature;• 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 to be expected and the engine is to remain out of service for an extended period.
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 (→ MTU Preservation and Represervation Specifications A001070/..).
Engine/generator/pump control	Switch off.

5 Maintenance

5.1 Maintenance task reference table [QL1]

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

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

Task	Option	Maintenance tasks	
W0500		Check engine oil level.	(→ Page 95)
W0501		Visually inspect engine for leaks and general condition.	(→ Page 48)
W0507		Drain water and contaminants from fuel prefilter.	(→ Page 48)
W0521		Check signal ring position of maintenance indicator, replace air filter if necessary.	(→ Page 94)
W1001		Replace fuel filter or fuel filter element.	(→ Page 89)
W1003		Check belt condition and tension, replace if necessary.	(→ Page 109)
W1005		Replace air filter.	(→ Page 92)
W1006		Replace fuel injectors.	(→ Page 82)
W1008		Replace engine oil filter when changing engine oil, or when the interval (years) is reached, at the latest.	(→ Page 98)
W1055		Replace oil separator.	(→ Page 75)
W1178		Replace pressure pipe neck in cylinder head.	(→ Page 83)
W1207		Check valve clearance, adjust if necessary. ATTENTION! First adjustment after 1,000 operating hours.	(→ Page 77)
W1298		Replace HP fuel lines.	(→ Page 83)
W1505		Replace drive belt of battery-charging generator and water pump.	(→ Page 111)
W1636		Reset drift compensation parameters (CDC) and enter injector codes (IIG).	(→ Page 83)
W1675	X	Replace fuel prefilter or filter element of fuel prefilter.	-
W1865		Measure compression stroke of resilient mounts, replace as necessary.	(→ Page 119)
W1866		Visually inspect resilient mounts, check tightness of all securing screws.	(→ Page 119)

Table 2: Maintenance task reference table [QL1]

6 Troubleshooting

6.1 Troubleshooting

Engine does not turn when starter is actuated

Cause	Corrective action
Battery low or defective	► Charge or replace (→ manufacturer's documentation).
Cable connections defective	► Check cable connections for secure seating (→ manufacturer's documentation).
Starter: Engine cabling o starter defective	► Check if cable connections are properly secured, contact Service.
Engine cabling defective	► Check (→ Page 116).
Engine / generator control: Assemblies or connectors possibly loose	► Carry out visual inspection (→ manufacturer's documentation).
Engine governor: Plug-in connections loose	► Check plug connections (→ Page 118).
Running gear blocked (engine cannot be barred manually)	► Contact Service.

Engine turns on starting but does not fire

Cause	Corrective action
Poor rotation by starter: Battery low or defective	► Charge or replace battery (→ manufacturer's documentation).
Engine cabling defective.	► Check (→ Page 116).
Air in fuel system	► Vent fuel system (→ Page 88).
Engine governor defective	► Contact Service.

Engine fires unevenly

Cause	Corrective action
Injector defective	► Check, replace if necessary (→ Page 83).
Engine cabling defective	► Check (→ Page 116)
Air in fuel system	► Vent fuel system (→ Page 88)
Engine governor defective	► Contact Service.

Engine does not reach nominal speed

Cause	Corrective action
Fuel prefilter clogged	► Replace (→ manufacturer's documentation).
Fuel filter clogged	► Replace (→ Page 89).
Air filter clogged	► Check, replace if necessary (→ Page 94).
Injector defective	► Check, replace if necessary (→ Page 83).
Engine cabling defective	► Check (→ Page 116).
Engine: Overload	► Contact Service.

Engine speed not steady

Cause	Corrective action
Injector defective	► Check, replace if necessary (→ Page 83).
Speed transmitter defective	► Contact Service.
Air in fuel system	► Vent fuel system (→ Page 88).
Engine governor defective	► Contact Service.

Charge-air temperature too high

Cause	Corrective action
Incorrect coolant concentration	► Check (→ MTU test kit).
Intercooler contaminated	► Contact Service.
Engine room: Air-intake temperature too high	► Check fans and intake/exhaust lines.

Charge-air pressure too low

Cause	Corrective action
Air filter clogged	► Check, replace if necessary (→ Page 94).
Intercooler contaminated	► Contact Service.
Exhaust turbocharger defective	► Contact Service.

Coolant discharge at intercooler

Cause	Corrective action
Intercooler: Leaking, major coolant discharge	► Contact Service.

Black exhaust gas

Cause	Corrective action
Air filter clogged	► Check, replace if necessary (→ Page 94).
Injector defective	► Check, replace if necessary (→ Page 83).
Engine: Overload	► Contact Service.

Blue exhaust gas

Cause	Corrective action
Too much engine oil in the engine	► Drain engine oil (→ Page 97).
Oil separator of crankcase breather contaminated	► Replace oil separator (→ Page 75).
Exhaust turbocharger, cylinder head, piston rings or cylinder liner defective	► Contact Service.

White exhaust gas

Cause	Corrective action
Engine is not at operating temperature	► Run up to operating temperature.
Water in fuel	► Check fuel system, at fuel prefilter (→ manufacturer's documentation). Drain water and contaminants from fuel prefilter (→ manufacturer's documentation).
Intercooler leaky	► Contact Service.

6.2 Engine governor ECU9 – Fault messages

Possible engine reactions to yellow alarm:

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

Possible engine reactions to red alarm:

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

5 – HI T-Charge Air

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

6 – SS T-Charge Air

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

15 – LO P-Lube Oil

Cause	Corrective action
The lube oil pressure at sensor B5.1 has fallen below limit value 1. The lube oil pressure is too low.	1. Check engine oil level (→ Page 95). 2. Contact Service.

16 – SS P-Lube Oil

Cause	Corrective action
The lube oil pressure at sensor B5.1 has fallen below limit value 2. The lube oil pressure is too low.	1. Check engine oil level (→ Page 95). 2. Contact Service.

23 – LO Coolant Level

Cause	Corrective action
Coolant level at switch F33 is too low.	1. Check engine coolant level (→ Page 102). 2. Check relief bore of charge-air coolant pump (→ Page 108). 3. Visually check coolant circuit for leaks. 4. Contact Service.

25 – HI P-Diff-Lube Oil

Cause	Corrective action
The differential oil pressure at sensors B5.1 and B5.3 has exceeded limit value 1. The differential oil pressure is too high.	1. Replace engine oil filter (→ Page 98). 2. Contact Service.

26 – SS P-Diff-Lube Oil

Cause	Corrective action
The differential oil pressure at sensors B5.1 and B5.3 has exceeded limit value 2. The differential oil pressure is too high.	1. Replace engine oil filter (→ Page 98). 2. Contact Service.

27 – HI Level Leakage Fuel

Cause	Corrective action
Switch F46 in the collection tank has tripped. A leak has occurred in the HP fuel system.	► Contact Service.

30 – SS Engine Overspeed

Cause	Corrective action
Engine speed has exceeded the limit value or the engine overspeed test has been tripped. Engine emergency stop has been tripped.	► If an emergency stop has been tripped by the engine overspeed test, restart the engine. If an emergency stop has been tripped by the engine, contact Service.

31 – HI ETC1 overspeed

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

32 – SS ETC1 Overspeed

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

51 – HI T-Lube Oil

Cause	Corrective action
The lube oil temperature at sensor B7 has exceeded limit value 1. Lube oil temperature is too high.	<ol style="list-style-type: none">1. Reduce power.2. Check operation of cooler and fan (plant side).3. Check engine coolant level (→ Page 102).4. Contact Service.

52 – SS T-Lube Oil

Cause	Corrective action
The lube oil temperature at sensor B7 has exceeded limit value 2. Lube oil temperature is too high.	<ol style="list-style-type: none">1. Check operation of cooler and fan (plant side).2. Check engine coolant level (→ Page 102).3. Contact Service.

57 – LO P-Coolant

Cause	Corrective action
The coolant pressure at sensor B16 has fallen below limit value 1. Coolant pressure is too low.	<ol style="list-style-type: none">1. Check relief bore of engine coolant pump (→ Page 107).2. Check engine coolant level (→ Page 102).3. Contact Service.

58 – SS P-Coolant

Cause	Corrective action
The coolant pressure at sensor B16 has fallen below limit value 2. Coolant pressure is too low.	<ol style="list-style-type: none">1. Check relief bore of engine coolant pump (→ Page 107).2. Check engine coolant level (→ Page 102).3. Contact Service.

67 – HI T-Coolant

Cause	Corrective action
The coolant temperature at sensor B6.1 has exceeded limit value 1. Coolant temperature is too high.	<ol style="list-style-type: none">1. Reduce power.2. Check operation of cooler and fan (plant side).3. Check engine coolant level (→ Page 102).4. Contact Service.

68 – SS T-Coolant

Cause	Corrective action
The coolant temperature at sensor B6.1 has exceeded limit value 2. Coolant temperature is too high.	<ol style="list-style-type: none">1. Check operation of cooler and fan (plant side).2. Check engine coolant level (→ Page 102).3. Contact Service.

82 – HI P-Fuel (Common Rail)

Cause	Corrective action
The fuel high pressure at sensor B48.1 has exceeded limit value 1. Fuel pressure is too high.	► Contact Service.

83 – LO P-Fuel (Common Rail)

Cause	Corrective action
The fuel high pressure at sensor B48.1 has fallen below limit value 1. Fuel pressure is too low.	► Contact Service.

89 – SS Engine Speed Too Low

Cause	Corrective action
The engine speed has fallen below the limit value. Engine emergency stop has been tripped.	<ol style="list-style-type: none">1. Acknowledge alarm.2. Observe additional messages.3. Contact Service.

118 – LO ECU Power Supply Voltage

Cause	Corrective action
The supply voltage of the ECU has fallen below the specified limit value 1.	<ol style="list-style-type: none">1. Check charging condition of batteries (plant side).2. Check plug connections to engine governor (→ Page 118).3. Contact Service.

119 – LOLO ECU Power Supply Voltage

Cause	Corrective action
The supply voltage of the ECU has fallen below the specified limit value 2.	<ol style="list-style-type: none">1. Check charging condition of batteries (plant side).2. Check plug connections to engine governor (→ Page 118).3. Contact Service.

120 – HI ECU Power Supply Voltage

Cause	Corrective action
The supply voltage of the ECU has exceeded the specified limit value 1.	<ol style="list-style-type: none">1. Check charging condition of batteries (plant side).2. Check plug connections to engine governor (→ Page 118).3. Contact Service.

121 – HIHI ECU Power Supply Voltage

Cause	Corrective action
The supply voltage of the ECU has exceeded the specified limit value 2.	<ol style="list-style-type: none">1. Check charging condition of batteries (plant side).2. Check plug connections to engine governor (→ Page 118).3. Contact Service.

186 – AL CAN1 Bus Off

Cause	Corrective action
Can bus 1 to MTU automation system (e. g. ECU/MAU/SAM) is interrupted or defective.	<ol style="list-style-type: none">1. Check plug connections to engine governor (→ Page 118).2. Contact Service.

187 – AL CAN1 Error Passive

Cause	Corrective action
Can bus 1 to MTU automation system (e. g. ECU/MAU/SAM) is interrupted or defective.	1. Check plug connections to engine governor (→ Page 118). 2. Contact Service.

188 – AL CAN2 Bus Off

Cause	Corrective action
Can bus 2 to plant-side automation system (e. g. Murphy display) is interrupted or defective.	1. Check connection between plant-side automation and MTU automation. 2. Contact Service.

189 – AL CAN2 Error Passive

Cause	Corrective action
Can bus 2 to plant-side automation system (e. g. Murphy display) is interrupted or defective.	1. Check connection between plant-side automation and MTU automation. 2. Contact Service.

201 – SD T-Coolant

Cause	Corrective action
Coolant temperature sensor (B6.1) on coolant distribution housing supplies incorrect signal or no signal.	1. Check engine wiring (→ Page 116). 2. Contact Service.

203 – SD T-Charge Air

Cause	Corrective action
Charge-air temperature sensor (B9) supplies incorrect signal or no signal.	1. Check engine wiring (→ Page 116). 2. Contact Service.

206 – SD T-Exhaust A

Cause	Corrective action
Exhaust temperature sensor (B4) in the exhaust pipe supplies incorrect signal or no signal.	1. Check engine wiring (→ Page 116). 2. Contact Service.

208 – SD P-Charge Air

Cause	Corrective action
Charge-air pressure sensor (B10) supplies incorrect signal or no signal.	1. Check engine wiring (→ Page 116). 2. Contact Service.

211 – SD P-Lube Oil

Cause	Corrective action
Lube-oil pressure sensor after filter (B5.1) supplies incorrect signal or no signal.	1. Check engine wiring (→ Page 116). 2. Contact Service.

212 – SD P-Coolant

Cause	Corrective action
Coolant pressure sensor after coolant pump (B16) supplies incorrect signal or no signal.	1. Check engine wiring (→ Page 116). 2. Contact Service.

215 – SD P-HD

Cause	Corrective action
Fuel HP sensor (B48.1) supplies incorrect signal or no signal.	1. Check engine wiring (→ Page 116). 2. Contact Service.

216 – SD T-Lube Oil

Cause	Corrective action
Lube oil temperature sensor (B7) supplies incorrect signal or no signal.	1. Check engine wiring (→ Page 116). 2. Contact Service.

220 – SD Level Coolant Water

Cause	Corrective action
Coolant level sensor (F33) supplies incorrect signal or no signal.	1. Check engine wiring (→ Page 116). 2. Contact Service.

221 – SD P-Diff Lube Oil

Cause	Corrective action
Lube oil pressure sensors B5.3 and/or B5.1 supply incorrect signal or no signal.	1. Check engine wiring (→ Page 116). 2. Contact Service.

222 – SD Level Leakage Fuel

Cause	Corrective action
Leak-fuel sensor (F46) supplies incorrect signal or no signal.	1. Check engine wiring (→ Page 116). 2. Contact Service.

227 – SD P- Lube Oil before Filter

Cause	Corrective action
Lube-oil pressure sensor before filter (B5.3) supplies incorrect signal or no signal.	1. Check engine wiring (→ Page 116). 2. Contact Service.

229 – AL Stop Camshaft Sensor Defect

Cause	Corrective action
Emergency stop following a failure of crankshaft speed sensor (B13.1) and camshaft speed sensor (B1).	► Contact Service.

230 – SD Crankshaft Speed

Cause	Corrective action
Crankshaft speed sensor (B13.1) supplies incorrect signal or no signal.	1. Check engine wiring (→ Page 116). 2. Contact Service.

231 – SD Camshaft Speed

Cause	Corrective action
Camshaft speed sensor (B1) supplies incorrect signal or no signal.	1. Check engine wiring (→ Page 116). 2. Contact Service.

232 – SD Charger 1 Speed

Cause	Corrective action
Speed sensor (B44) of ETC on A side supplies incorrect signal or no signal.	1. Check engine wiring (→ Page 116). 2. Contact Service.

240 – SD P-Fuel

Cause	Corrective action
Fuel pressure sensor after main filter (B34.1) supplies incorrect signal or no signal.	1. Check engine wiring (→ Page 116). 2. Contact Service.

266 – SD Speed Demand

Cause	Corrective action
Signal of analog speed setting missing.	1. Switch on plant-side automation system. 2. Contact Service.

321 – AL Wiring Cylinder A1

Cause	Corrective action
Short circuit in injector wiring of cylinder A1 or injector defective.	1. Check wiring of the applicable injector (→ Page 116). 2. Replace injector (→ Page 82). 3. Contact Service.

322 – AL Wiring Cylinder A2

Cause	Corrective action
Short circuit in injector wiring of cylinder A2 or injector defective.	1. Check wiring of the applicable injector (→ Page 116). 2. Replace injector (→ Page 82). 3. Contact Service.

323 – AL Wiring Cylinder A3

Cause	Corrective action
Short circuit in injector wiring of cylinder A3 or injector defective.	1. Check wiring of the applicable injector (→ Page 116). 2. Replace injector (→ Page 82). 3. Contact Service.

324 – AL Wiring Cylinder A4

Cause	Corrective action
Short circuit in injector wiring of cylinder A4 or injector defective.	1. Check wiring of the applicable injector (→ Page 116). 2. Replace injector (→ Page 82). 3. Contact Service.

325 – AL Wiring Cylinder A5

Cause	Corrective action
Short circuit in injector wiring of cylinder A5 or injector defective.	1. Check wiring of the applicable injector (→ Page 116). 2. Replace injector (→ Page 82). 3. Contact Service.

326 – AL Wiring Cylinder A6

Cause	Corrective action
Short circuit in injector wiring of cylinder A6 or injector defective.	1. Check wiring of the applicable injector (→ Page 116). 2. Replace injector (→ Page 82). 3. Contact Service.

341 – AL Open Load Cylinder A1

Cause	Corrective action
Disruption fault in injector wiring to cylinder A1.	1. Check wiring of the applicable injector (→ Page 116). 2. Contact Service.

342 – AL Open Load Cylinder A2

Cause	Corrective action
Disruption fault in injector wiring cylinder A2.	1. Check wiring of the applicable injector (→ Page 116). 2. Contact Service.

343 – AL Open Load Cylinder A3

Cause	Corrective action
Disruption fault in injector wiring cylinder A3.	1. Check wiring of the applicable injector (→ Page 116). 2. Contact Service.

344 – AL Open Load Cylinder A4

Cause	Corrective action
Disruption fault in injector wiring cylinder A4.	1. Check wiring of the applicable injector (→ Page 116). 2. Contact Service.

345 – AL Open Load Cylinder A5

Cause	Corrective action
Disruption fault in injector wiring cylinder A5.	1. Check wiring of the applicable injector (→ Page 116). 2. Contact Service.

346 – AL Open Load Cylinder A6

Cause	Corrective action
Disruption fault in injector wiring cylinder A6.	1. Check wiring of the applicable injector (→ Page 116). 2. Contact Service.

365 – AL Stop MV-Wiring Ground

Cause	Corrective action
Short circuit of injector positive connection to ground of one or more injectors. Short circuit of the negative injector connection or of one or more injectors to ground.	1. Check wiring (→ Page 116). 2. Re-start engine. 3. Contact Service.

440 – AL L1 P-Aux1

Cause	Corrective action
Pressure sensor on pressure measuring channel has fallen below limit value 1. The pressure value on pressure measuring channel is too low.	► Contact Service.

442 – AL L2 P-Aux1

Cause	Corrective action
Pressure sensor on pressure measuring channel has fallen below limit value 2. The pressure value on pressure measuring channel is too low.	► Contact Service.

536 – AL Wiring PWM_CM1

Cause	Corrective action
The control block M8 of the HP fuel pump cannot be activated.	1. Check engine wiring (→ Page 116). 2. Contact Service.

549 – AL Power Cut-Off detected

Cause	Corrective action
ECU operating voltage was switched off while the engine was running. Disconnect power supply only when the engine is at standstill.	<ol style="list-style-type: none">1. If power supply has not been disconnected manually, check engine wiring (→ Page 116).2. Contact Service.

615 – AL EIL Protection

Cause	Corrective action
Engine number in EIL does not match with the engine number stored in the ECU.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 116).2. Contact Service.

616 – AL EIL Error

Cause	Corrective action
ECU cannot detect EIL.	► Contact Service.

973 – AL Check Sum IIG

Cause	Corrective action
The IIG value entered does not correspond with the specified input format.	<ol style="list-style-type: none">1. Check IIG entry in Diasys, replace if necessary.2. Contact Service.

7 Task Description

7.1 SOLAS

7.1.1 Installation locations for SOLAS shielding

General information

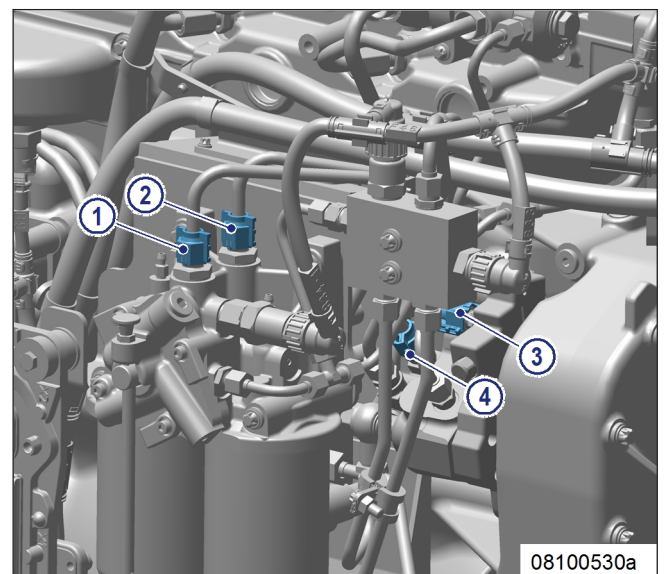
Primarily fit SOLAS shielding as per MTN 5233 (→ Page 69).

Shield unions with adhesive tape if SOLAS shielding as per MTN 5233 is not feasible (→ Page 70).

When affixing adhesive connections ensure that escaping fluid can flow out without pressure (→ Page 70).

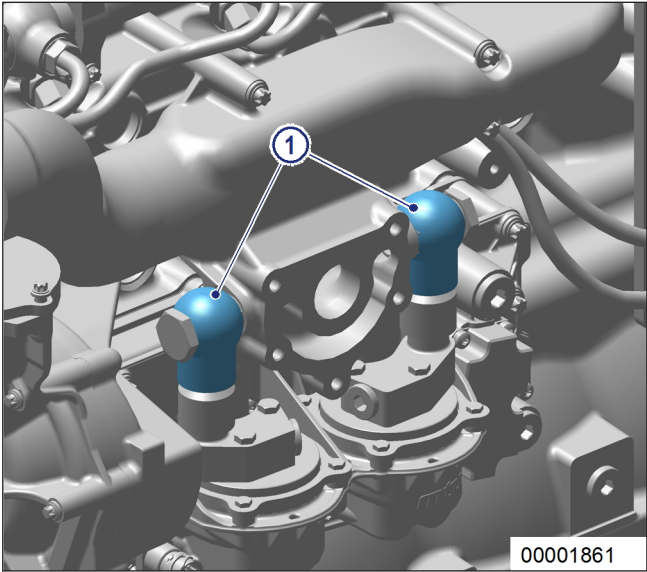
Left engine side

Shields in fuel system



Item	Type of shielding	Comments
1	Shield A5	At union of return line to fuel pump (HP stage)
2	Shield A5	At union of supply line from fuel pump (LP stage)
3	Shield A5	At union of supply line to fuel filter
4	Shield A5	At union of supply line from fuel filter

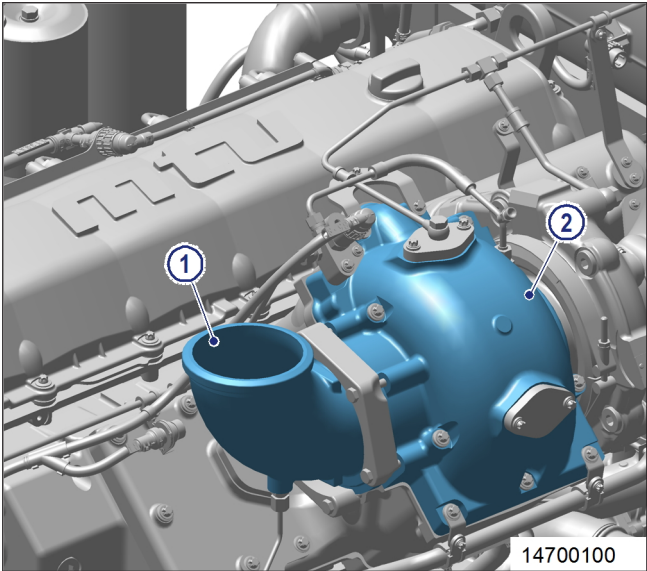
Shields in oil system



Item	Type of shielding	Comments
1	Adhesive tape (not shown)	Banjo union between oil module and charge-air pipe

Right engine side

Shields in exhaust system



Item	Type of shielding	Comments
1	Insulation (not shown)	Exhaust elbow with ISOTHERM insulation
2	Cooling jacket	Carrier housing of exhaust turbocharger

TIM-ID: 00000043477 - 001

7.1.2 SOLAS shielding as per MTN 5233 – Installation

Preconditions

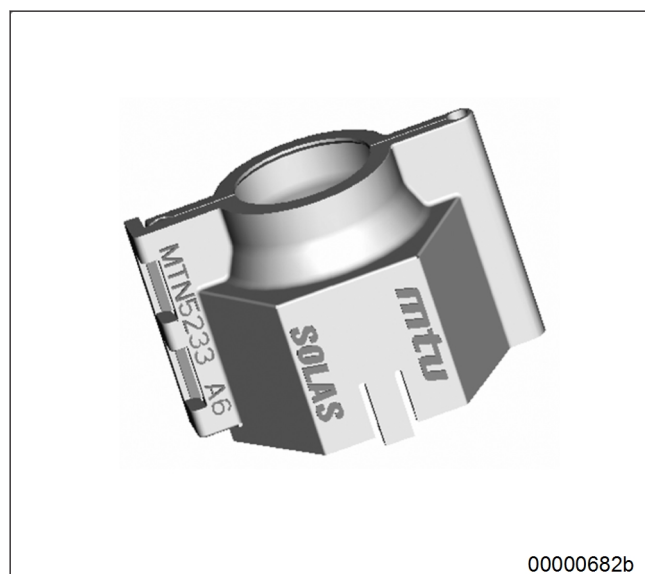
- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Shield A5	735233000101	4

SOLAS shielding – Installation

1. Pinpoint installation location (→ Page 67).
2. Install suitable shielding.
3. Press shielding until locked.



7.1.3 Adhesive tape for SOLAS shielding – Application

Preconditions

- ☑ Engine is stopped and starting disabled.

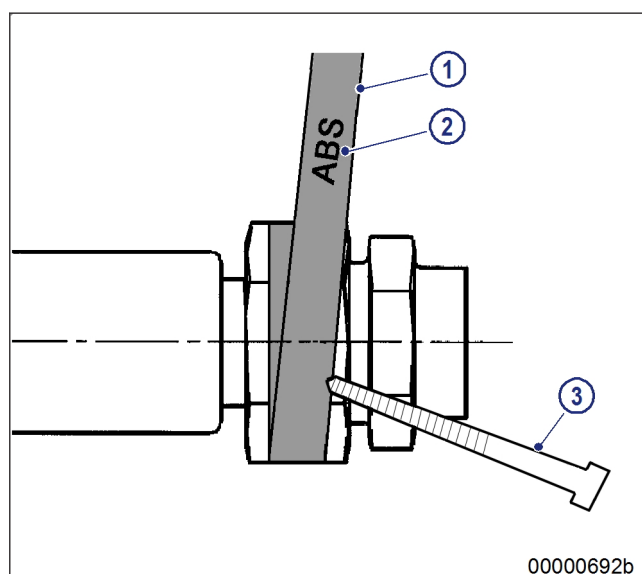
Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Adhesive tape	X00026424	1

Applying adhesive tape – general information

Note: Use the cable clamp to make a drainage channel. This allows fluid to flow out without pressure in case of leakage.

1. Place cable clamp (3) on union.
2. Affix adhesive tape (1) such that lettering (2) faces out.
3. Wrap adhesive tape without tensioning.
4. Pull out cable clamp (3) after affixing adhesive tape.



Banjo unions

Note: For installation positions of banjo unions, refer to (→ Page 67).

1. Apply adhesive tape flush.
2. Wrap three layers of adhesive tape in such a way that all joints are covered at least 30 mm.

7.2 Engine

7.2.1 Engine - Barring manually

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Barring gear	F6790714	1
Adapter	F30011619	1
Ratchet	F30027340	1

DANGER



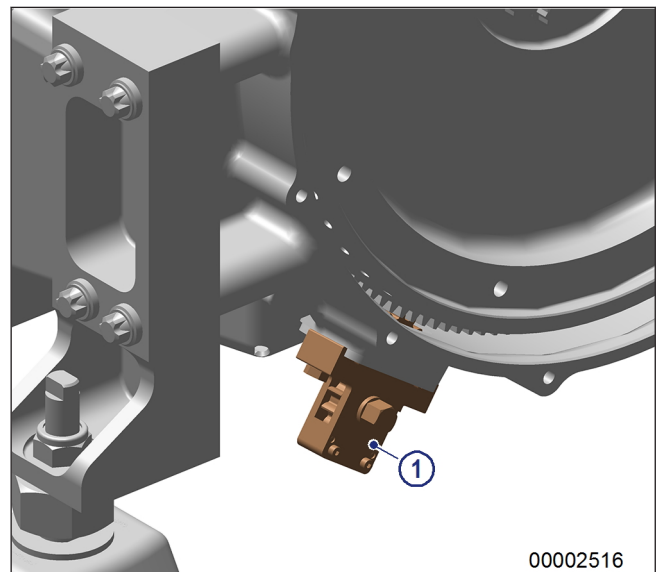
Rotating and moving engine parts.

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

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

Barring engine manually – Variant A

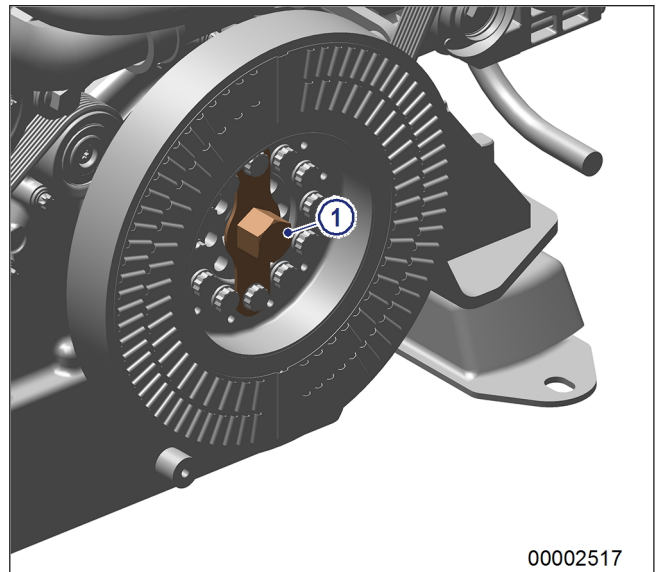
1. Remove guard plate from flywheel housing.
2. Engage barring gear (1) in ring gear and mount on flywheel housing.
3. Fit adapter and ratchet on barring gear (1).
4. Rotate crankshaft in engine direction of rotation. Apart from the normal compression resistance, there should be no resistance.
5. For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



00002516

Barring engine manually – Variant B

- Note: Barring gear (1) is installed on vibration damper on engine free end.
1. Fit ratchet with extension on barring gear (1).
 2. Rotate crankshaft in engine direction of rotation. Apart from the normal compression resistance, there should be no resistance.



00002517

7.2.2 Engine – Barring with starting system

Preconditions

- ☑ External pushbutton 'Bar engine without starting' is provided.

DANGER



Rotating and moving engine parts.

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

- Before cranking the engine with starter system, make sure that there are no persons in the engine's danger zone.

Engine – Barring with starting system

1. Press pushbutton 'Bar engine without starting' and keep depressed.
2. Let the crankshaft rotate until oil pressure is indicated, but not longer than 10 seconds.
3. Repeat procedure after approx. 20 seconds if necessary.

7.2.3 Engine – Test run

DANGER



Rotating and moving engine parts.

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

- Before cranking the engine with starter system, make sure that there are no persons in the engine's danger zone.

WARNING



High level of engine noise when the engine is running.

Risk of damage to hearing!

- Wear ear protectors.

Engine – Test run

1. Start engine (→ Page 46).
2. Perform test run not below 1/3 load and at least until steady-state temperature is reached.
3. Carry out operational checks (→ Page 48).
4. Stop engine (→ Page 49).

7.3 Crankcase Breather

7.3.1 Crankcase breather – Fine oil mist separator replacement

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 4–20 Nm	F30044239	1
Ratchet	F30027340	1
Assembly compound (Kluthe Hakuform 30-15)	X00067260	1
Oil mist fine separator	(→ Spare Parts Catalog)	
O-ring	(→ Spare Parts Catalog)	

WARNING



Hot oil.

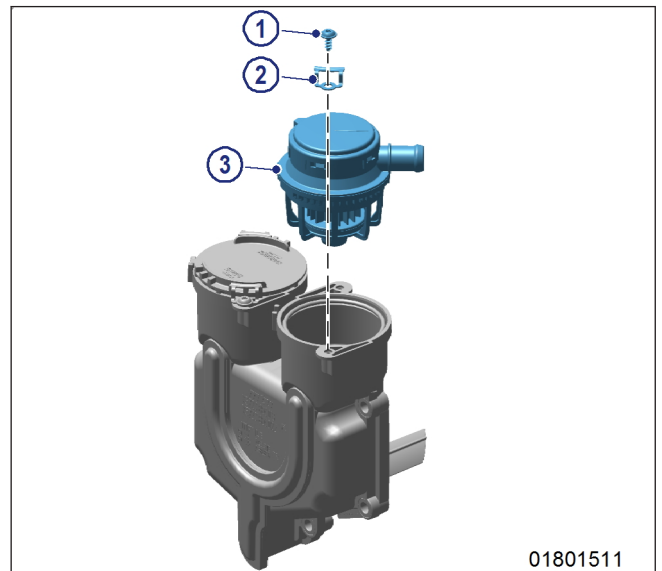
Oil can contain combustion residues which are harmful to health.

Risk of injury and poisoning!

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

Oil mist fine separator – Removal

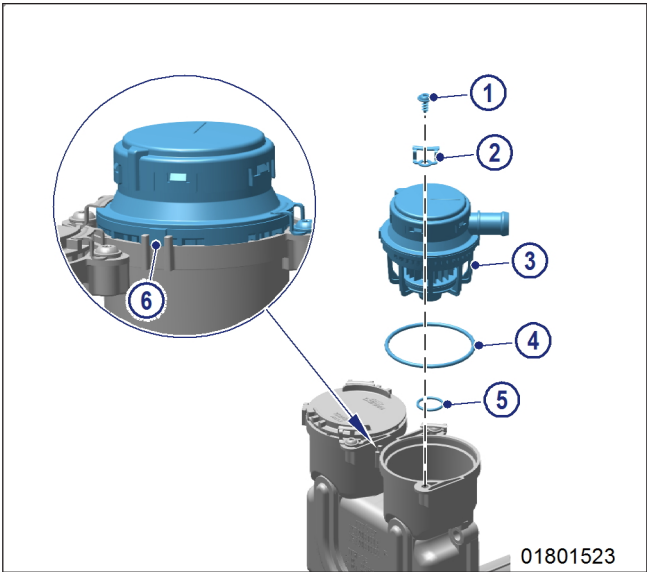
1. Unscrew screw (1).
2. Remove screw together with clamp (2).
3. Remove oil mist fine separator (3) with O-rings from vent housing.



01801511

Oil mist fine separator – Installation

1. Apply assembly compound to new O-rings (4, 5).
- Note:
- Make sure not to twist O-rings (4, 5) during installation.
 - The lug (6) of the oil mist fine separator (3) must be in the groove of the vent housing when installing the separator.
2. Follow the reverse sequence of working steps to install new oil mist fine separator (3) with O-rings (4, 5) on vent housing.



3. Use torque wrench to tighten screw (1) to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
PT screw		Tightening torque		7 Nm ±0.5 Nm

7.4 Valve Drive

7.4.1 Valve clearance – Check and adjustment

Preconditions

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

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Feeler gauge	Y20010128	1
Torque wrench, 20–100 Nm	F30026582	1
Box wrench, 14 mm	F30028346	1

Preparatory steps

1. Remove cylinder head cover (→ Page 79).
2. Rotate crankshaft with barring device in engine direction of rotation (→ Page 71) until "OT-A1" mark and pointer are aligned.

Diagram for 6R engines (two crankshaft positions)

- 1 Cylinder A1 is in firing TDC
 - 2 Cylinder A1 is in overlap TDC
- E Inlet valve
A Exhaust valve

①		②	
A6		A6	E, A
A5	A	A5	E
A4	E	A4	A
A3	A	A3	E
A2	E	A2	A
A1	E, A	A1	
KS		KS	

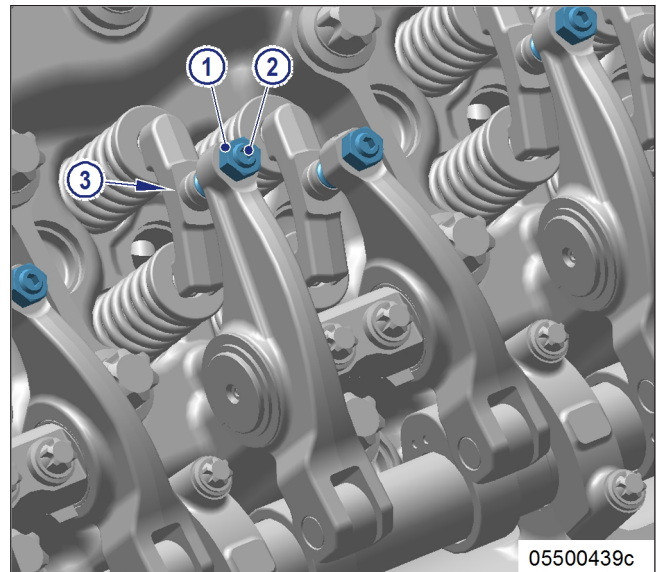
05500478b

Valve clearance at two crankshaft positions – Check

1. Check TDC position of piston in cylinder A1:
 - If rocker arms on cylinder A1 are unloaded, the piston is in firing TDC.
 - If rocker arms on cylinder A1 are loaded, the piston is in overlap TDC.
2. Check valve clearance with cold engine:
 - Inlet = 0.3 mm ±0.05 mm
 - Exhaust = 0.6 mm ±0.05 mm
3. Check all valve clearances in two crankshaft positions (firing TDC and overlap TDC of cylinder A1) as per diagram.
4. Use feeler gauge to determine the distance between valve bridge and rocker arm.
5. If the deviation from the reference value exceeds 0.1 mm, adjust valve clearance.

Valve clearance – Adjustment

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



4. Use torque wrench to tighten locknut (1) to specified tightening torque, holding adjusting screw (2) firm with Allen key.

Name	Size	Type	Lubricant	Value/Standard
Nut	M10 x 1	Tightening torque		43 Nm +4 Nm

5. Check if feeler gauge just passes through between valve bridge and rocker arm (3).

Result: If not, adjust valve clearance.

Final steps

1. Remove barring device.
2. Install cover on flywheel housing.
3. Install cylinder head cover (→ Page 79).

7.4.2 Cylinder head cover – Removal and installation

Preconditions

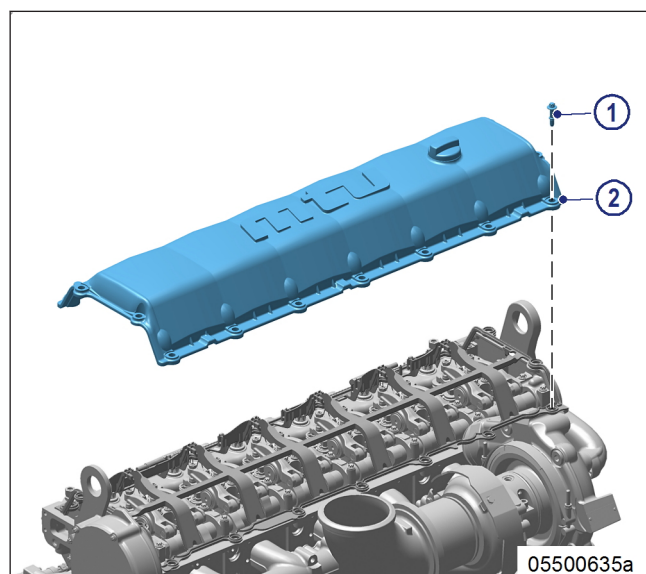
- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

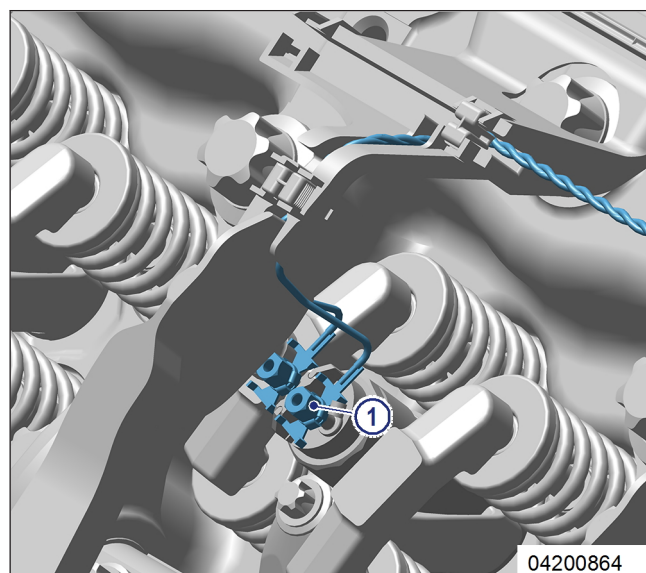
Designation / Use	Part No.	Qty.
Torque wrench, 8-40 Nm	F30043446	1
Ratchet	F30027340	1
Gasket	(→ Spare Parts Catalog)	

Cylinder head cover – Removal and installation

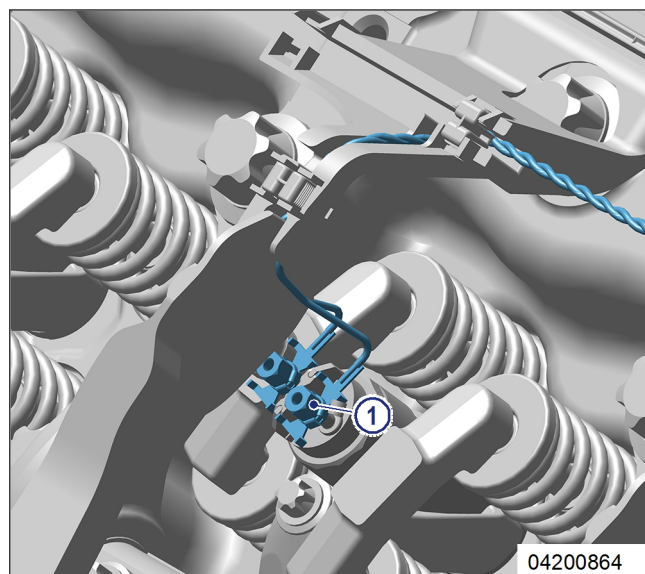
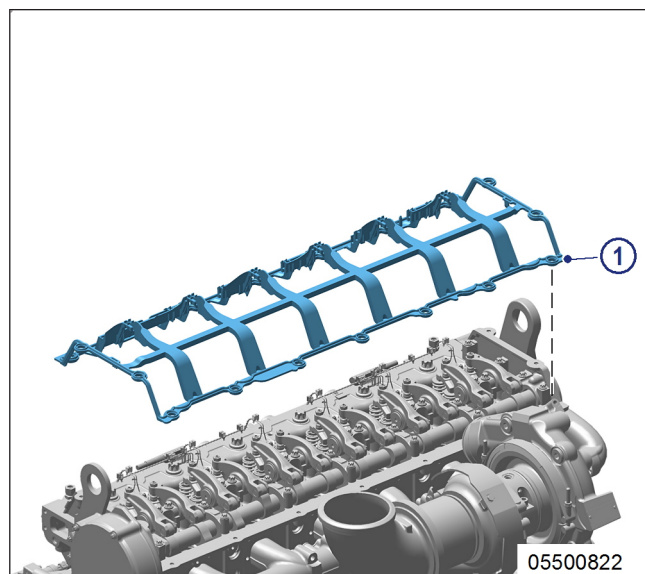
1. Remove screws (1).
2. Remove cylinder head cover (2).



3. Disconnect injector (1) cabling.

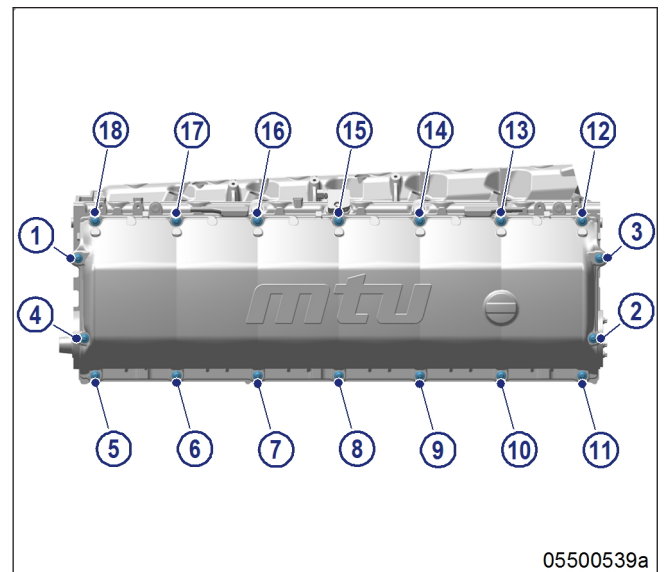


4. Remove gasket (1) with wiring.
5. Check condition of gasket (1) and replace if required.
6. Clean installation surface.
7. Fit gasket (1).



8. Tighten cabling (1) on injector.

Name	Size	Type	Lubricant	Value/Standard
Hex nut	M4	Tightening torque		1.5 Nm



9. Fit cylinder head cover and tighten screws at positions 1 to 4 to specified tightening torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw with twin collar	M8	Preload torque		10 Nm

10. Tighten screws at positions 1 to 18 to specified tightening torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw with twin collar	M8	Tightening torque		20 Nm \pm 2 Nm

Consecutive tightening sequence starting at position 1:	1 to 18
---	---------

7.5 Injector

7.5.1 Injector – Replacement

Special tools, Material, Spare parts

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

Injector – Replacement

- ▶ Remove injector and install a new one (→ Page 83).

7.5.2 Injector – Removal and installation

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Alignment device	F6791418	1
Puller	F6790992	1
Puller	F6796371	1
Installation device	F6790085	1
Milling cutter	F30454305	
Torque wrench, 20-100 Nm	F30026582	1
Ratchet	F30027340	1
Crowfoot box wrench, 22 mm	F30027425	1
Crowfoot box wrench, 27 mm	F30029816	1
Torque wrench, 8-40 Nm	F30043446	1
Engine oil		
Assembly compound (Kluthe Hakuform 30-15)	X00067260	1
Assembly paste (Optimoly Paste White T)	40477	1
Sealing ring	(→ Spare Parts Catalog)	
Pressure pipe neck	(→ Spare Parts Catalog)	1
Injector	(→ Spare Parts Catalog)	
HP fuel line	(→ Spare Parts Catalog)	
O-ring	(→ Spare Parts Catalog)	
Hold-down clamp screw	(→ Spare Parts Catalog)	

WARNING



Fuels are combustible and explosive.

Risk of fire and explosion!

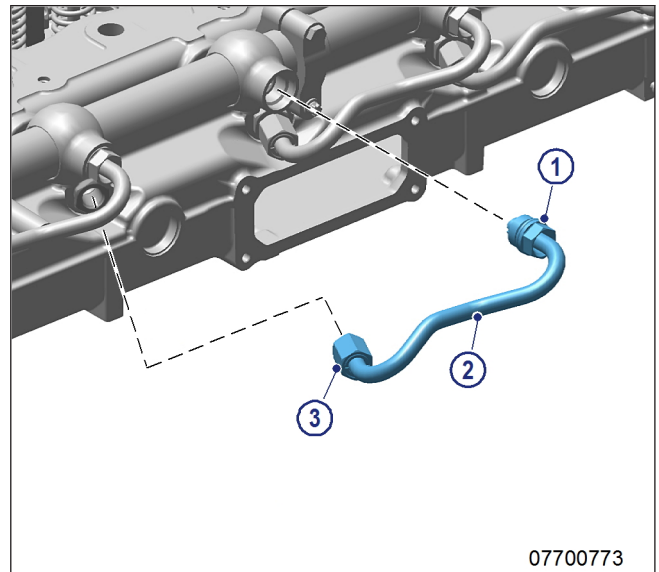
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

Preparatory steps

1. Shut off fuel supply to the engine.
2. Remove cylinder head cover (→ Page 79).

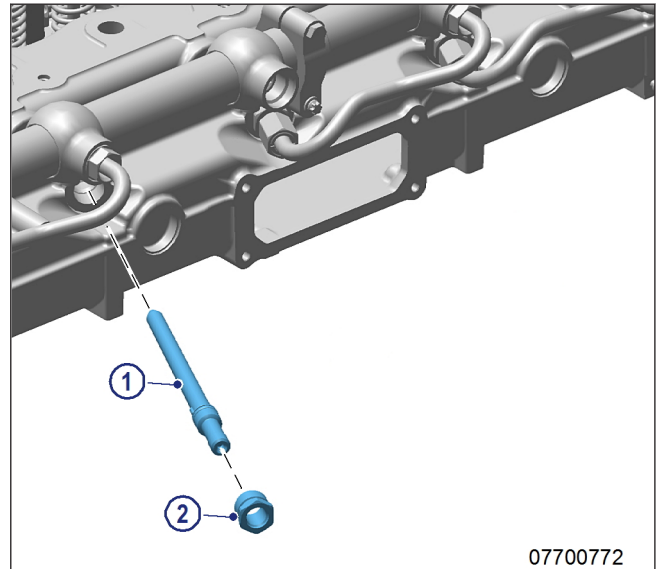
HP line – Removal

- Loosen union nuts (1, 3) and remove HP line (2) from HP accumulator and cylinder head.

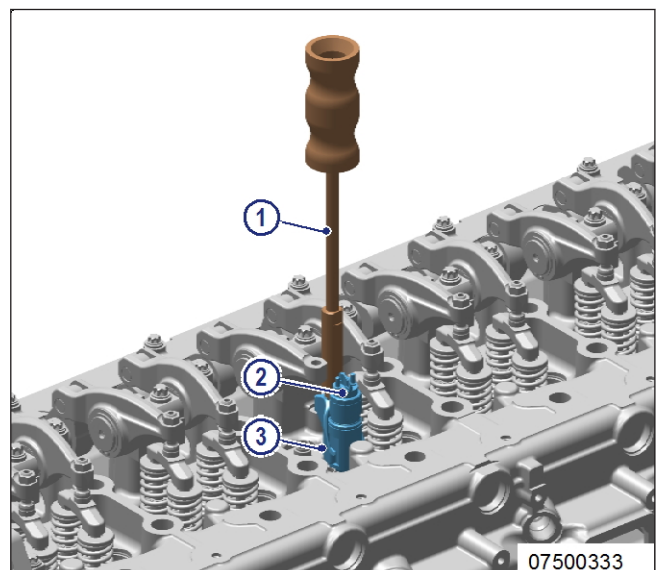


Remove injector

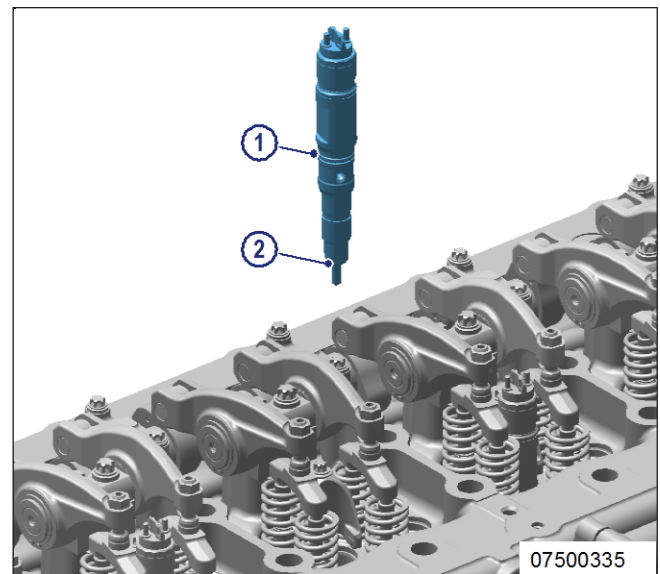
1. Loosen union nut (2) and remove pressure pipe neck (1) with puller (F6796371).



2. Remove hold-down clamp screw.
3. Install puller (F6790992) (1) on hold-down clamp (3).
4. Use puller (F6790992) (1) to pull out injector (2) and hold-down clamp (3).



5. Remove sealing ring (2) from injector or use wire hook to remove from cylinder head.
6. Remove O-ring (1) from injector.
7. Seal all openings with suitable covers.



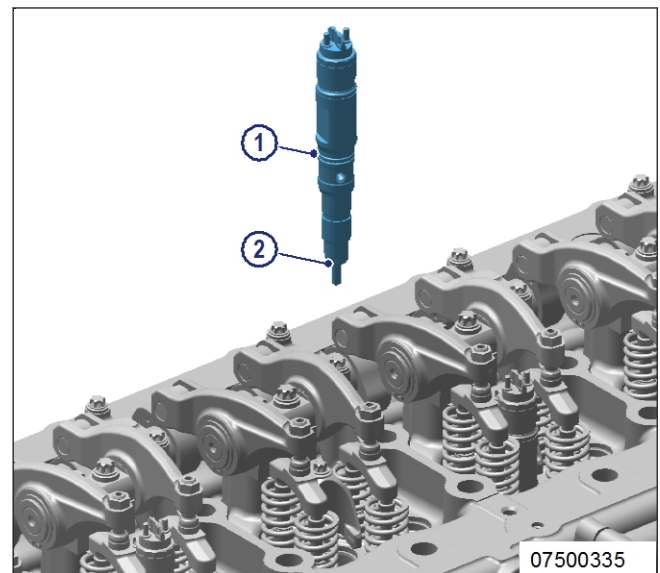
Installing injector

Note: Use sealing rings, O-rings, hold-down clamp screws, pressure pipe neck, and HP lines only once.

1. Remove all covers prior to installation.

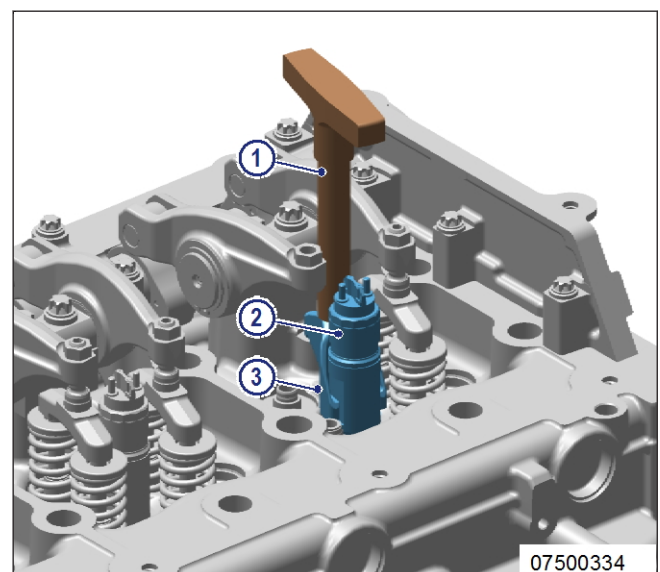
Note: Before installing the injector for the very first time: Apply assembly compound (Kluthe Hakuform 30-15) to O-ring.

2. Fit new O-ring (1) on injector and apply assembly compound.
3. Apply assembly compound (Optimoly Paste White T) to new sealing ring (2) to secure it on the injector, making sure that the sealing ring is positioned correctly.
4. Clean injector sealing surface on the cylinder head using the milling cutter.
5. Coat sealing cone of injector with engine oil.



Note: Do not introduce load to the solenoid assembly of the injector. Force must only be applied through the hold-down clamp.

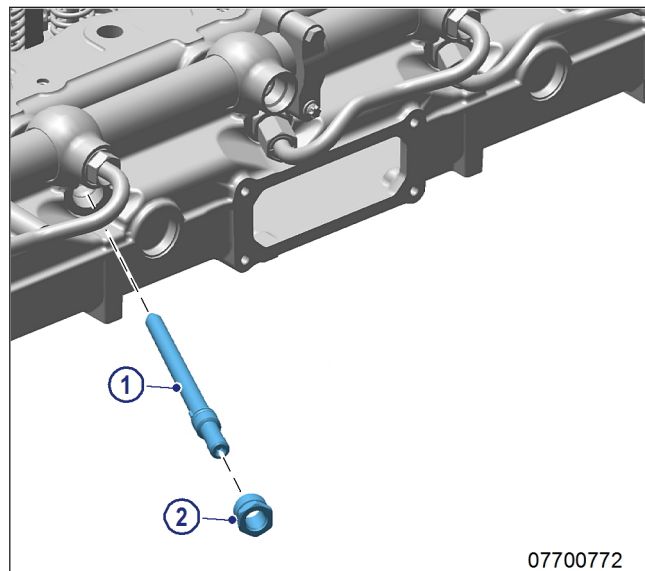
6. Install injector (2) and hold-down clamp (3) with installation device (1) in cylinder head.
7. Remove installation device (1).



8. Install new hold-down clamp screw.

Name	Size	Type	Lubricant	Value/Standard
Screw	M7	Tightening torque		5 Nm

9. Loosen hold-down clamp screws again to completely unload the injector.
 10. Use the alignment device to align the HP connection of the injector at the pressure pipe neck (1).
 11. Coat the taper of the new pressure-pipe neck (1) with engine oil.
- Note: Do not lubricate union nut (2) at initial installation.
12. Apply engine oil to thread and sealing area of union (2) nut for pressure pipe neck (1).



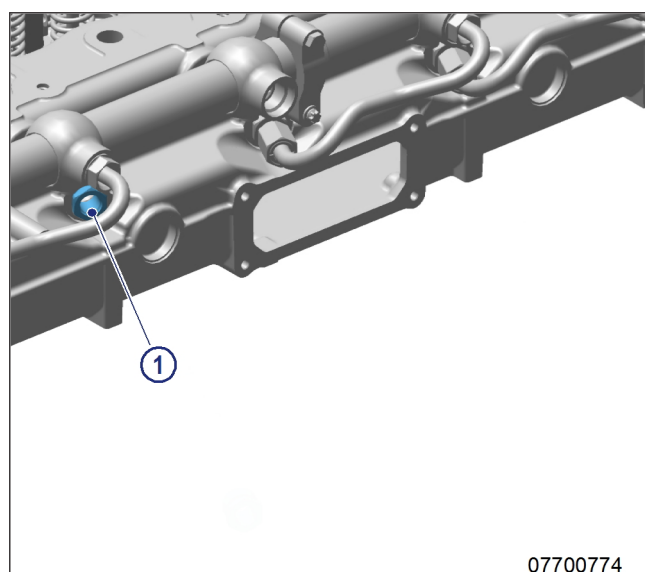
13. Press in pressure pipe neck (1) by hand and tighten union nut (2) to specified initial tightening torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Union nut	M24	Preload torque	(Engine oil)	15 Nm +5 Nm

Result: Injector is secured in position.

14. Tighten hold-down clamp screw to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw	M7	Tightening torque		18 Nm +2 Nm
Screw	M7	Residual angle of rotation		90° +5°



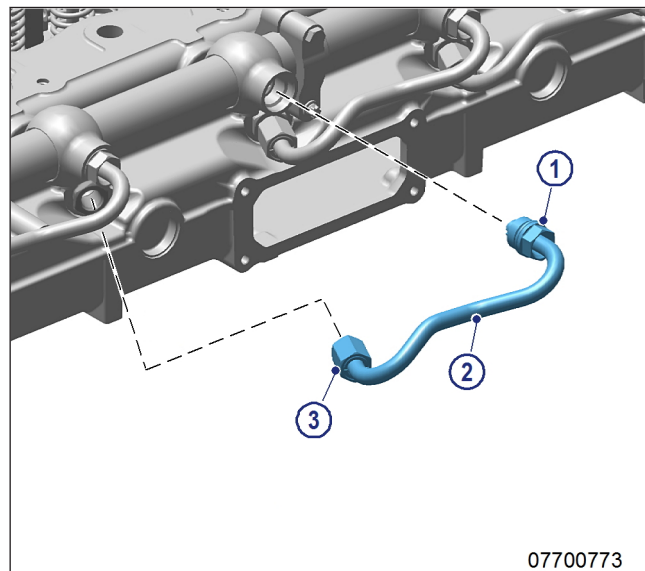
TIM-ID: 0000043254 - 003

15. Tighten union nut (1) of pressure pipe neck with torque wrench to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Union nut	M24	Tightening torque		50 Nm +5 Nm

HP line – Installation

1. Fit new HP line (2) and tighten union nuts (1, 3) hand-tight:
 - Tighten union nut (1) on HP accumulator first
 - Then tighten union nut (3) on pressure pipe neck



2. Use torque wrench to tighten union nut (1) to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Nut	M24	Tightening torque	(Engine oil)	50 Nm +5 Nm

3. Use torque wrench to tighten union nut (3) to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Nut	M14	Tightening torque	(Engine oil)	30 Nm +3 Nm

Final steps

1. Install cylinder head cover (→ Page 79).

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

2. Reset drift compensation (CDC) with DiaSys® (→ E531920/...). If DiaSys® is not available, contact Service.
3. Open fuel supply to engine.
4. Vent fuel system (→ Page 88).

7.6 Fuel System

7.6.1 Fuel system - Venting

Preconditions

- ☑ Engine is stopped and starting disabled.

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.

Fuel system - Venting

1. Screw out handle (1).

Result: Fuel priming pump is unlocked.

2. Loosen banjo screw (2).

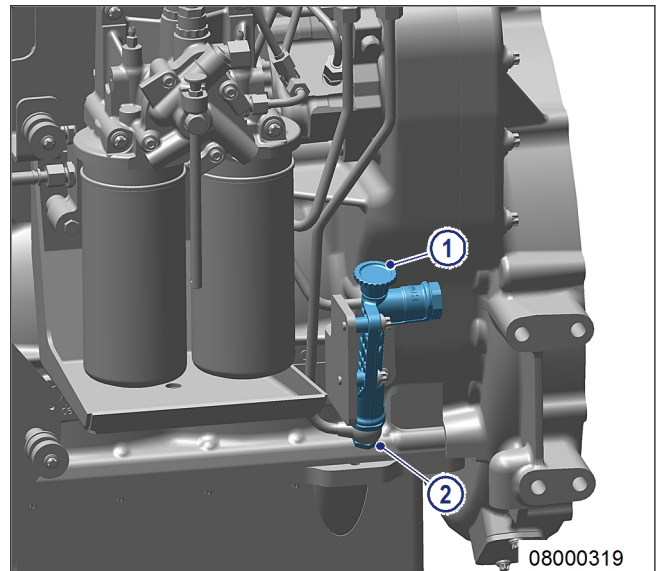
Note: Catch emerging fuel with a suitable cloth.

3. Operate pump with handle (1) until bubble-free fuel emerges.

4. Tighten banjo screw (2).

5. Screw in handle (1) and tighten.

Result: Fuel priming pump is locked.



7.7 Fuel Filter

7.7.1 Fuel filter – Replacement

Special tools, Material, Spare parts

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

DANGER



Rotating and moving engine parts.

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

- Before cranking the engine with starter system, make sure that there are no persons in the engine's danger zone.

WARNING



High level of engine noise when the engine is running.

Risk of damage to hearing!

- Wear ear protectors.

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!

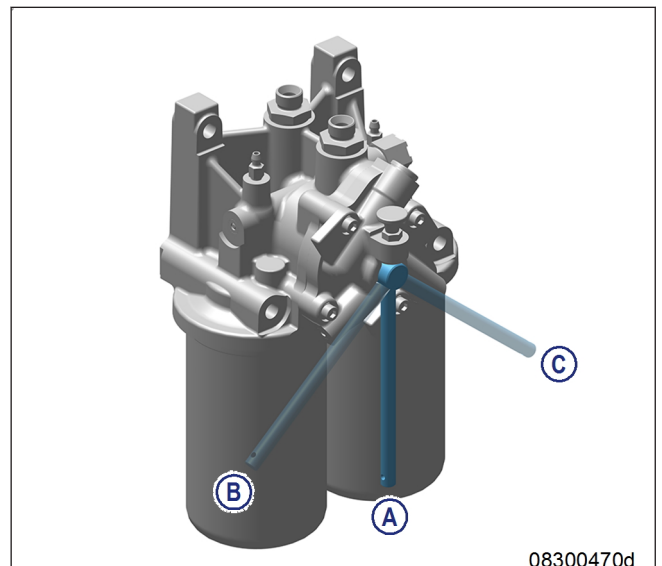
- For filter replacement with the engine running, operate the engine at low engine load.
- The filter which is to be replaced must be cut out for a brief period only.

Preparatory step

- Provide a suitable container to collect the fuel.

Replacing fuel filter with the engine running

1. Note the three-way cock settings listed below:
 - (A) Both filters are cut in (standard position).
 - (B) Right filter is cut out.
 - (C) Left filter is cut out.



Note: Filter replacement on a running engine is permissible only with a short-time cutout of the filter to be replaced.

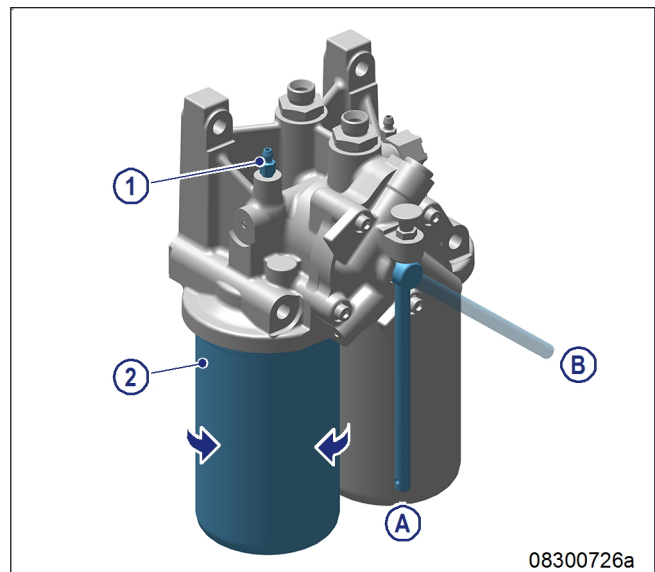
2. Turn three-way cock to setting (B) to cut out the filter (2) which is to be replaced:

Result: Fuel filter (2) is cut out of the fuel circuit, but is still under pressure.

3. Connect venting hose to threaded vent plug (1) of filter which has been cut out. Lead the end of the hose to the prepared collecting container.
4. Carefully turn the threaded vent plug (1) of the cut out filter to the left. Check that the fuel filter is depressurized.
5. Close vent plug (1).
6. Unscrew cut out easy-change filter (2) using a filter wrench.
7. Clean sealing surface on filter head.
8. Lightly oil sealing ring of new easy-change filter.
9. Screw on easy-change filter (2) by hand until seal makes contact, then tighten by hand.

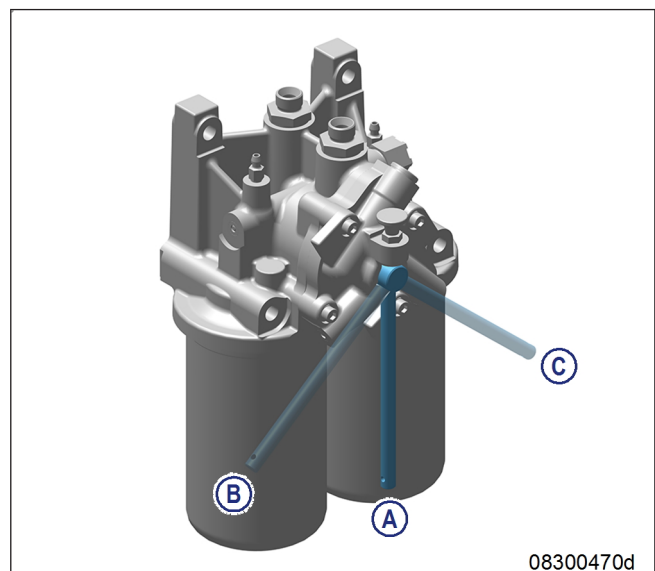
Note: Cut the fuel filter back in slowly following replacement to return both filters to operation. The engine may shut down if the filter is cut back in too quickly.

10. Turn three-way cock slowly to position (A) to allow fuel to flow through both filters (standard position).
11. Replace other fuel filters in the same way.

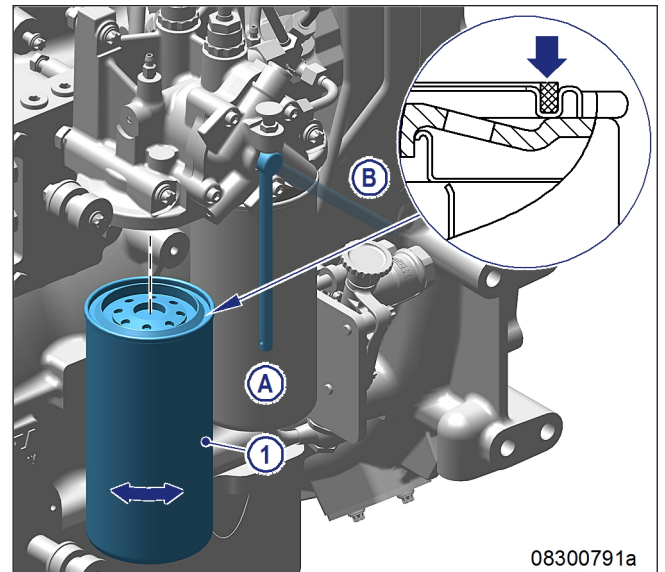


Replacing fuel filter with the engine at standstill

1. Note the three-way cock settings listed below:
 - (A) Both filters are cut in (standard position).
 - (B) Right filter is cut out.
 - (C) Left filter is cut out.



2. Stop engine and disable engine start.
3. Turn three-way cock to setting (B) to cut out the filter (1) which is to be replaced.
4. Unscrew cut out easy-change filter (1) using a filter wrench.
5. Clean sealing surface on filter head.
6. Lightly oil sealing ring of new easy-change filter.
7. Screw on easy-change filter (1) by hand until seal makes contact, then tighten by hand.
8. Turn three-way cock to position (A) so both filters are in use (standard position).
9. Replace other fuel filters in the same way.
10. Vent fuel system (→ Page 88).



7.8 Air Filter

7.8.1 Air filter – Replacement

Special tools, Material, Spare parts

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

Air filter – Replacement

1. Remove air filter and install new one (→ Page 93).
2. Reset signal ring of service indicator (→ Page 94).

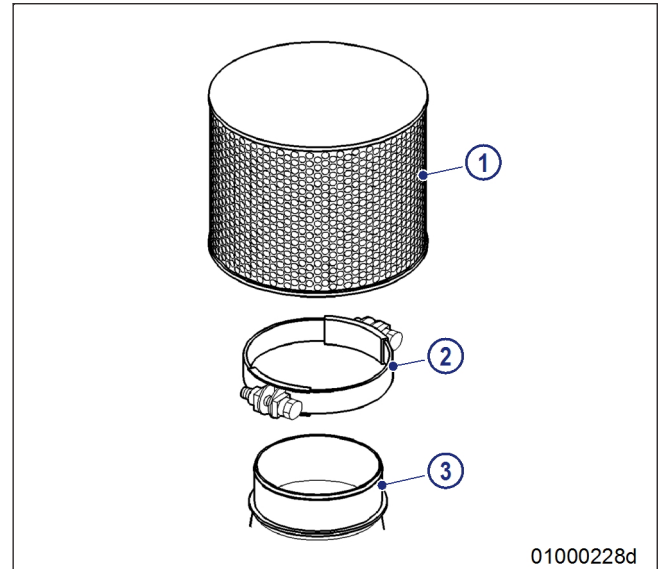
7.8.2 Air filter – Removal and installation

Preconditions

- ☑ Engine is stopped and starting disabled.

Air filter – Removal and installation

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



7.9 Air Intake

7.9.1 Service indicator – Signal ring position check

Preconditions

- ☑ Engine is stopped and starting disabled.

Checking signal ring position

1. Replace air filter if the signal ring (2) is completely visible in the red area of the observation window (3) (→ Page 92).
2. After installation of new filter, press reset button (1).

Result: Signal ring returns to initial position.



7.10 Lube Oil System, Lube Oil Circuit

7.10.1 Engine oil – Level check

DANGER



Rotating and moving engine parts.

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

- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING



Hot oil.

Oil can contain combustion residues which are harmful to health.

Risk of injury and poisoning!

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

WARNING



High level of engine noise when the engine is running.

Risk of damage to hearing!

- Wear ear protectors.

NOTICE



Damage to component!

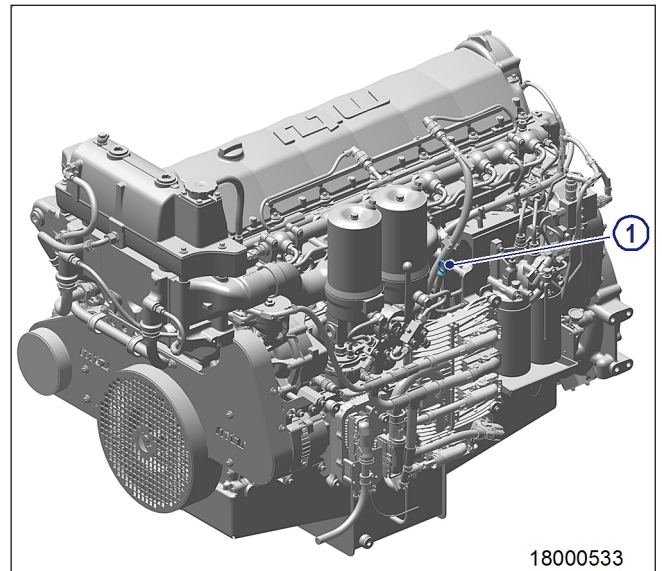
Severe material damage!

- 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.

Oil level check after stopping the engine

- Note:
- Engine is stopped and starting disabled.
 - Engine is at operating temperature.

1. 5 minutes after stopping the engine, remove oil dipstick (1) from the guide tube and wipe it.
2. Insert oil dipstick (1) into guide tube up to the stop, withdraw after approx. 10 seconds and check oil level.
3. The oil level must be between the min. and max. mark in the hatched area on the oil dipstick side "5 Min. after ENGINE STOP".
4. If oil level is too low, top up until oil level is at the upper mark (→ Page 97).
5. Insert oil dipstick (1) in guide tube up to the stop.



18000533

Checking engine oil level before engine start after extended out-of-service periods

Note: Engine is stopped and starting disabled.

1. Remove oil dipstick (1) from guide tube and wipe it.
2. Insert oil dipstick (1) into guide tube up to the stop, withdraw after approx. 10 seconds and check oil level.
3. The oil level must be above the center of the measurement range in the hatched area on the oil dipstick side "5 Min. after ENGINE STOP".

Note: If the engine was filled with the maximum admissible oil quantity, the oil level may be above the max. mark.

4. If oil level is too low, top up until oil level is at the upper mark (→ Page 97).
5. Insert oil dipstick (1) in guide tube up to the stop.

Checking engine oil level with the engine running idle

Note: Engine is at operating temperature.

1. Engine is running at constant idling speed.
2. Insert dipstick (1) into guide tube up to the stop, pull out after approx. 10 seconds.
3. The oil level must be between the min. and max. mark in the hatched area on the oil dipstick side "ENGINE IDLE".
4. If oil level is too low, top up until oil level is at the upper mark (→ Page 97).
5. Insert oil dipstick (1) in guide tube up to the stop.

7.10.2 Engine oil – Change

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ Engine is at operating temperature.
- ☑ MTU Fluids and Lubricants Specifications (A001063/..) are available.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine oil		

WARNING



Hot oil.

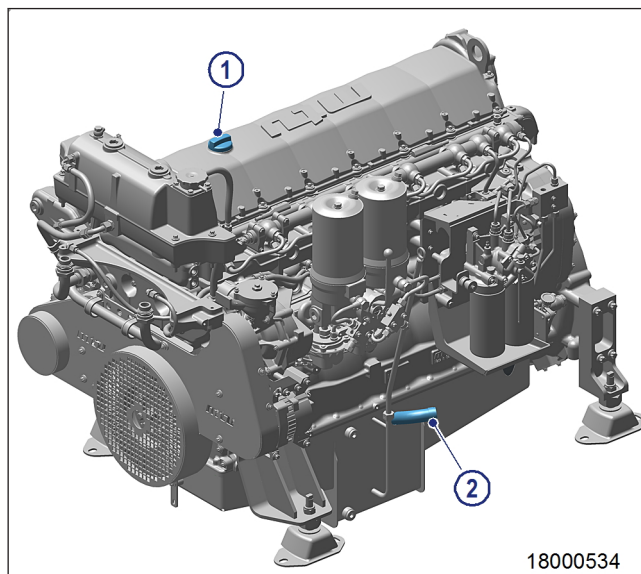
Oil can contain combustion residues which are harmful to health.

Risk of injury and poisoning!

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

Oil extraction

1. Provide a suitable container to collect the oil.
2. Remove plug screw (2) on oil drain pipe.
3. Extract all oil from oil pan using the oil-pump unit (order-dependent).
4. Install plug screw (2) with new sealing ring.
5. Replace engine oil filter (→ Page 98).



Filling with new oil

1. Open cap (1) on cylinder head cover.
2. Fill with oil.
3. Close cap (1) on cylinder head cover.
4. Check engine oil level (→ Page 95).

7.11 Oil Filtration / Cooling

7.11.1 Engine oil filter - Replacement

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Drain hose with quick-release coupling	X57299100654	1
Torque wrench, 20–100 Nm	F30026582	1
Ratchet	F30027340	1
Vent hose	X57299100655	1
Socket wrench 8-22 A/F	F30452510	1
Socket wrench 17 A/F	F30030450	1
Engine oil		
Oil filter element	(→ Spare Parts Catalog)	2
Sealing ring	(→ Spare Parts Catalog)	2
O-ring	(→ Spare Parts Catalog)	2

DANGER



Rotating and moving engine parts.

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

- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING



High level of engine noise when the engine is running.

Risk of damage to hearing!

- Wear ear protectors.

WARNING



Hot oil.

Oil can contain combustion residues which are harmful to health.

Risk of injury and poisoning!

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

NOTICE



Damage to component!

Severe material damage!

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

Preparatory step

- Provide a suitable container in which to collect the engine oil.

Engine oil filter replacement with the engine running

1. To cut out the filter to be replaced, set the three-way cock (2) to the corresponding position.
 - a Both filters cut in (operating position)
 - b Right-hand filter cut out
 - c Left-hand filter cut out

Result: The oil filter is isolated from the oil circuit but still under pressure.

2. Connect vent hose to threaded vent plug (1) of the cut-out oil filter. Place the end of the hose in the container provided.
3. Turn threaded vent plug (1) counterclockwise by one revolution.

Result: The gauge pressure in the filter housing is released through the vent hose.

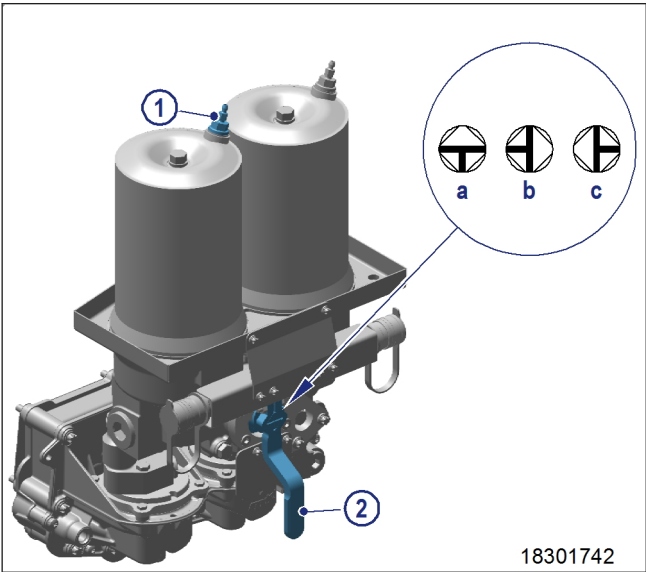
4. Wait until air no longer escapes from hose.
5. Use torque wrench to tighten threaded vent plug (1) to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Threaded vent plug		Tightening torque		25±2 Nm

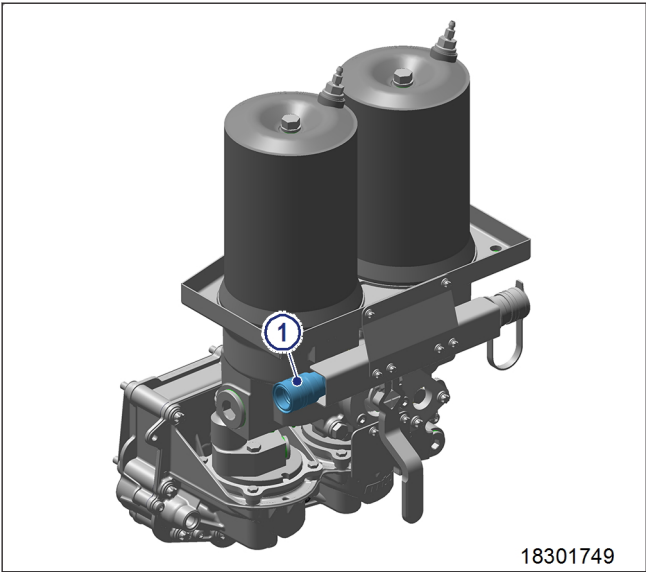
6. Remove vent hose.
7. Place open end of oil drain hose in container.
8. Remove dust cap from coupling sleeve (1).
9. Connect quick-release coupling of oil drain hose to coupling sleeve (1).

Result: Oil drains from filter housing.

10. Wait until the oil has completely drained from oil filter housing via oil drain hose.
11. Disconnect quick-release coupling of oil drain hose and remove hose. Close coupling sleeve (1) with dust cap.

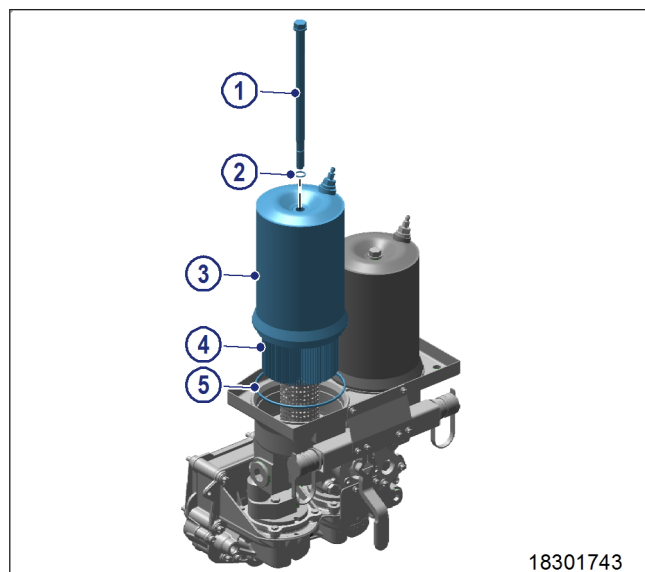


18301742



18301749

12. Remove central screw (1) with sealing ring (2).
13. Remove filter bowl (3) with oil filter element (4) and O-ring (5).
14. Insert new oil filter element (4) in filter bowl (3) with the front face with coil spring facing upwards.
15. Position filter bowl (3) with new O-ring (5) on filter head.
16. Tighten central screw (1) with new sealing ring (2) manually.



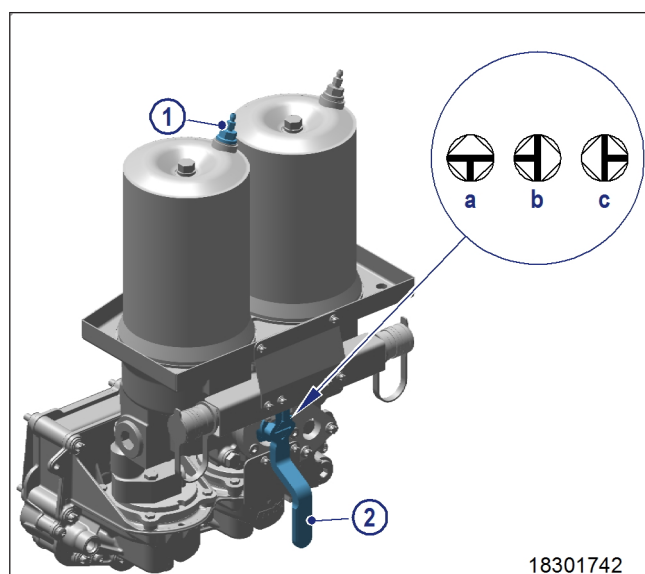
17. Use torque wrench to tighten central screw (1) to specified tightening torque .

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

18. Make sure that threaded vent plug (1) was tightened to specified tightening torque (\rightarrow Step 5) and that the oil drain hose was removed (\rightarrow Step 11).

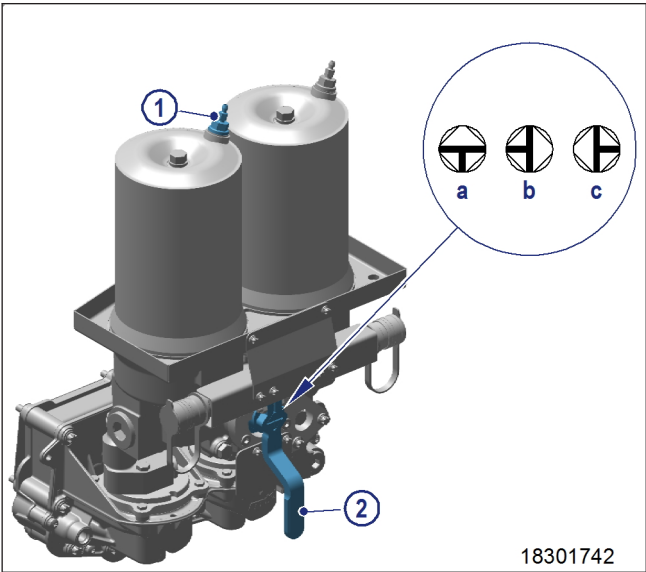
Note: Switching back to the position where both oil filters are cut in (position a) after oil filter element replacement must be carried out slowly. Otherwise, an engine shutdown may occur.

19. Slowly cut in the filter with the new filter element at the three-way cock (2) (position a).
20. Replace other oil filters in the same way.
21. Check oil level (\rightarrow Page 95).



Engine oil filter replacement with the engine at standstill

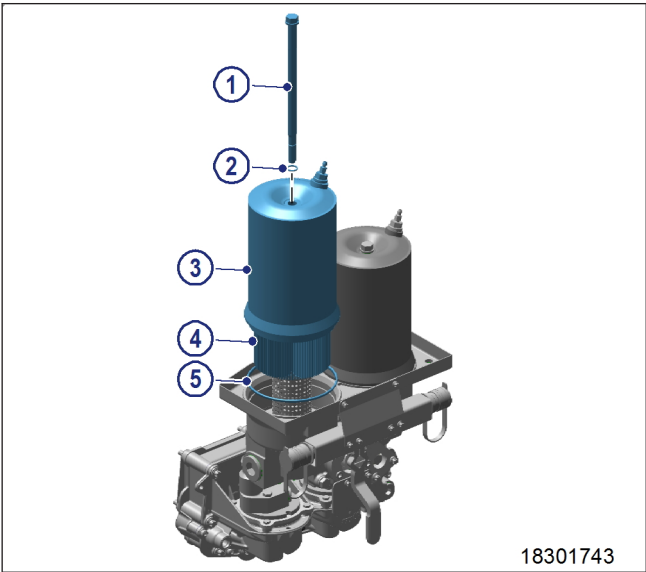
- 1. Stop engine and disable engine start.
 - 2. Set three-way cock (2) the position where both filters are cut-in:
 - a Both filters cut in (operating position)
 - b Right-hand filter cut out
 - c Left-hand filter cut out
 - 3. Turn threaded vent plug (1) counterclockwise by one revolution.
- Result: Oil drains from oil filter through the oil ducts in the engine.



- 4. Use torque wrench to tighten threaded vent plug (1) to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Threaded vent plug		Tightening torque		25±2 Nm

- 5. Remove central screw (1) with sealing ring (2).
- 6. Take off filter bowl (3) with oil filter element (4).
- 7. Insert new oil filter element (4) in filter bowl (3) with the front face with coil spring facing upwards.
- 8. Position filter bowl (3) with new O-ring (5) on filter head.
- 9. Tighten central screw (1) with new sealing ring (2) manually.



- 10. Use torque wrench to tighten central screw (1) to specified tightening torque .

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

- 11. Replace other oil filters in the same way.
- 12. After each oil change and filter replacement, bar engine with starting system (→ Page 73).
- 13. Check oil level (→ Page 95).

7.12 Coolant System, General, High-Temperature Circuit

7.12.1 Engine coolant – Level check

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specifications (A001063/..) are available.

WARNING



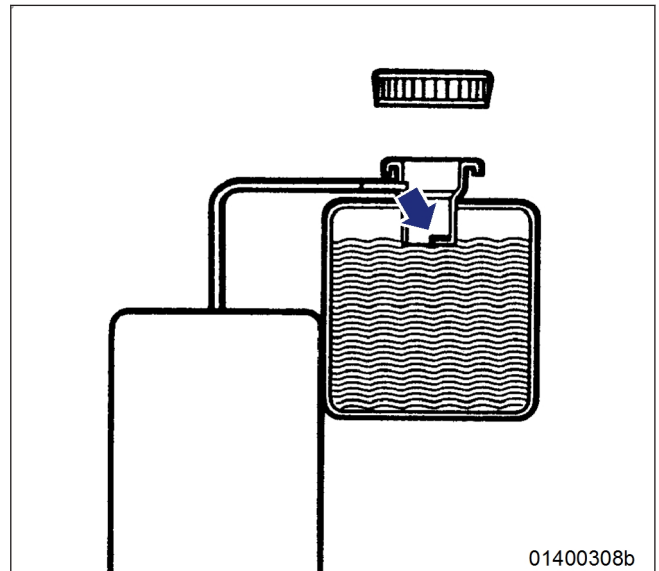
Coolant is hot and under pressure.

Risk of injury and scalding!

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

Checking engine coolant level at filler neck

1. Turn breather valve on coolant expansion tank counterclockwise to the first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Check coolant level (coolant must be visible at the lower edge of the cast-in eye or at the marking plate).
4. Top up with treated coolant as necessary (→ Page 105).
5. Check breather valve (visual inspection) and clean if necessary.
6. Position breather valve on filler neck and close.



01400308b

Checking engine coolant level by means of level sensor

1. Switch on engine control system and check readings on the display.
2. Top up with treated coolant as necessary (→ Page 105).

7.12.2 Engine coolant – Change

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Coolant		

Engine coolant change

- 1. Drain engine coolant (→ Page 104).
- 2. Fill with engine coolant (→ Page 105).

7.12.3 Engine coolant – Draining

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

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

WARNING



Coolant is hot and under pressure.

Risk of injury and scalding!

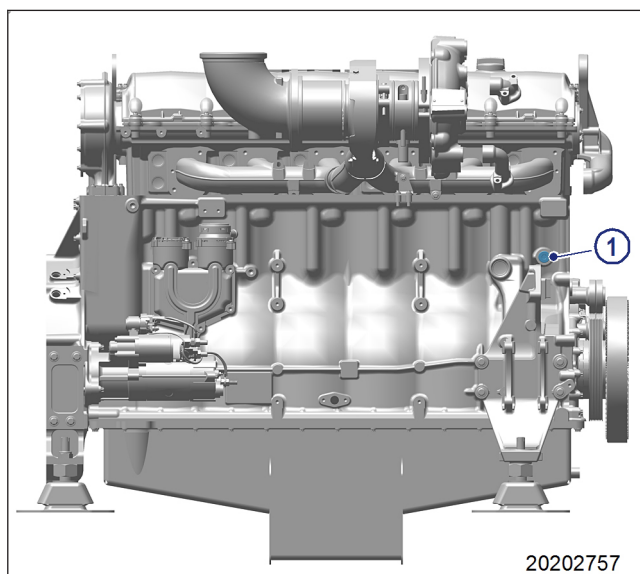
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Preparatory steps

1. Provide a suitable receptacle to catch the coolant.
2. Switch off preheater, if installed.

Engine coolant – Draining

1. Turn breather valve of filler neck on coolant expansion tank counterclockwise to first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Draw off separated corrosion inhibitor oil in expansion tank through the filler neck.
4. Remove drain plug (1) and drain coolant.



20202757

5. Insert drain plug with new sealing ring and use torque wrench to tighten to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Drain screw		Tightening torque	(Engine oil)	70 Nm

6. Place breather valve on filler neck and close.

7.12.4 Engine coolant – Filling

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specifications (A001063/..) are available.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Coolant		

WARNING



Coolant is hot and under pressure.

Risk of injury and scalding!

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

WARNING



High level of engine noise when the engine is running.

Risk of damage to hearing!

- Wear ear protectors.

NOTICE



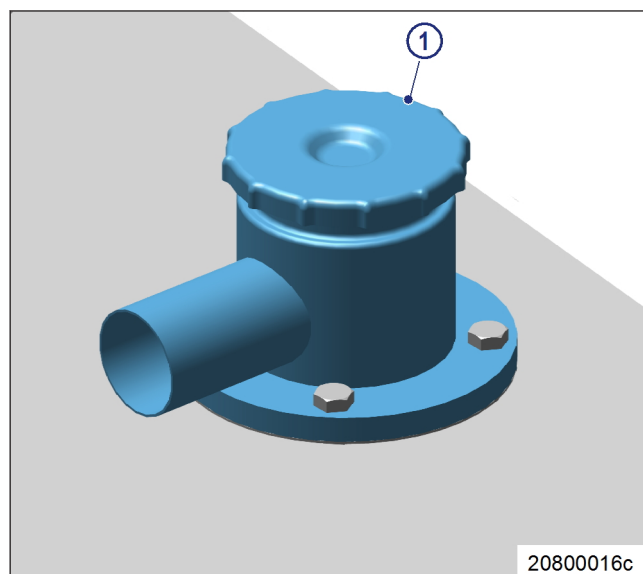
Cold coolant in hot engine can cause thermal stress.

Possible formation of cracks in the engine!

- Fill / top up coolant only into cold engine.

Preparatory steps

1. Turn breather valve (1) of coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
2. Continue to turn valve cover (1) counterclockwise and remove.



Coolant – Filling

1. Fill coolant through filler neck on expansion tank or through filling line until coolant level reaches lower edge of cast-in eye or marking plate.
2. Check proper condition of breather valve (1), clean sealing faces if required.
3. Fit breather valve (1) and close it.

Final steps

1. Start the engine and operate it at idle speed for some minutes.
2. Check coolant level (→ Page 102), top up with coolant if required.

7.12.5 Engine coolant pump – Relief bore check

DANGER



Rotating and moving engine parts.

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

- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING



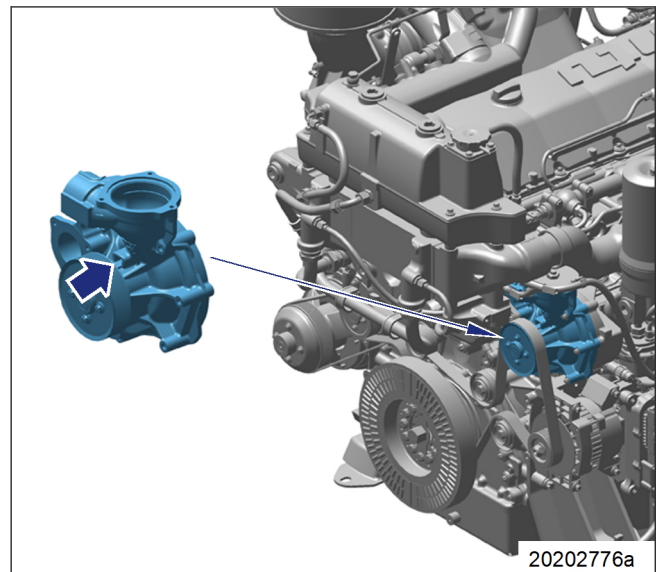
High level of engine noise when the engine is running.

Risk of damage to hearing!

- Wear ear protectors.

Engine coolant pump – Relief bore check

1. Check relief bore (arrow) for engine coolant discharge.
 - Permissible engine coolant discharge: max. 0.25 ml per operating hour.
2. If discharge exceeds the specified limits, contact Service.
3. If relief bore (arrow) is dirty:
 - Stop engine (→ Page 49) and disable engine start.
 - Clean relief bore (arrow) with a wire.



7.13 Low-Temperature Circuit

7.13.1 Charge-air coolant pump - Relief bore check

DANGER



Rotating and moving engine parts.

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

- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING



High level of engine noise when the engine is running.

Risk of damage to hearing!

- Wear ear protectors.

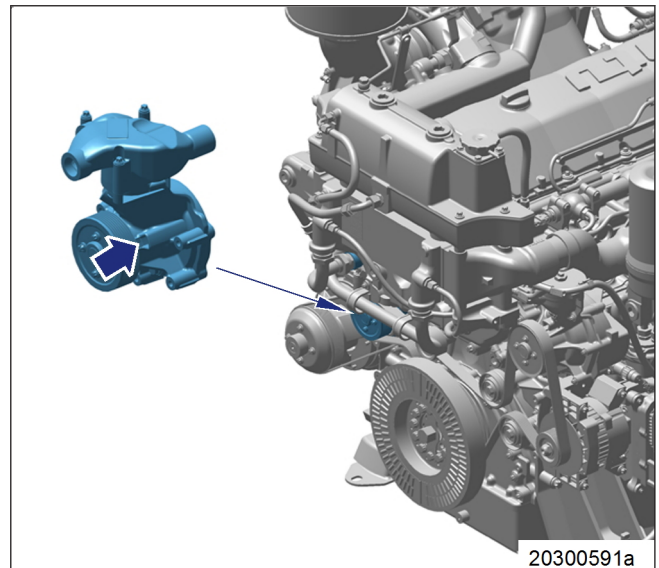
Charge-air coolant pump - Relief bore check

1. Check relief bore (arrow) for coolant discharge.

- Permissible engine coolant discharge: max. 0.25 ml per operating hour.

Result: If discharge exceeds the specified limits, contact Service.

2. If relief bore (arrow) is dirty:
 - Stop engine (→ Page 49) and disable engine start.
 - Clean relief bore (arrow) with a wire.



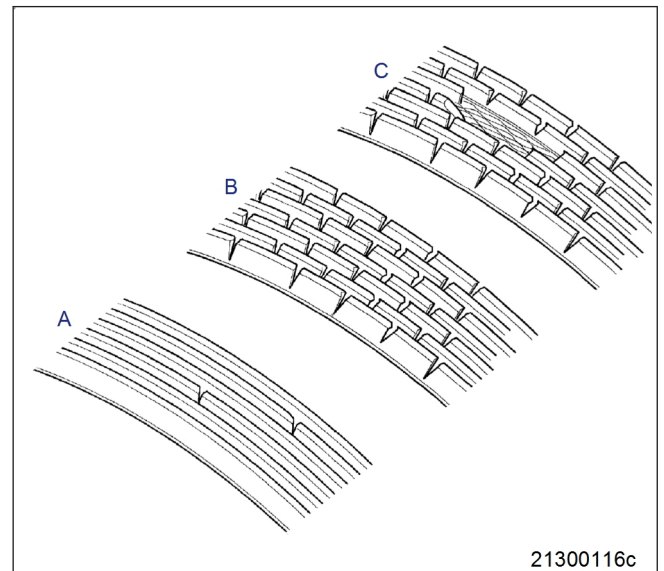
7.14 Belt Drive

7.14.1 Drive belt - Condition check

Preconditions

- ☑ Engine is stopped and starting disabled.

Checking condition



Item	Findings	Action
Drive belt A	Singular cracks	None
Drive belt B	Cracks on entire circumference	Fit new part (→ Page 111)
Drive belt C	Chunking	
Drive belt	Fouling by oil, overheating	

7.14.2 Belt tensioner – Check

WARNING



Belt tensioner spring is pretensioned.

Risk of hands being crushed!

- Lock belt tensioner in position.
- Only use specified tools and devices.

Checking belt tensioner

Item	Findings	Action
Tensioner	Rubber cracked on spring and damper. Traces of oil (indicating leakage).	Replace (→ Page 113).
Tensioning roller	Tensioning roller does not run smoothly or has too much backlash.	Replace (→ Page 113).

Table 3: Checking belt tensioner: Findings – Action

7.14.3 Drive belt – Replacement

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Ratchet	F30006211	1
Drive belt	(→ Spare Parts Catalog)	

WARNING



Belt tensioner spring is pretensioned.

Risk of hands being crushed!

- Lock belt tensioner in position.
- Only use specified tools and devices.

Belt drive without raw water pump – Drive belt replacement

Note: A second person is required to carry out the following steps.

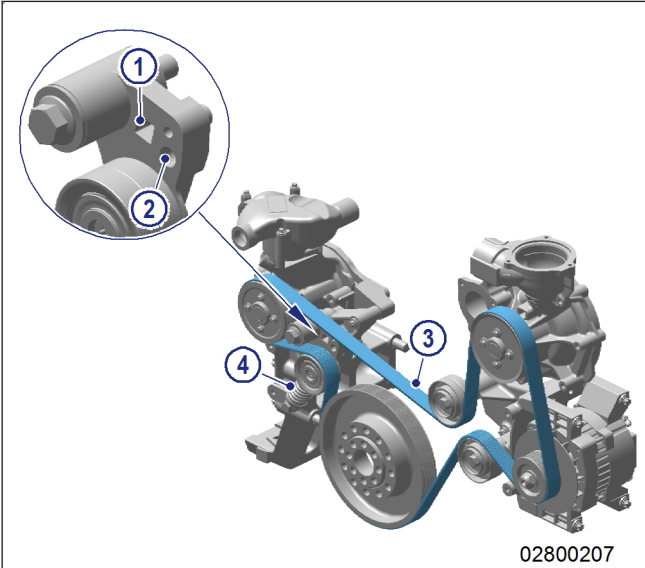
1. Fit ratchet with extension in square hole (1) on belt tensioner (4).
2. Turn belt tensioner (4) clockwise almost up to the stop against spring force.

Result: The circular bore (2) of belt tensioner (4) and retainer are aligned.

3. Insert 10 mm bolt to lock belt tensioner in position.
4. Remove drive belt (3).

Note: When placing the drive belt in the grooves, no force must be applied, and displacement must be avoided.

5. Fit new drive belt (3).
6. Turn belt tensioner (4) clockwise almost up to the stop against spring force to remove the bolt.
7. Remove bolt.
8. Release belt tensioner (4) and remove ratchet with extension.
9. Verify that belt (3) is exactly seated in the grooves.



Belt drive with raw water pump – Drive belt replacement

Note: A second person is required to carry out the following steps.

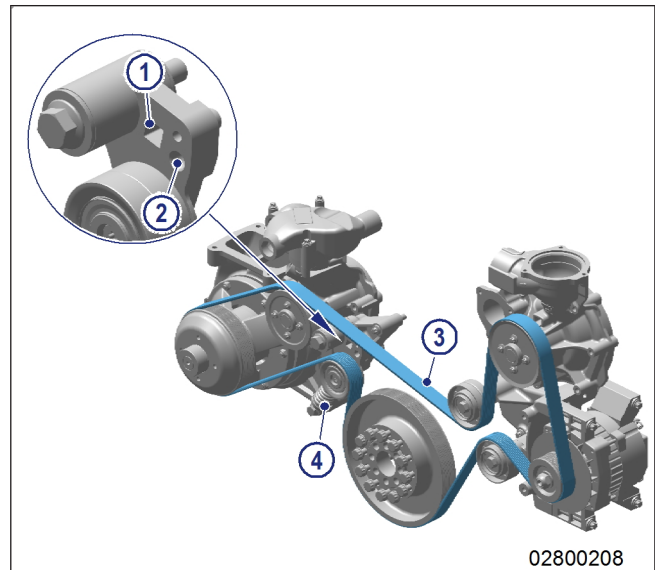
1. Fit ratchet with extension in square hole (1) on belt tensioner (4).
2. Turn belt tensioner (4) clockwise almost up to the stop against spring force.

Result: The circular bore (2) of belt tensioner (4) and retainer are aligned.

3. Insert 10 mm bolt to lock belt tensioner in position.
4. Remove drive belt (3).

Note: When placing the drive belt in the grooves, no force must be applied, and displacement must be avoided.

5. Fit new drive belt (3).
6. Turn belt tensioner (4) clockwise almost up to the stop against spring force to remove the bolt.
7. Remove bolt.
8. Release belt tensioner (4) and remove ratchet with extension.
9. Verify that belt (3) is exactly seated in the grooves.



7.14.4 Belt tensioner – Tensioning element and tensioning roller replacement

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 20–100 Nm	F30026582	1
Ratchet	F30027340	1
Torque wrench, 80–400 Nm	F30027338	1
Ratchet	F30027342	
Tension element	(→ Spare Parts Catalog)	
Tension roller	(→ Spare Parts Catalog)	

WARNING



Belt tensioner spring is pretensioned.

Risk of hands being crushed!

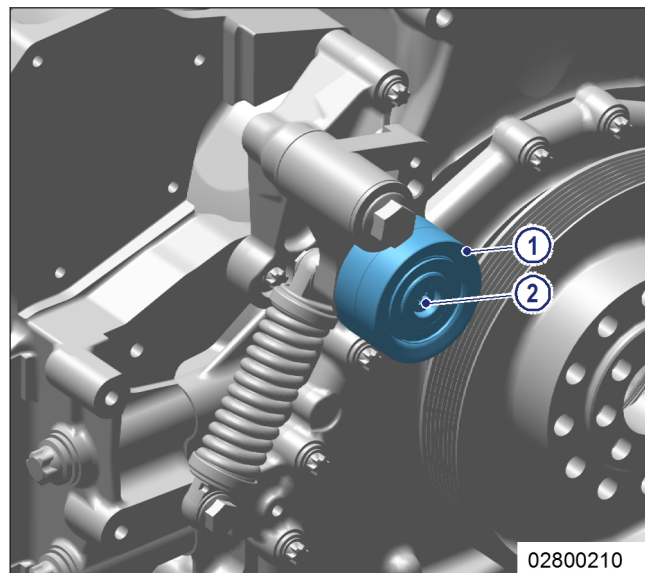
- Lock belt tensioner in position.
- Only use specified tools and devices.

Preparatory step

- Remove drive belt (→ Page 111) and release belt tensioner.

Replacing tensioning roller

1. Remove screw (2) and take off tensioning roller (1).
2. Fasten new tensioning roller (1) with screw (2) by hand.

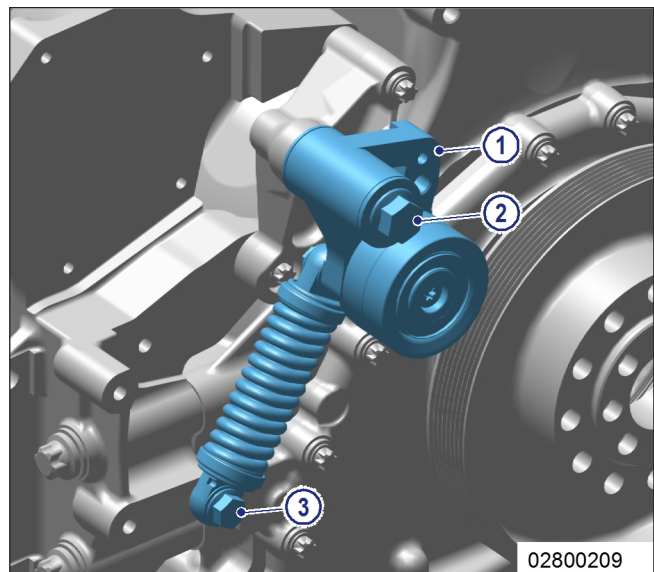


3. Tighten screw (2) to specified torque using a torque wrench.

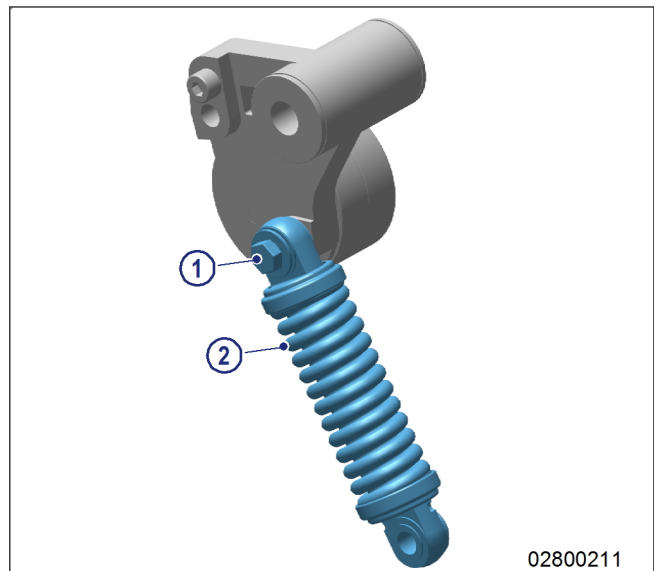
Name	Size	Type	Lubricant	Value/Standard
Screw	M10	Tightening torque		43 Nm

Replacing tensioning element

1. Remove screws (2, 3) and belt tensioner (1).



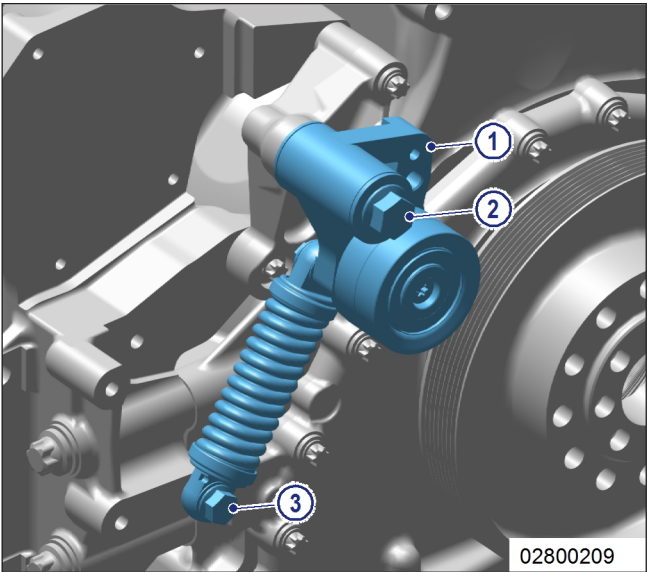
2. Remove screw (1) and take off tensioning element (2).
3. Fasten new tensioning element (2) with screw (1) by hand.



4. Tighten screw (1) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw	M8	Tightening torque		25 Nm

5. Fasten belt tensioner (1) with screws (2, 3) by hand.



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

Name	Size	Type	Lubricant	Value/Standard
Screw	M14	Tightening torque		150 Nm

7. Tighten screw (3) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw	M10	Tightening torque		30 Nm

Final steps

- Install drive belt (→ Page 111).

7.15 Wiring (General) for Engine/Gearbox/Unit

7.15.1 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 cable clamps for secure fit, tighten loose clamps.
6. Replace faulty cable clamps.
7. Visually inspect the following electrical components for damage:
 - Connector housings
 - Contacts
 - Plug connectors
 - Cables and terminals
 - Plug-in contacts

Result: If cable conductors are damaged, contact Service.

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

8. Use isopropyl alcohol to clean dirty connector housings, plug connectors and contacts.
9. Ensure that all connecting plugs of the sensors are correctly engaged.

7.16 Accessories for (Electronic) Engine Governor / Control System

7.16.1 Engine governor and connector – Cleaning

Preconditions

- ☑ Engine is stopped and starting disabled.

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 connector – 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 connectors that are not plugged in with the protective cap supplied.

1. Release latches of connectors and withdraw connectors.
2. Clean connector housings, connector socket housings and all contacts with isopropyl alcohol.
3. When connectors, sockets and all contacts are dry: Fit connectors and latch them.

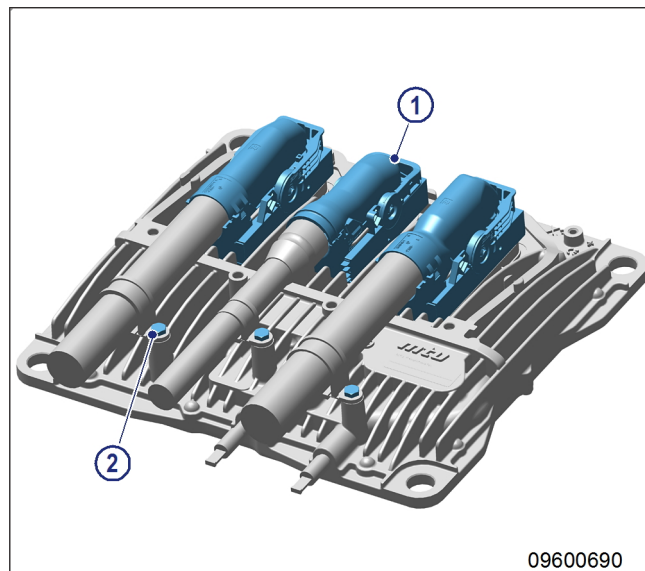
7.16.2 Engine governor – Checking plug-in connections

Preconditions

- ☑ Engine is stopped and starting disabled.

Checking engine governor plug connections

1. Check firm seating of all connectors on the engine governor. Ensure that the clips (1) are engaged.
2. Check firm seating of all screws (2) on engine governor cable clamps. Make sure that cable clamps are not defective.



7.17 Engine Mounting / Support

7.17.1 Engine mounting - Check

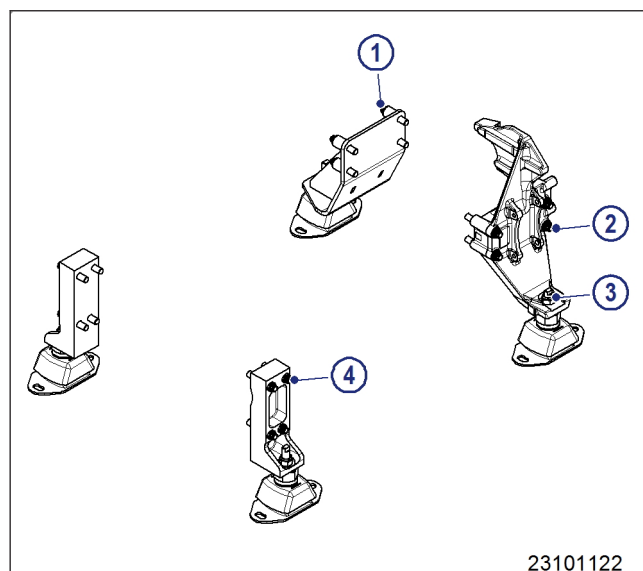
Preconditions

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

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 80–400 Nm	F30027338	1
Ratchet	F30027342	1

Engine mounts – Securing screws check



1. Check-tighten securing screws (1, 2 and 4) of engine mounting brackets to confirm that they are seated firmly.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque		250 Nm +25 Nm

2. Check-tighten securing nuts of resilient mounts (3) to confirm that they are seated firmly.

Name	Size	Type	Lubricant	Value/Standard
Nut		Tightening torque		350 Nm +35 Nm

Engine mounts – Resilient elements check

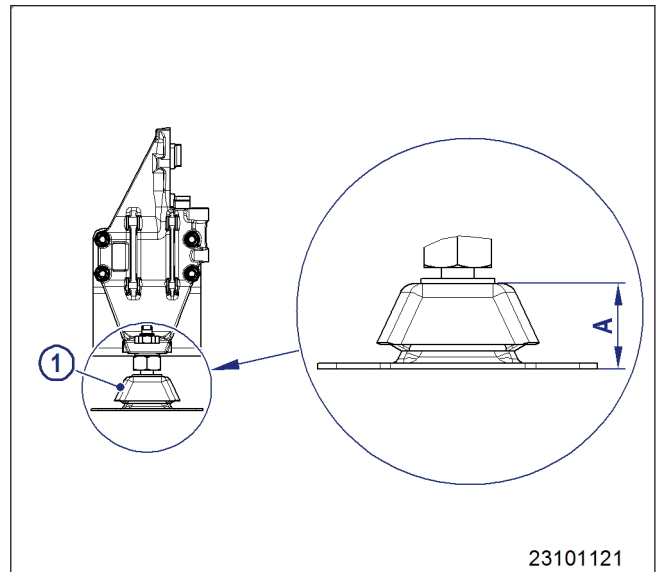
1. Inspect resilient element (1) for crack formation and deformation.

Result: Have cracked resilient element (1) replaced, contact Service.

2. Wipe rubber surface with dry cloth, do not use organic detergents.

3. Check reference dimension (A) of resilient element (1).

Result: If the reference dimension is $(A) \leq 62$, have resilient element (1) replaced, contact Service.



8 Appendix A

8.1 Abbreviations

Abbrevia- tion	Meaning	Explanation
ADEC	Advanced Diesel Engine Control	Engine governor
AL	Alarm	Alarm (general)
ANSI	American National Standards Institute	Governing body for US American standards
ETC	Exhaust turbocharger	
BR	Baureihe (Series)	
BV	Betriebsstoffvorschrift	Fluids and Lubricants Specifications, MTU Publication No. A01061/..
CAN	Controller Area Network	Data bus system, bus standard
CDC	Calibration Drift Compensation	Setting for drift correction with DiaSys in engine governor
CPP	Controllable Pitch Propeller	
DILA	Diagnostic lamp	on EIM
DIN	Deutsches Institut für Normung e. V.	German Standardization Organization, at the same time identifier of German standards ("Deutsche Industrie-Norm")
DIS	Display unit	Display panel
DL	Default Lost	Alarm: Default CAN bus failure
ECS	Engine Control System	Engine management system
ECU	Engine Control Unit	Engine governor
EDM	Engine Data Module	Memory module for engine data
EIM	Engine Interface Module	Interface to engine monitoring system
EMU	Engine Monitoring Unit	
SPC	Spare Parts Catalog	
FPP	Fixed Pitch Propeller	
GCU	Gear Control Unit	
GMU	Gear Monitoring Unit	
HAT	Harbor Acceptance Test	
HI	High	Alarm: Measured value exceeds 1st maximum limit
HIHI	High High	Alarm: Measured value exceeds 2nd maximum limit
HT	High Temperature	
ICFN	ISO - Continuous rating - Fuel stop power - Net	Power specification in accordance with DIN-ISO 3046-7
IDM	Interface Data Module	Memory module for interface data
IIG	Initial Injector Equalization	Entering of injector code with DiaSys in engine governor
IMO	International Maritime Organization	
ISO	International Organization for Standardization	International umbrella organization for all national standardization institutes
KGS	Kraftgegenseite	Engine free end in accordance with DIN ISO 1204

Abbrevia- tion	Meaning	Explanation
KS	Kraftseite	Engine driving end in accordance with DIN ISO 1204
LCD	Liquid Crystal Display, Liquid Crystal Device	
LCU	Local Control Unit	LOP subassembly
LED	Light Emitting Diode	
LMU	Local Monitoring Unit	LOP subassembly
LO	Low	Alarm: Measured value lower than 1st minimum limit
LOLO	Low Low	Alarm: Measured value lower than 2nd minimum limit
LOP	Local Operating Panel	Control console, control panel
LOS	Local Operating Station	
MCS	Monitoring and Control System	
MG	Message	
MPU	Microprocessor Unit, Microprocessing Unit	Microprocessor (unit)
TDC	Top Dead Center	
P-xyz	Pressure-xyz	Pressure measuring point xyz
PAN	Panel	Operating panel
PCU	Propeller Control Unit	
PIM	Peripheral Interface Module	
RCS	Remote Control System	
RL	Redundancy Lost	Alarm: Redundant CAN bus failure
SAE	Society of Automotive Engineers	U.S. standardization organization
SAT	Sea Acceptance Test	
SD	Sensor Defect	Alarm: Sensor failure
SDAF	Shut Down Air Flaps	Emergency-air shutoff flap(s)
SILA	Fuse lamp	on EIM
SOLAS	International Convention for the Safety of Life at Sea	
SS	Safety System	Indicated alarm is initiated by the safety system
SSK	Emergency-air shutoff flap(s)	
T-xyz	Temperature-xyz	Temperature measuring point xyz
TD	Transmitter Deviation	Alarm: Sensor comparison fault
BDC	Bottom Dead Center	
VS	Voith Schneider	Voith-Schneider drive
WJ	Water Jet	Water jet drive
TC	Tool Catalog	
ZKP	Zugehörigkeit-Kategorie-Parameter	Numbering plan for ADEC ECU signals

8.2 MTU contact persons/service partners

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

Local support

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

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

24h hotline

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

Your contact person in our Customer Assistance Center:

E-mail: info@mtu-online.com

Tel.: +49 7541 9077777

Fax: +49 7541 9077778

Asia/Pacific: +65 6100 2688

North and Latin America: +1 248 560 8000

Spare parts service

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

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

Your contact at Headquarters:

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

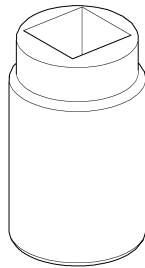
Tel.: +49 7541 908555

Fax: +49 7541 908121

9 Appendix B

9.1 Special Tools

Adapter

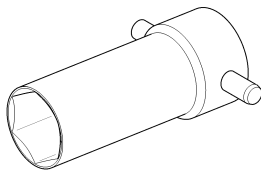


Part No.: F30011619

Qty.: 1

Used in: 7.2.1 Engine – Barring manually (→ Page 71)

Alignment device

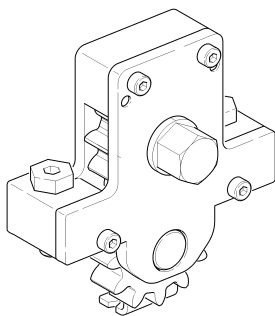


Part No.: F6791418

Qty.: 1

Used in: 7.5.2 Injector – Removal and installation (→ Page 83)

Barring gear

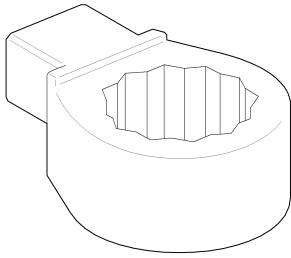


Part No.: F6790714

Qty.: 1

Used in: 7.2.1 Engine – Barring manually (→ Page 71)

Box wrench, 14 mm

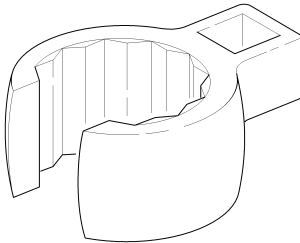


Part No.: F30028346

Qty.: 1

Used in: 7.4.1 Valve clearance – Check and adjustment
(→ Page 77)

Crowfoot box wrench, 22 mm

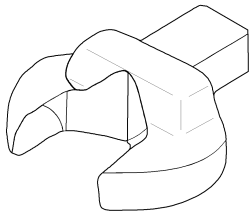


Part No.: F30027425

Qty.: 1

Used in: 7.5.2 Injector – Removal and installation (→ Page 83)

Crowfoot box wrench, 27 mm

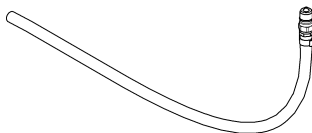


Part No.: F30029816

Qty.: 1

Used in: 7.5.2 Injector – Removal and installation (→ Page 83)

Drain hose with quick-release coupling

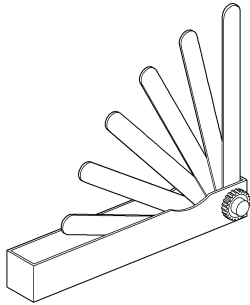


Part No.: X57299100654

Qty.: 1

Used in: 7.11.1 Engine oil filter – Replacement (→ Page 98)

Feeler gauge

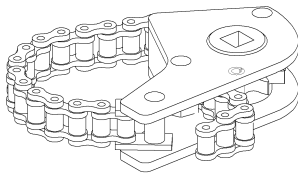


Part No.: Y20010128

Qty.: 1

Used in: 7.4.1 Valve clearance – Check and adjustment
(→ Page 77)

Filter wrench

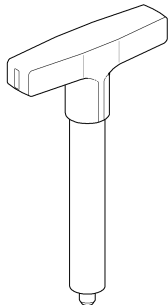


Part No.: F30379104

Qty.: 1

Used in: 7.7.1 Fuel filter – Replacement (→ Page 89)

Installation device

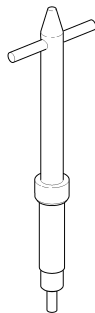


Part No.: F6790085

Qty.: 1

Used in: 7.5.2 Injector – Removal and installation (→ Page 83)

Milling cutter

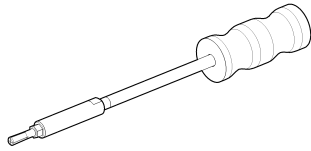


Part No.: F30454305

Qty.: 1

Used in: 7.5.2 Injector – Removal and installation (→ Page 83)

Puller

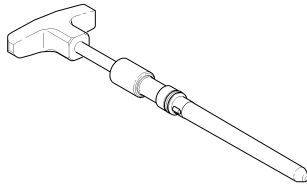


Part No.: F6790992

Qty.: 1

Used in: 7.5.2 Injector – Removal and installation (→ Page 83)

Puller

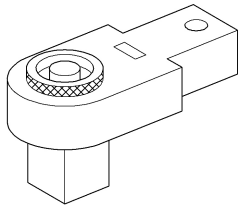


Part No.: F6796371

Qty.: 1

Used in: 7.5.2 Injector – Removal and installation (→ Page 83)

Ratchet



Part No.: F30027340

Qty.: 1

Used in: 7.2.1 Engine – Barring manually (→ Page 71)

Qty.: 1

Used in: 7.3.1 Crankcase breather – Fine oil mist separator replacement (→ Page 75)

Qty.: 1

Used in: 7.4.2 Cylinder head cover – Removal and installation (→ Page 79)

Qty.: 1

Used in: 7.5.2 Injector – Removal and installation (→ Page 83)

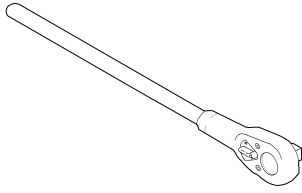
Qty.: 1

Used in: 7.11.1 Engine oil filter – Replacement (→ Page 98)

Qty.: 1

Used in: 7.14.4 Belt tensioner – Tensioning element and tensioning roller replacement (→ Page 113)

Ratchet

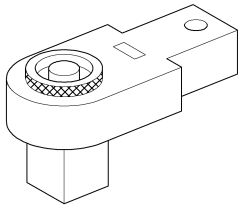


Part No.: F30006211

Qty.: 1

Used in: 7.14.3 Drive belt – Replacement (→ Page 111)

Ratchet

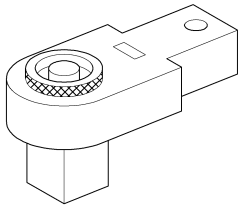


Part No.: F30027342

Qty.: 1

Used in: 7.14.4 Belt tensioner – Tensioning element and tensioning roller replacement (→ Page 113)

Ratchet

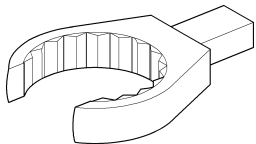


Part No.: F30027342

Qty.: 1

Used in: 7.17.1 Engine mounting – Check (→ Page 119)

Socket wrench 17 A/F

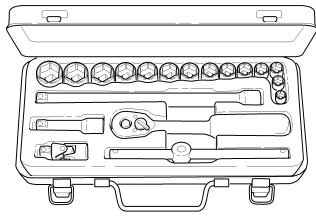


Part No.: F30030450

Qty.: 1

Used in: 7.11.1 Engine oil filter – Replacement (→ Page 98)

Socket wrench 8-22 A/F

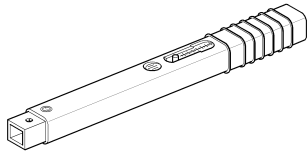


Part No.: F30452510

Qty.: 1

Used in: 7.11.1 Engine oil filter – Replacement (→ Page 98)

Torque wrench, 20-100 Nm

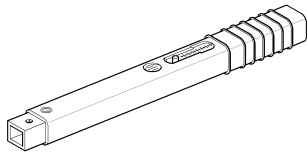


Part No.: F30026582

Qty.: 1

Used in: 7.5.2 Injector – Removal and installation (→ Page 83)

Torque wrench, 20-100 Nm



Part No.: F30026582

Qty.: 1

Used in: 7.4.1 Valve clearance – Check and adjustment (→ Page 77)

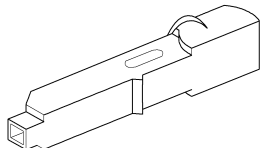
Qty.: 1

Used in: 7.11.1 Engine oil filter – Replacement (→ Page 98)

Qty.: 1

Used in: 7.14.4 Belt tensioner – Tensioning element and tensioning roller replacement (→ Page 113)

Torque wrench, 4-20 Nm

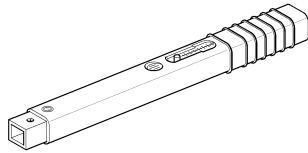


Part No.: F30044239

Qty.: 1

Used in: 7.3.1 Crankcase breather – Fine oil mist separator replacement (→ Page 75)

Torque wrench, 8-40 Nm

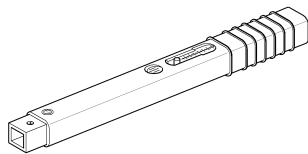


Part No.: F30043446

Qty.: 1
Used in: 7.4.2 Cylinder head cover – Removal and installation (→ Page 79)

Qty.: 1
Used in: 7.5.2 Injector – Removal and installation (→ Page 83)

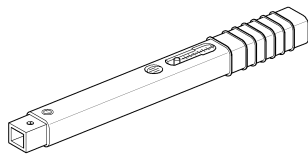
Torque wrench, 80-400 Nm



Part No.: F30027338

Qty.: 1
Used in: 7.14.4 Belt tensioner – Tensioning element and tensioning roller replacement (→ Page 113)

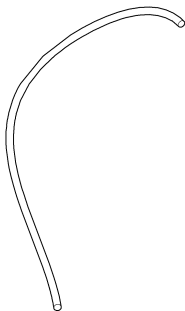
Torque wrench, 80-400 Nm



Part No.: F30027338

Qty.: 1
Used in: 7.17.1 Engine mounting – Check (→ Page 119)

Vent hose



Part No.: X57299100655

Qty.: 1
Used in: 7.11.1 Engine oil filter – Replacement (→ Page 98)

9.2 Index

A

- Abbreviations 121
- Actuators
 - Overview 25
- Adhesive tape for SOLAS shielding
 - Application 70
- After stopping the engine
 - Engine remains ready for operation 51
- Air filter
 - Installation 93
 - Removal 93
 - Replacement 92
 - Service indicator check 94
- Auxiliary materials, fire prevention and environmental protection 15

B

- Belt tensioner
 - Check 110
 - Tensioning element
 - Replacement 113
 - Tensioning roller
 - Replacement 113

C

- Cabling
 - Check
 - On engine 116
- Charge-air coolant pump
 - Relief bore check 108
- Connector
 - Cleaning 117
- Contact persons 123
- Coolant
 - Change 103
 - Draining 104
- Coolant level
 - Check 102
- Cylinder head cover
 - Installation 79
 - Removal 79
- Cylinders
 - Designation 19

D

- Drive belt
 - Condition check 109
 - Replacement 111

E

- ECU9
 - Fault messages 57

- Engine
 - Barring
 - Manually 71
 - With starting system 73
 - Main dimensions 43
 - Putting engine out of operation 52
 - Test run 74

Engine cabling

- Check 116

Engine coolant

- Change 103
- Check
 - Level at filler neck 102
 - Level with level sensor 102
- Draining 104
- Filling 105

Engine coolant level

- Check 102

Engine coolant pump

- Relief bore check 107

Engine data

- 6R1600M20F
 - IMO Tier 2 29, 33
- 6R1600M20S
 - EPA Marine Tier 3 36, 39
 - IMO Tier 2 29, 33

Engine driving end

- Definition 19

Engine free end

- Definition 19

Engine governor

- Checking plug-in connections 118
- Cleaning 117

Engine mounting

- Check 119

Engine oil

- Change 97

Engine oil filter

- Replacement 98

Engine oil level

- Check 95

Engine overview 23

Engine sides

- Designation 19

F

Fault messages

- ECU9 57

Fine oil mist separator

- Replacement 75

Firing order 42

Fuel filter

- Replacement 89

Fuel system

- Venting 88

H

Hotline 123

I

Injector

- Installation 83
- Removal 83
- Replacement 82

Installation locations for SOLAS shielding 67

M

Maintenance schedule

- Task reference table [QL1] 53

MTU contact persons 123

O

Operational checks 48

P

Product description 20

Putting into operation

- After scheduled out-of-service-period 45

R

Relief bore

- Charge-air coolant pump check 108
- Engine coolant pump check 107

S

Safety notices, standards 17

Safety regulations

- Auxiliary materials 13
- Environmental protection 13
- Fire prevention 13
- Fluids and lubricants 13
- Important provisions 5
- Maintenance work 10
- Operation 8
- Organizational requirements 7
- Personnel requirements 7
- Repair work 10
- Startup 8

Safety requirements

- Safety notices, standards 17

Safety system

- Override 47

Sensors

- Overview 25

Service indicator

- Check 94

Service partners 123

SOLAS shielding

- Installation as per MTN 5233 69
- Installation locations 67
- SOLAS shielding application 70

Spare parts service 123

T

Task reference table [QL1] 53

Transport 18

Troubleshooting 54

V

Valve clearance

- Adjustment 77
- Check 77