

Operating Instructions

Diesel engine
12V4000Cx5
16V4000Cx5

MS15041/01E



Power. Passion. Partnership.

Engine model	kW/cyl.	rpm	Application group
12V4000C15	95.8 kW/cyl.	1800	5A, continuous operation, unlimited
12V4000C25	104.1 kW/cyl.	1800	5A, continuous operation, unlimited
12V4000C35	125.0 kW/cyl.	1800	5A, continuous operation, unlimited
12V4000C55	145.8 kW/cyl.	1900	5B, continuous operation, variable
12V4000C65	155.3 kW/cyl.	1800	5B, continuous operation, variable
12V4000C65	155.3 kW/cyl.	1900	5B, continuous operation, variable
16V4000C45	125 kW/cyl.	1800	5B, continuous operation, variable
16V4000C45	125 kW/cyl.	1900	5B, continuous operation, variable
16V4000C55	140 kW/cyl.	1800	5B, continuous operation, variable
16V4000C55	140 kW/cyl.	1900	5B, continuous operation, variable
16V4000C65	150 kW/cyl.	1800	5B, continuous operation, variable
16V4000C65	150 kW/cyl.	1900	5B, continuous operation, variable

All 5A power ratings can also be applied in the 5B applications.

Table 1: Applicability

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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

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

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

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

Please note the following when replacing components with emission labels:

- The relevant emission labels must be affixed to the spare part.
- Do not transfer the emission labels from the replaced part to the spare part.
- Remove the emission labels from the replaced part and destroy them.

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, assembly, installation, or transportation.

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

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

This is important in the case of personnel who only occasionally perform work on or around the product. These 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, assembly, installation, and transport in writing.

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

Clothing and personal protective equipment

Always wear appropriate personal protective equipment, e.g. safety shoes, ear protectors, protective gloves, goggles, breathing mask. Follow the instructions concerning personal protective equipment in the descriptions of the individual activities.

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.

Whenever the product is subsequently taken into operation ensure that:

- All personnel is clear of the danger zone surrounding moving parts of the machine.
Electrically-actuated linkages may be set in motion when the Engine Control Unit (governor) is switched on.
- All maintenance and repair work has been completed.
- All loose parts have been removed from rotating machine components.
- All safety equipment is in place.
- No persons wearing pacemakers or any other technical body aids are present.
- The service room is adequately ventilated.
- In the first few hours of operation, the product emits gases as a result of smoldering e.g. lacquers or oil. These gases may be hazardous to health. Always wear respiratory protection in the operating room during this period.
- The exhaust system is leak-tight and that the gases are vented to atmosphere.
- 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 signaling and alarm systems work properly.

Smoking is prohibited in the area of the product.

Safety regulations during operation

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

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

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

Malfunctions and emergency stop

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

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 by taking any necessary emergency action, e.g. 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 protection.
- Mop up any leaked or spilled fluids and lubricants immediately or soak up with a suitable binder agent.

Operation of electrical equipment

Parts of the electrical equipment are live, i.e. under voltage/high tension, during operation.

Follow the applicable warning instructions pertaining to such devices.

1.4 Safety precautions when working on the engine

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 cables or actuate the battery isolating switch, if fitted. 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 the recommended special tools or suitable equivalents when instructed to do so.

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.

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

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 the engine, 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).

Ensure that the grounding system is properly connected.

Welding work

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

Before starting welding work:

- Switch off the power supply master switch.
- Disconnect the battery cables or actuate the battery isolating switch.
- 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 cabling harnesses of the product. The welding current may otherwise induce an interference voltage in the cabling 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 H.P. 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 pushed-in plunger.
- During the removal procedure, screw on device with retracted plunger.

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.

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 battery acids to come into contact with skin or clothing.

Wear protective clothing, goggles and protective gloves.

Do not place objects on the battery.

Before connecting the cable to the battery, check the battery polarity. 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-energise 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. Check correct execution of the emergency stop function in particular.

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.

Work with laser devices

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

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

Laser devices must be equipped, in accordance with their class and usage, with protective devices for ensuring safe operation.

Measuring component dimensions

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

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 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.

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.

Auxiliary materials

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 lead-containing compounds, 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).
- Release residual pressure before removing or replacing pneumatic equipment in the supply line. To depressurize compressed-air lines, shut off the lines first, then release the residual pressure.
- 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 Standards for safety notices in the text

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

Warning notices

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

2 Transport

2.1 Transportation

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Crossbeam	T80091826	1
Crossbeam	T80092210	1

DANGER



Suspended load

Danger to life

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

Transportation

1. Install the engine mount locking devices and the engine shipping lock prior to transportation (→ Page 17).
2. Use the lifting eyes provided to transport the engine/generator (→ Page 15).
3. Use suitable transport and lifting gear only.
4. Transport the system, engine/generator in their respective installation positions only: max. admissible diagonal pull 10° (→ Page 15).
5. Do not place unsecured parts on the system, engine/generator.
6. Raise and lower the system, engine/generator slowly. Do not allow hoist slings or chains to contact the system, engine/generator or any of their component parts. Readjust lifting gear as necessary.
7. For special packaging with aluminum foil: Suspend the engine by the lifting eyes on the bearing pedestal or transport by means of handling equipment (forklift truck) capable of bearing the load.
8. Secure the system, engine/generator to prevent tipping during transportation. Secure such as to preclude slipping and tipping when driving up or down inclines and ramps.

Placement after transport

1. Set the system down on a firm, flat surface only.
2. Make sure that the consistency and load-bearing capacity of the ground or support surface is adequate.
3. Never set the engine down on its oil pan unless expressly authorized to do so by MTU.

2.2 Lifting requirements

Lifting requirements

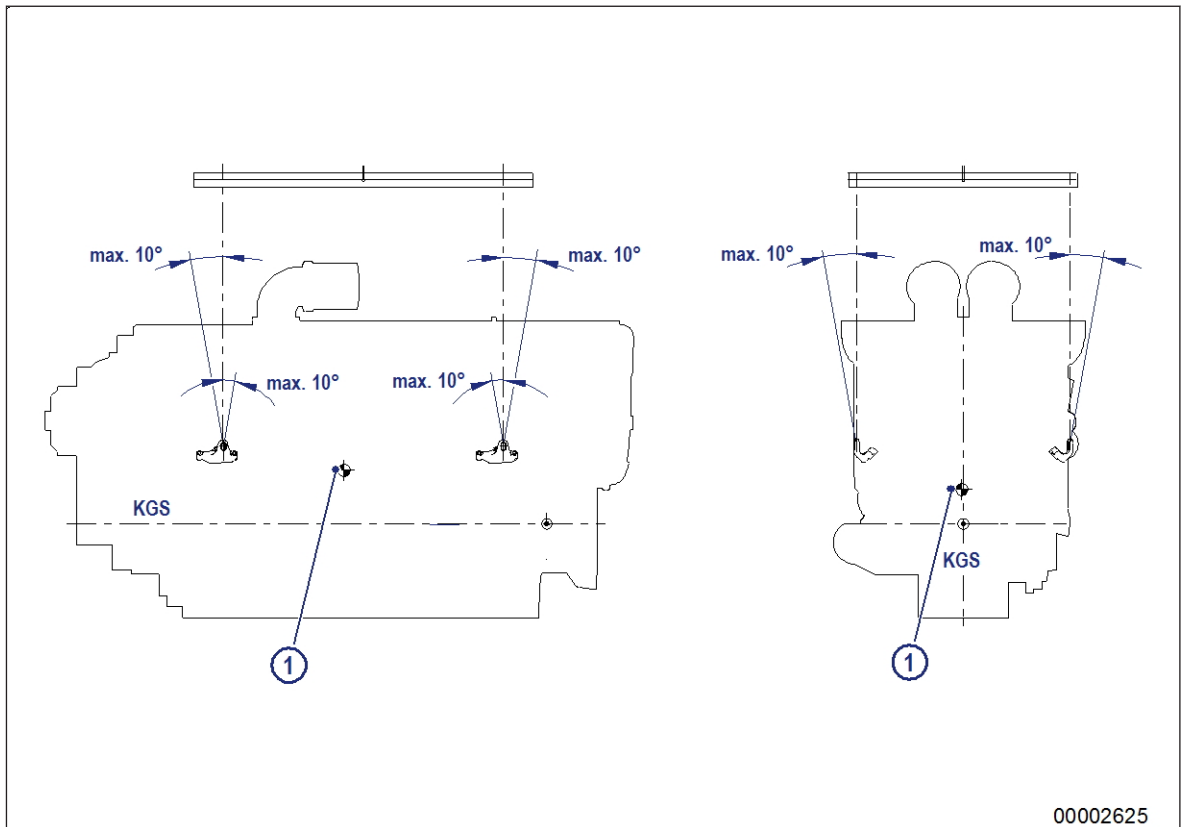
DANGER



Suspended load.

Danger to life!

- Use appropriate lifting devices and appliances.
- Never stand beneath a suspended load.



1 Center of gravity

Take note of the engine center of gravity

Refer to the installation/arrangement drawings for details of the center of gravity of the system or the center of gravity of the engine/generator.

2.3 Crankshaft – Transport locking device

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 10–60 Nm	F30452769	1
Torque wrench, 60–320 Nm	F30452768	1
Ratchet adapter	F30027340	1
Engine oil		

Transport locking device

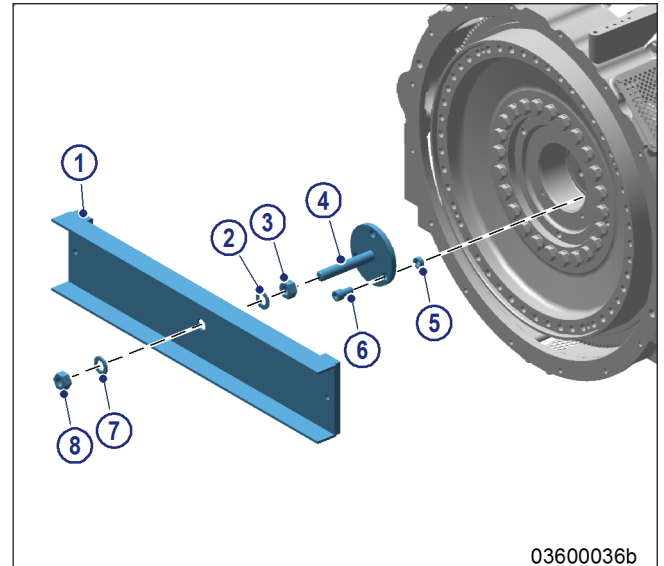
Note: The locking device protects the crankshaft bearings from shocks and vibration damage during engine transport.

For removal and installation of the transport locking device, observe the following:

- The transport locking device must remain installed as long as possible during engine installation in order to avoid damage.
- Starting or barring the engine is allowed only with the transport locking device removed. If the generator/gearbox is installed, ensure that the transport locking device of the generator/gearbox is removed.
- Prior to transport of the engine, always install the transport locking device according to the specifications.
- If the generator/gearbox is installed and also has to be moved, install transport locking device of generator/gearbox.
- Always use the screws supplied with or installed in the transport locking device to secure it on the engine.
- Fit this documentation in an easily visible place on the engine.

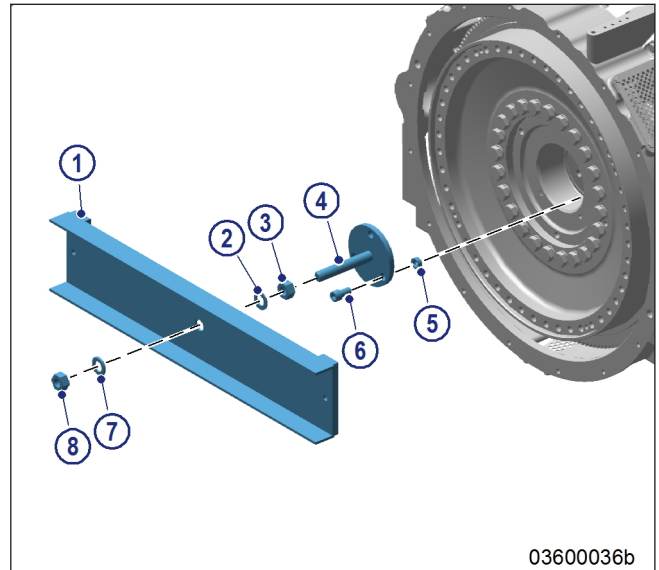
Removing transport locking device on driving end (KS), variant A

1. Remove parts (1) to (8) from engine. Spacer sleeves (5) are optional.
2. Store the removed parts of the transport locking device for possible reuse.



Installing transport locking device on driving end (KS), variant A

1. Screw retainer (4) with spacer sleeves (5) and screws (6) on crankshaft. Spacer sleeves (5) are optional.



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

Name	Size	Type	Lubricant	Value/Standard
Screw	M16	Tightening torque	(Engine oil)	180 Nm + 18 Nm

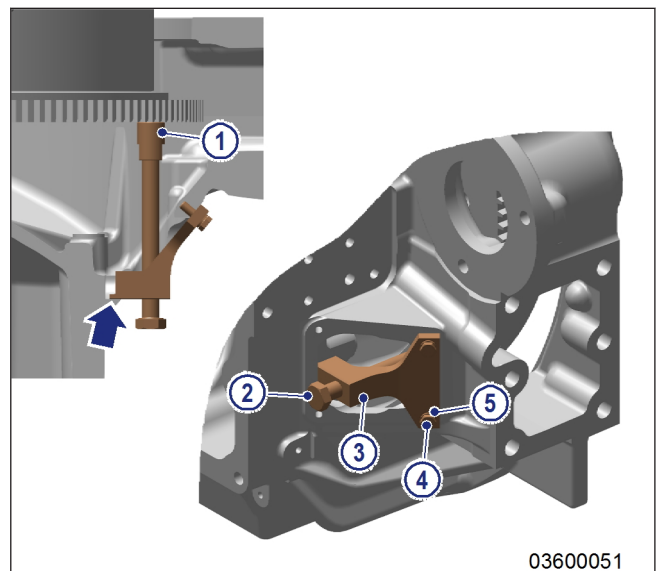
3. Screw nut (3) with washer (2) onto retainer (4). Fit support (1) with washer (7) and nut (8) and tighten nut (8) with torque wrench to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Nut	M24	Tightening torque	(Engine oil)	100 Nm + 10 Nm

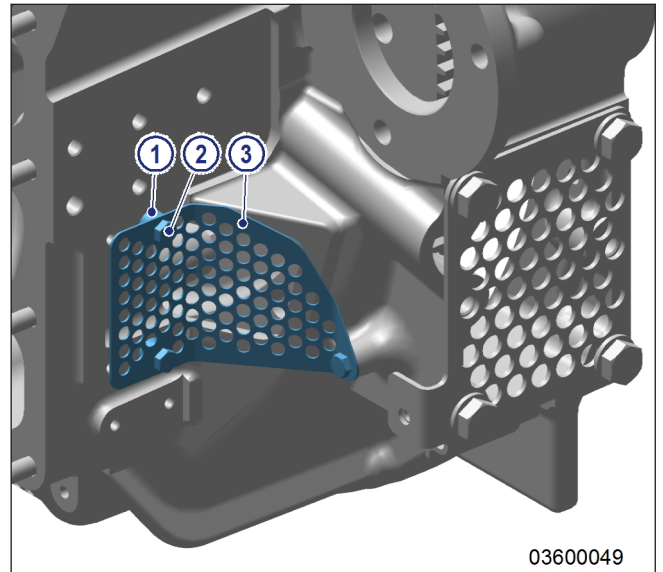
4. Secure with nut (3).
5. Mark the engine as "Fitted with transportation locking device".

Removing transport locking device on driving end (KS), variant B

1. Unscrew screw (2) on both sides of the fly-wheel housing.
2. Unscrew screws (4) on both sides of the fly-wheel housing and take off washers (5).
3. Remove retainer (3) and threaded bushing (1).



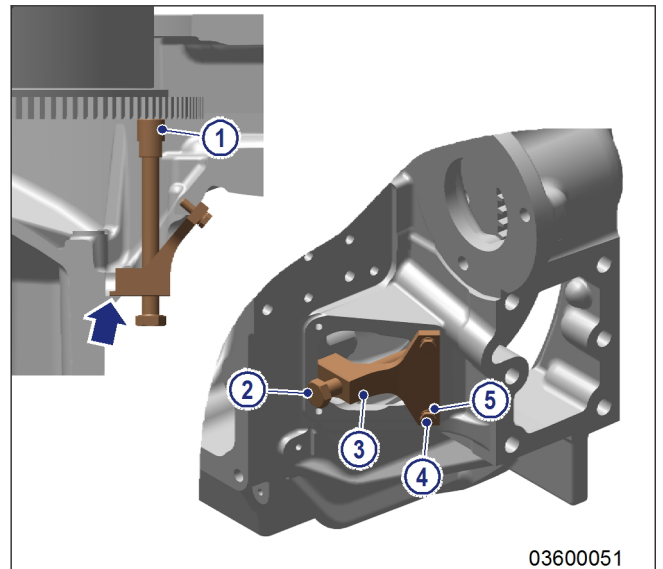
4. Install guard plate (3) with screws (2) and spacer sleeves (1) on flywheel housing.
5. Store the removed parts of the transport locking device carefully for possible reuse.



Installing transport locking device on driving end (KS), variant B

Note: Keep guard plate and screws on the engine. They must be reinstalled when the transport locking device has been removed.

1. Remove guard plate (3) from flywheel housing.
2. Install barring device (→ Page 92).
3. Insert screw (2) in retainer (3), mount threaded bushing (1) and hand-tighten.
4. Install retainer (3) in opening on flywheel housing on both sides with screw (4) and washers (5).



Note: Ensure retainer is seated flush (arrow).

5. Tighten screws (4) with torque wrench to specified tightening torque.

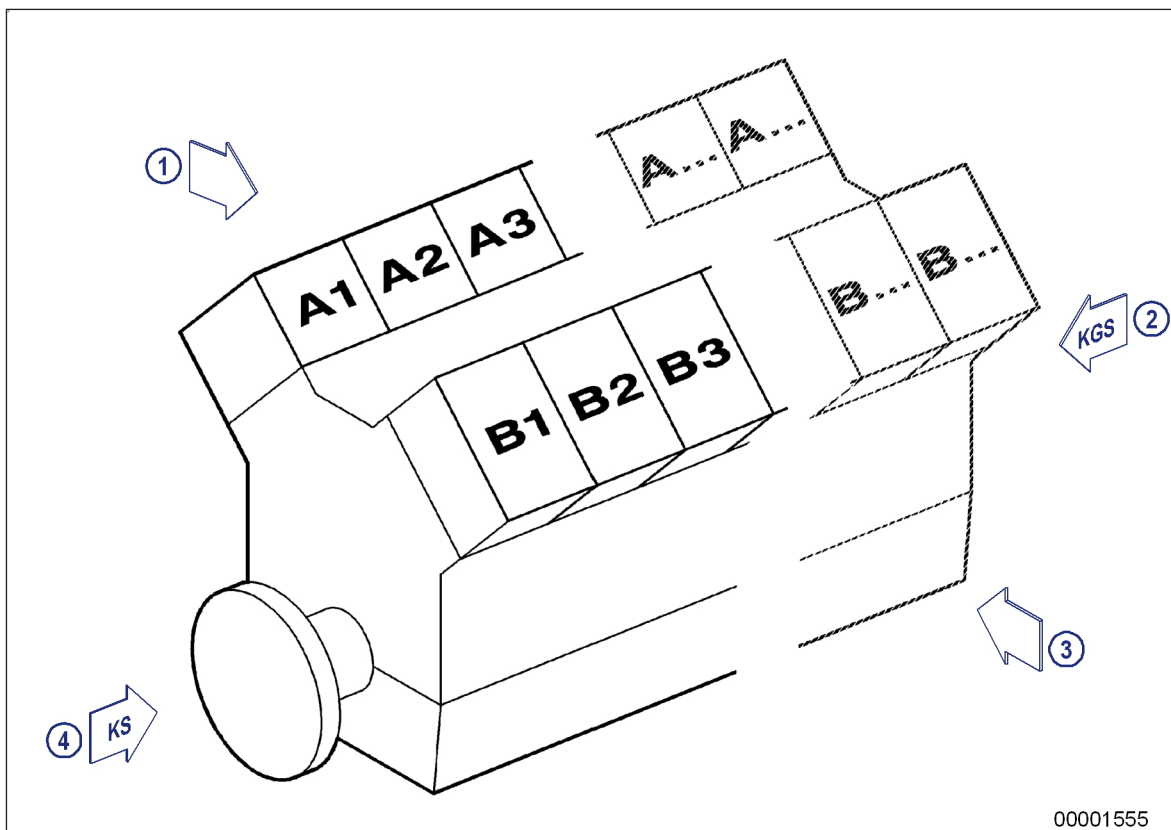
Name	Size	Type	Lubricant	Value/Standard
Screw	M8x25	Tightening torque	(Engine oil)	31 Nm +3 Nm

6. Tighten screw (2) on both sides alternately in three steps with torque wrench to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M16x160	Preload torque	(Engine oil)	15 Nm +2 Nm
Screw	M16x160	Residual torque	(Engine oil)	30 Nm +3 Nm
Screw	M16x160	Tightening torque	(Engine oil)	45 Nm +5 Nm

3 General Information

3.1 Engine side and cylinder designations



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

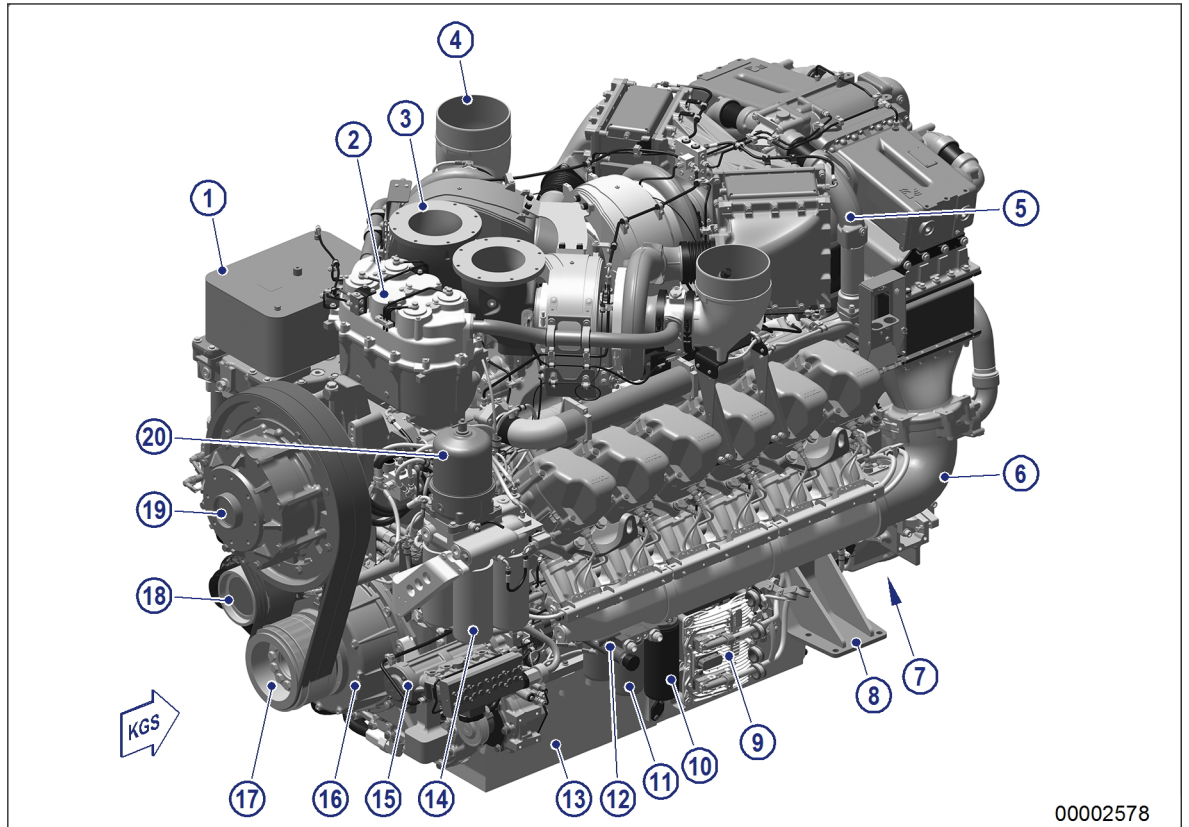
Engine sides are always designated (in accordance with DIN ISO 1204) as viewed from driving end (4).

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

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

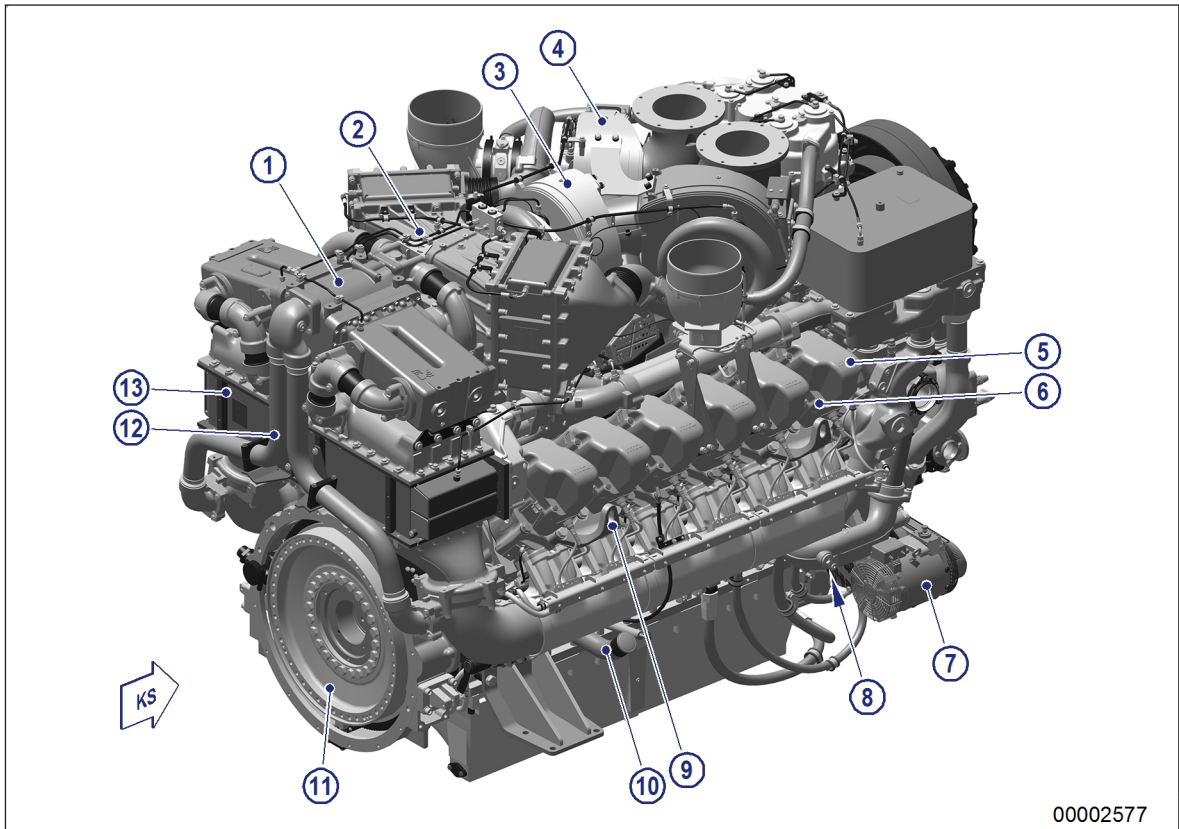
3.2 Engine layout - 12V4000Cx5

Engine overview - Free end



- | | | |
|-----------------------|---------------------------|---------------------------|
| 1 Oil heat exchanger | 8 Engine mounting bracket | 15 HP fuel pump |
| 2 Crankcase breather | 9 Engine governor ECU9 | 16 Vibration damper |
| 3 Exhaust outlet | 10 Additional fuel filter | 17 Fan drive |
| 4 Air intake | 11 Fuel filter | 18 Belt tensioner |
| 5 Engine coolant line | 12 Fuel priming pump | 19 Fan coupling |
| 6 Charge-air line | 13 Oil pan | 20 Centrifugal oil filter |
| 7 Starter | 14 Engine oil filter | |

Engine overview – Driving end



00002577

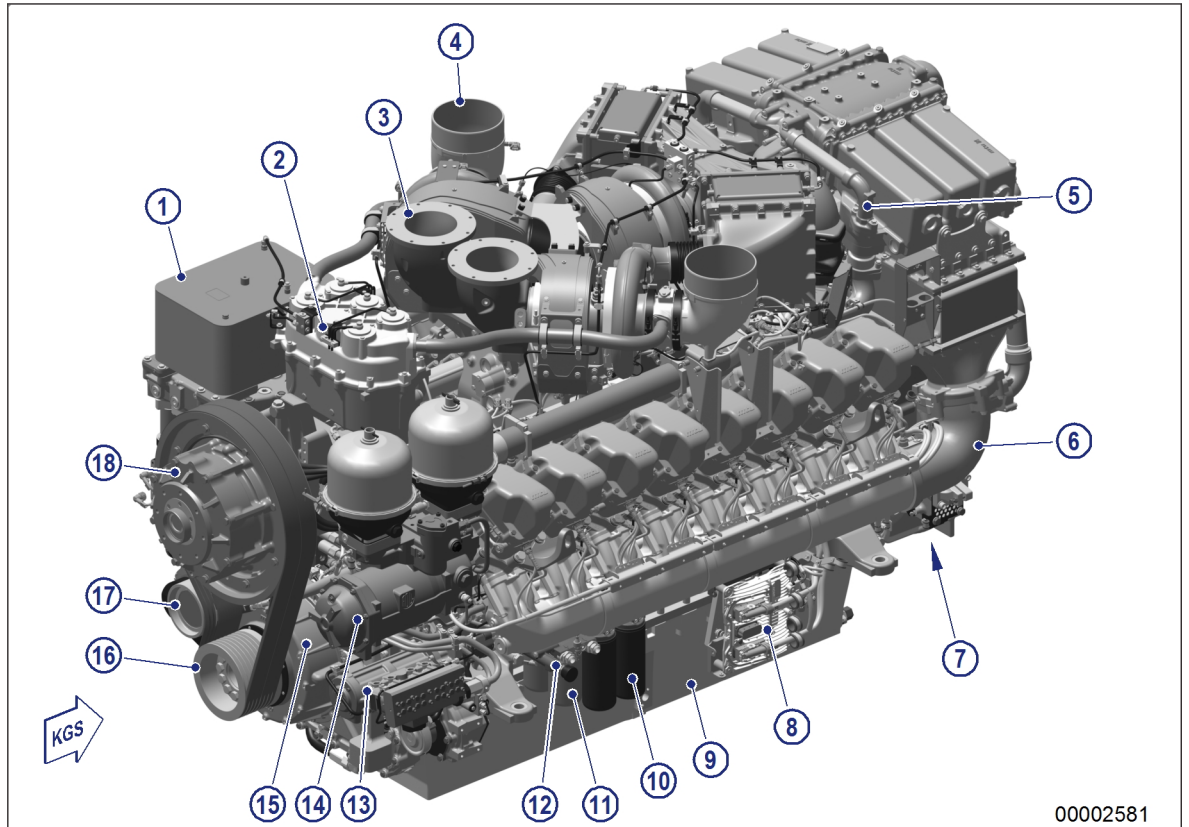
- | | | |
|--|------------------------------|--------------------------------|
| 1 EGR cooler | 6 Cylinder head | 11 Flywheel |
| 2 Intercooler (low pressure) | 7 Battery-charging generator | 12 EGR system after EGR cooler |
| 3 Exhaust turbocharger (high pressure) | 8 Oil priming pump | 13 Intercooler (high pressure) |
| 4 Exhaust turbocharger (low pressure) | 9 Engine lifting equipment | |
| 5 Cylinder head cover | 10 Oil filler neck | |

Engine model designation

Key to engine model designation 12V4000Cx5	
12	Number of cylinders
V	Cylinder arrangement: V engine
4000	Series
C	Application: Construction and Industrial (C&I)
x	Application segment: 1,2,3,4,5,6
5	Design index

3.3 Engine layout - 16V4000Cx5

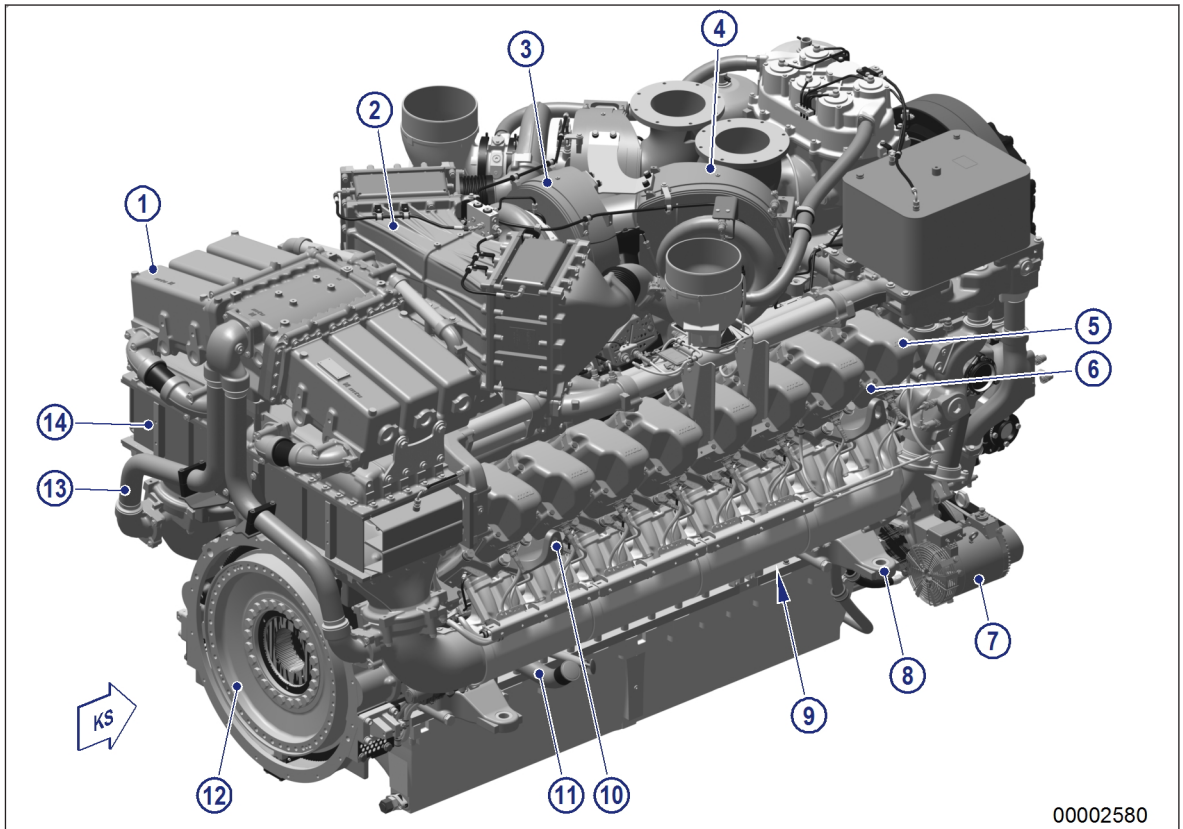
Engine overview - Free end



00002581

- | | | |
|-----------------------|---------------------------|-------------------------|
| 1 Oil heat exchanger | 7 Starter | 13 HP fuel pump |
| 2 Crankcase breather | 8 Engine governor ECU9 | 14 Automatic oil filter |
| 3 Exhaust outlet | 9 Oil pan | 15 Vibration damper |
| 4 Air intake | 10 Additional fuel filter | 16 Fan drive |
| 5 Engine coolant line | 11 Fuel filter | 17 Belt tensioner |
| 6 Charge-air line | 12 Fuel priming pump | 18 Fan coupling |

Engine overview – Driving end



00002580

- | | | |
|--|------------------------------|--------------------------------|
| 1 EGR cooler | 6 Cylinder head | 11 Oil filler neck |
| 2 Intercooler (low pressure) | 7 Battery-charging generator | 12 Flywheel |
| 3 Exhaust turbocharger (high pressure) | 8 Engine mounting bracket | 13 EGR system after EGR cooler |
| 4 Exhaust turbocharger (low pressure) | 9 Oil priming pump | 14 Intercooler (high pressure) |
| 5 Cylinder head cover | 10 Engine lifting equipment | |

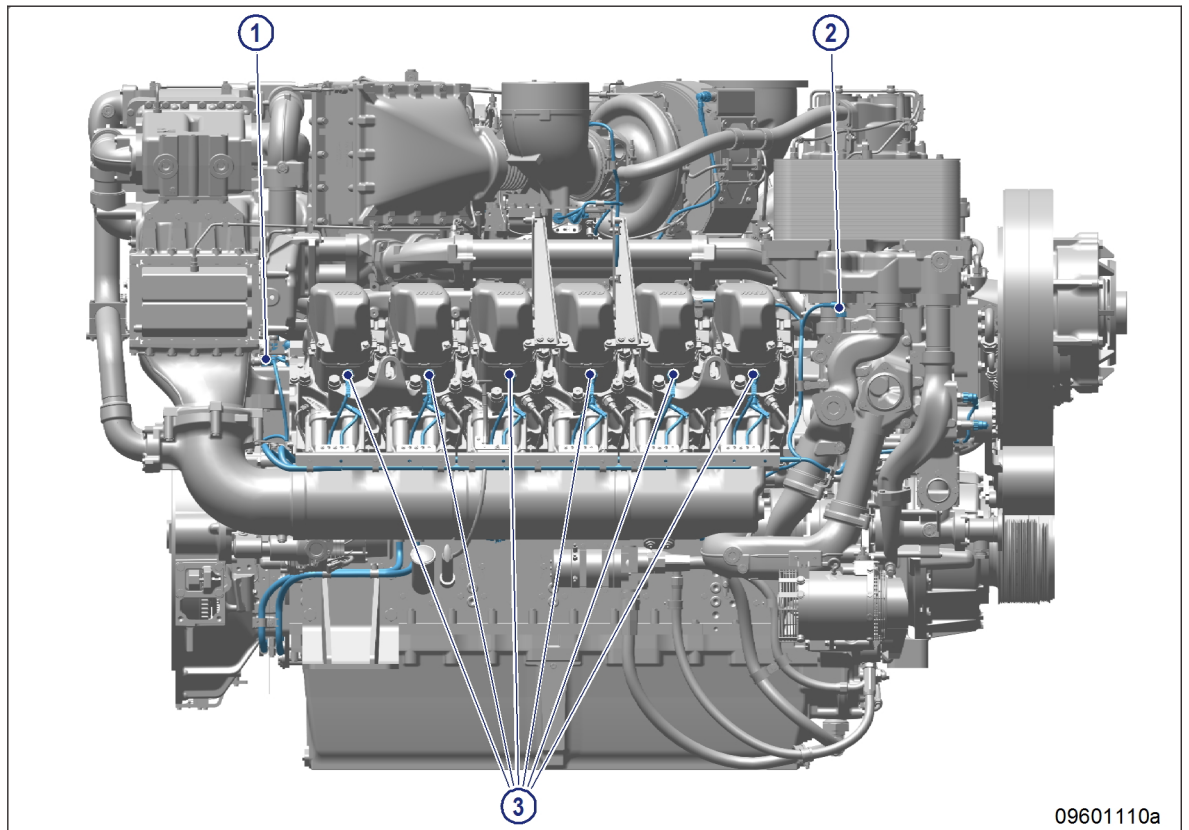
Engine model designation

Key to engine model designation 16V4000Cx5

16	Number of cylinders
V	Cylinder arrangement: V engine
4000	Series
C	Application: Construction and Industrial (C&I)
x	Application segment: 1,2,3,4,5,6
5	Design index

TIM-ID: 0000063500 - 001

3.4 Overview of sensors, actuators and injectors - 12V4000Cx5

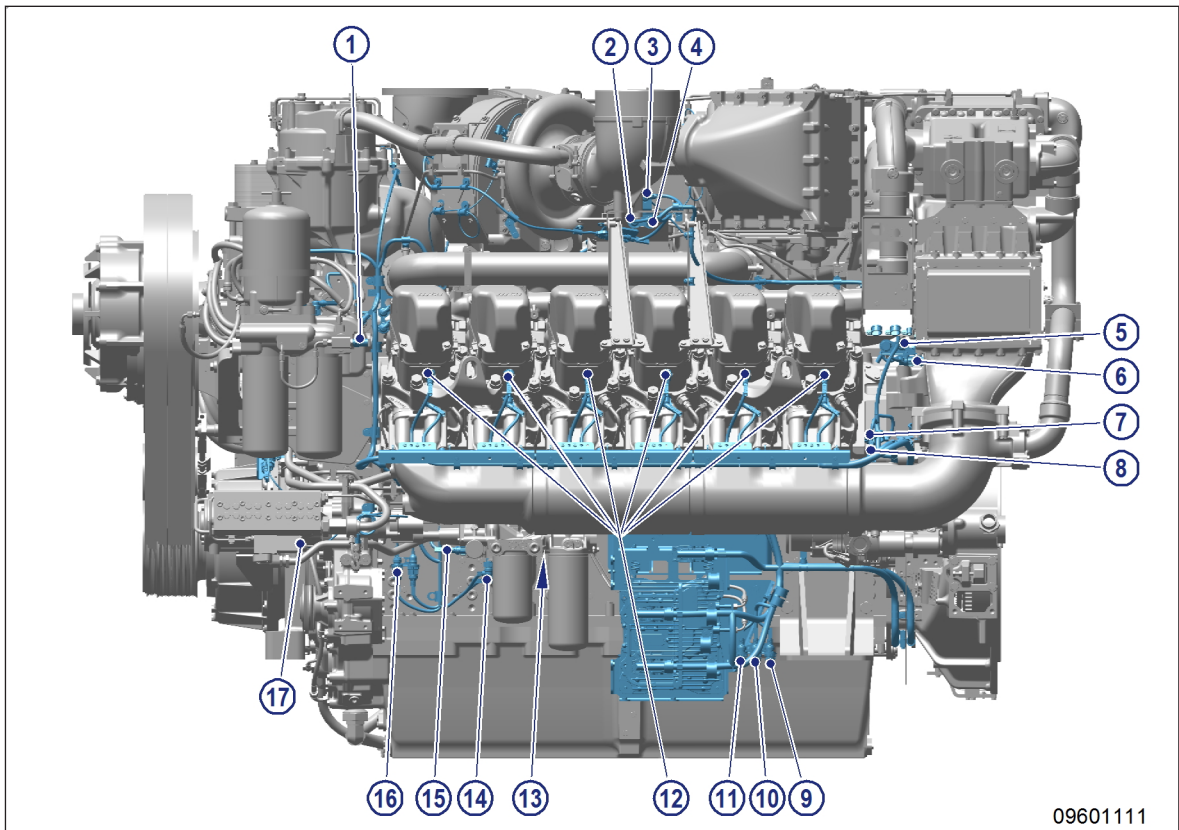


09601110a

1 B10.2 - Charge-air pressure,
B side

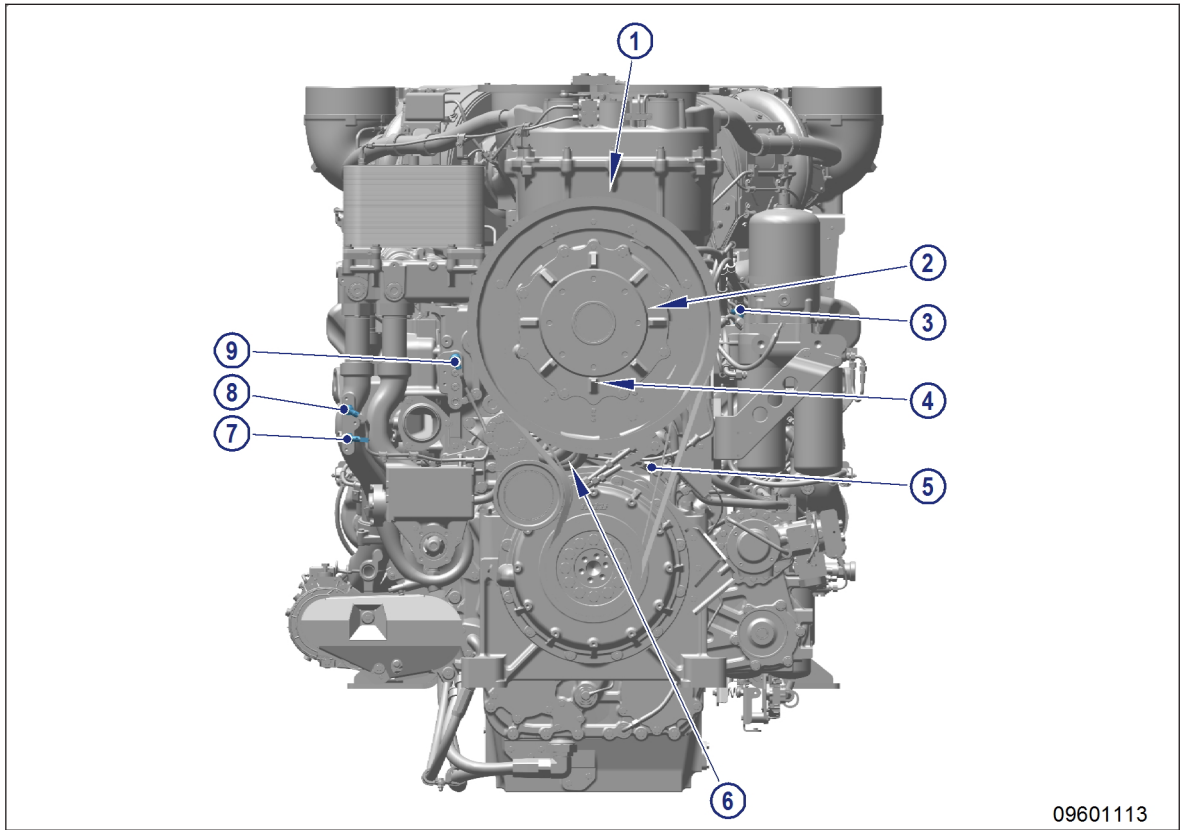
2 B16 - Coolant pressure

12 Y39 - Injector (B1-B6)



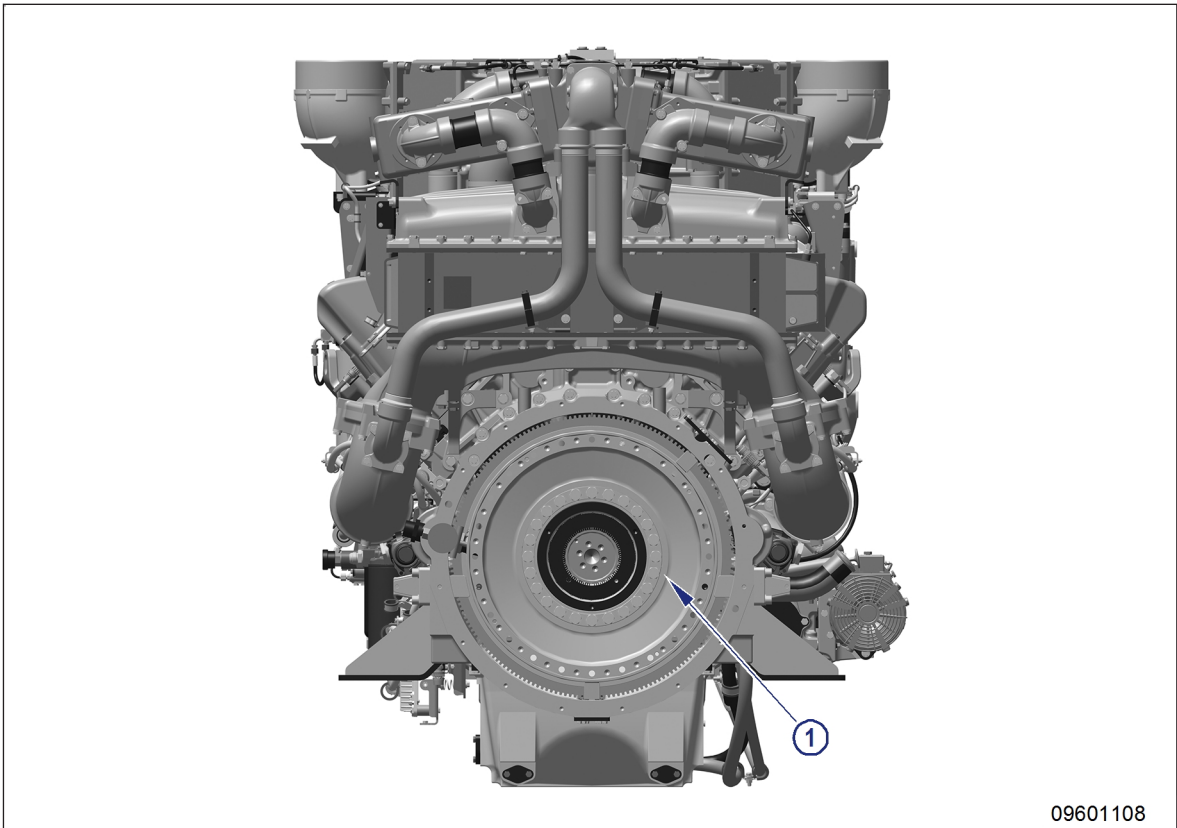
09601111

- | | | |
|--|--|---|
| 1 B5.3 - Lube oil pressure before filter | 7 A19 - Electronic engine identification label (EIL) | 13 B34.3 - Fuel pressure before optional filter |
| 2 M52 - HP turbine bypass flap | 8 B9 - Charge air temperature | 14 F34.2 - Fuel pressure before filter |
| 3 B4 - Exhaust temperature | 9 F57 - Charge-air coolant | 15 F34.1 - Fuel pressure after filter |
| 4 M55 - EGR dispenser cylinder flap | 10 F70 - Water level in fuel pre-filter | 16 M8 - Suction restrictor (HP pump) |
| 5 M53 - EGR shutoff flap | 11 F33 - Coolant | 17 F46 - Leak fuel level |
| 6 B10.1 - Charge-air pressure, A side | 12 Y39 - Injector (A1-A6) | |



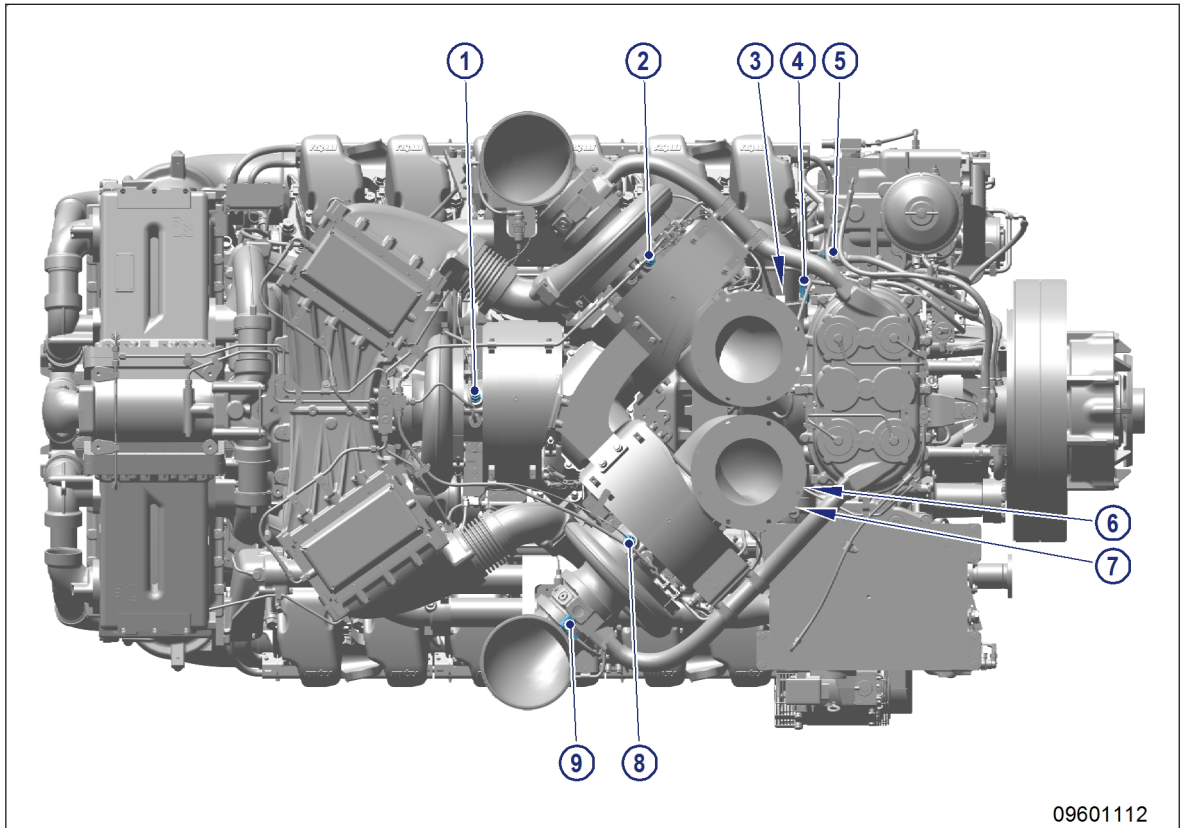
09601113

- | | | |
|---|---------------------------------|--|
| 1 B50 - Crankcase pressure | 4 B33 - Fuel temperature (Rail) | 7 B43 - Charge-air coolant pressure |
| 2 Y44 - Fan control valve | 5 B48 - Fuel pressure (Rail) | 8 B26 - Charge-air coolant temperature |
| 3 B5.1 - Lube oil pressure after filter | 6 B1 - Camshaft speed | 9 B6 - Engine coolant temperature |



09601108

1 B13 - Crankskaft speed



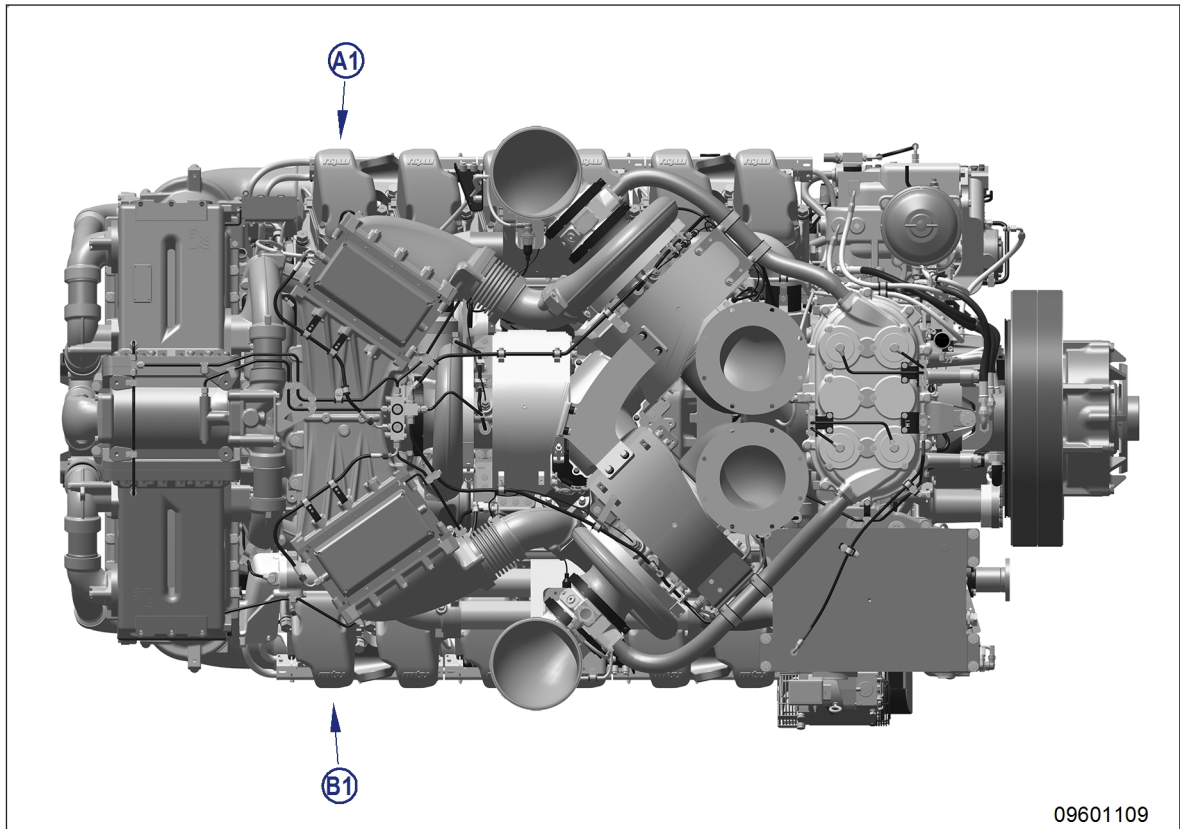
09601112

- 1 B44.3 - Turbocharger speed (high pressure)
- 2 B44.1 - Turbocharger speed (low pressure) A side
- 3 B88.1 - LAMBDA NOx (Conti) A side

- 4 B89 - LAMBDA (Bosch)
- 5 B7 - Lube oil temperature
- 6 B91.3 - Exhaust pressure LAMDA

- 7 B88.2 - LAMBDA NOx (Conti) B side
- 8 B44.2 - Turbocharger speed (low pressure) B side
- 9 B90 - Intake-air humidity (pressure, temperature)

Injectors



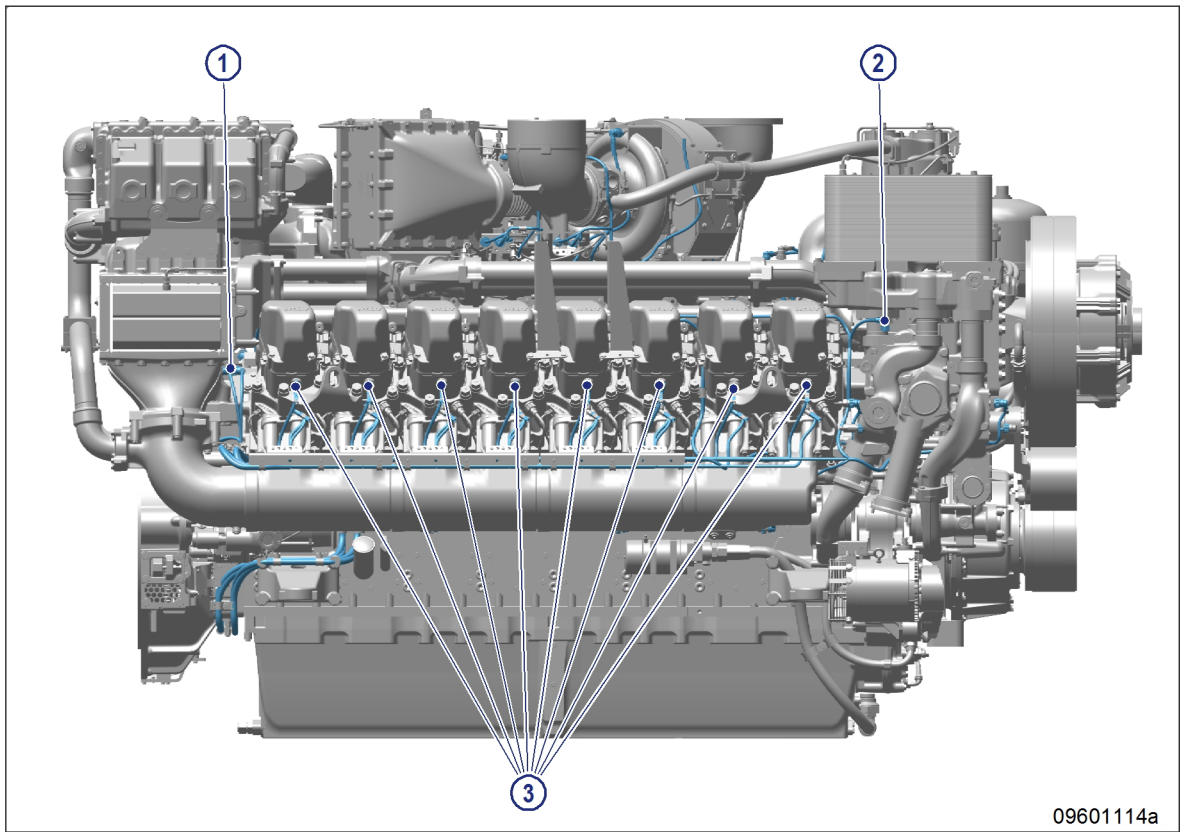
A1 Injector Y39A1
A2 Injector Y39A2
A3 Injector Y39A3
A4 Injector Y39A4

A5 Injector Y39A5
A6 Injector Y39A6
B1 Injector Y39B1
B2 Injector Y39B2

B3 Injector Y39B3
B4 Injector Y39B4
B5 Injector Y39B5
B6 Injector Y39B6

The injectors are numbered in ascending order and located below the cylinder head covers. Injector replacement and necessary activities (→ Page 114).

3.5 Overview of sensors, actuators and injectors - 16V4000Cx5

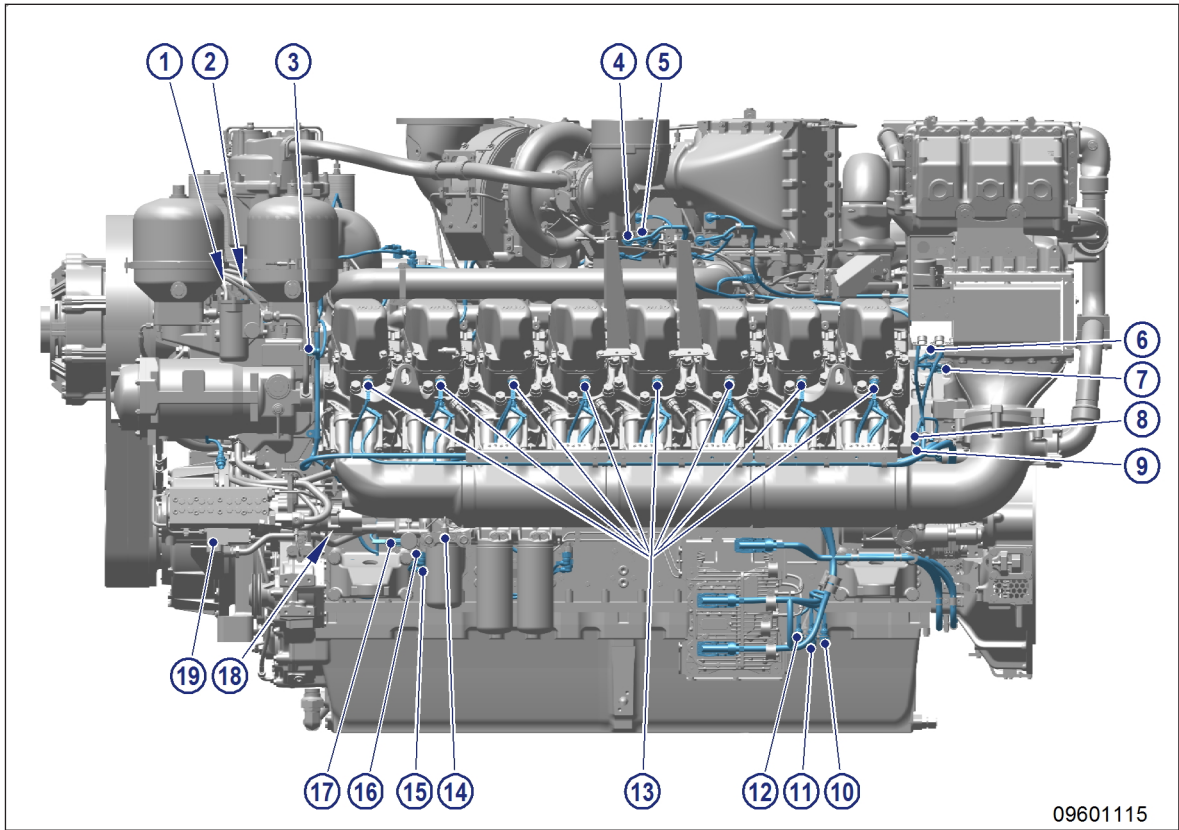


09601114a

1 B10.2 - Charge-air pressure,
B side

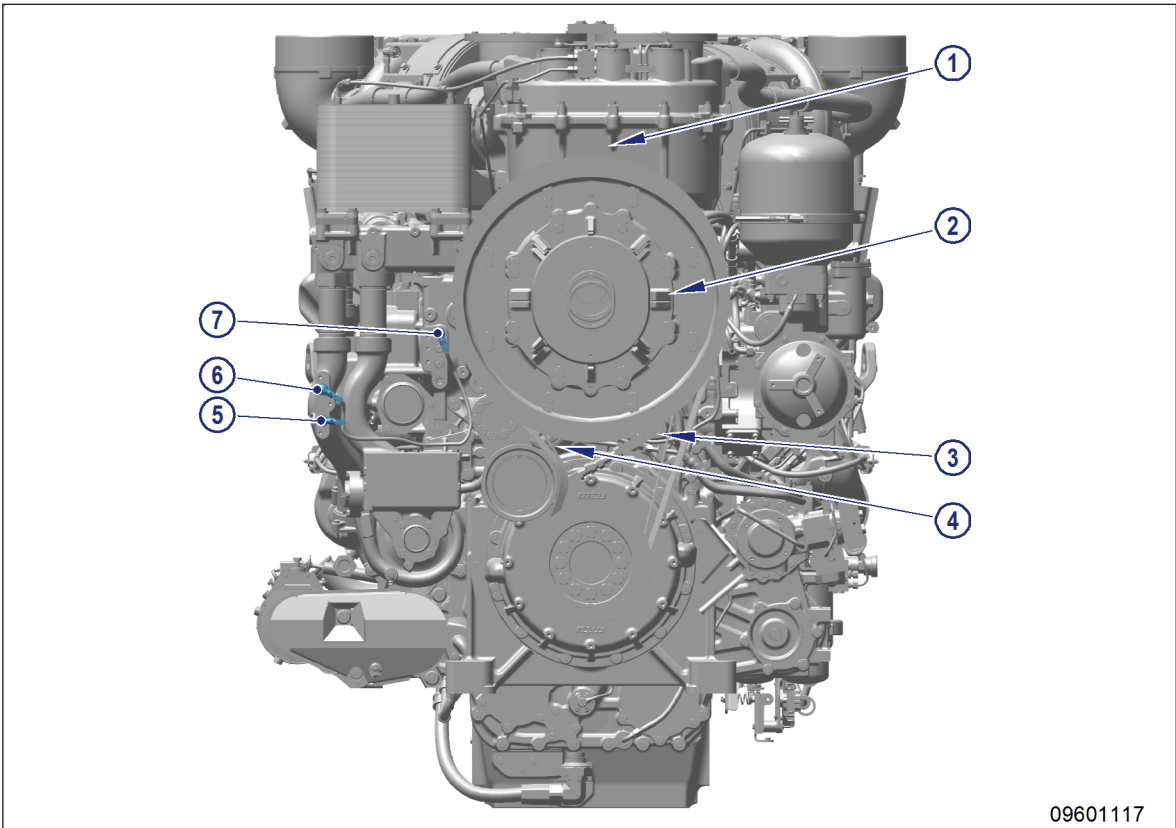
2 B16 - Coolant pressure

12 Y39 - Injector (B1-B8)



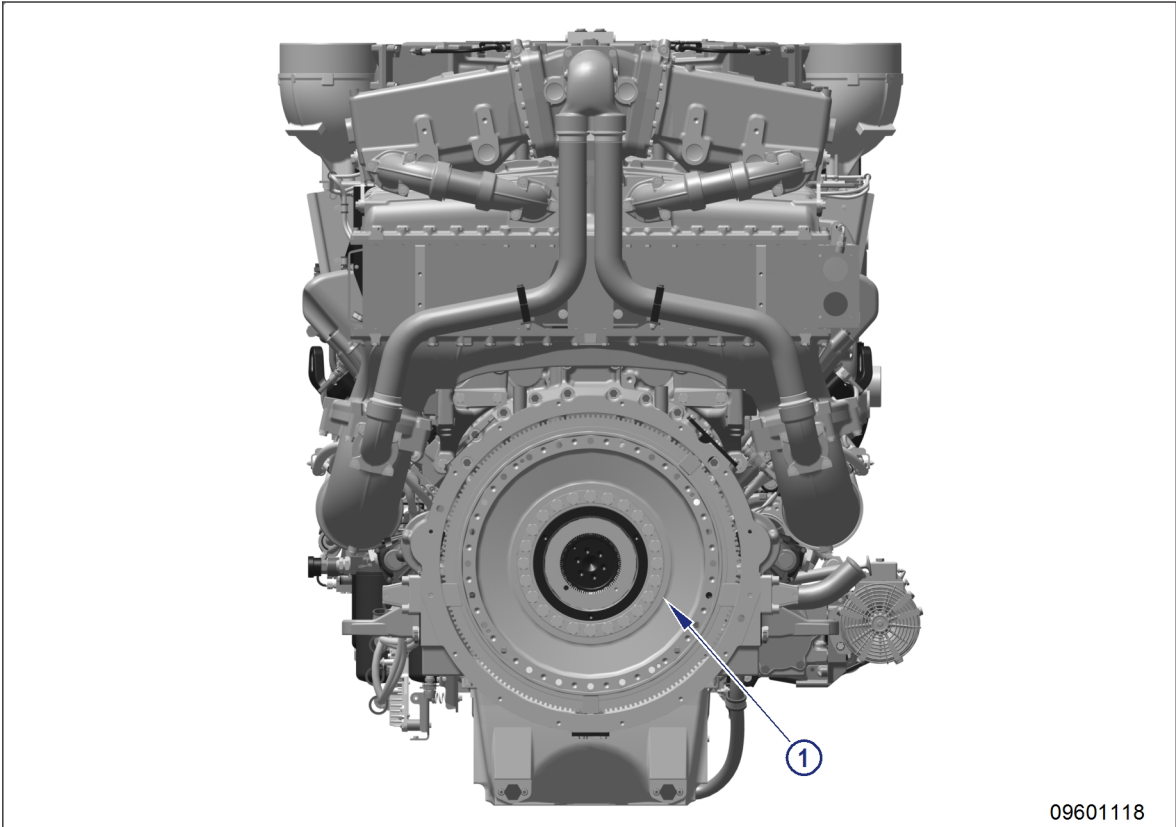
09601115

- | | | |
|--|--|--|
| 1 B5.3 - Lube oil pressure before filter | 8 A19 - Electronic engine identification label (EIL) | 15 F34.2 - Fuel pressure before filter |
| 2 B5.1 - Lube oil pressure after filter | 9 B9 - Charge air temperature | 16 B33 - Fuel temperature (Rail) |
| 3 B7 - Lube oil temperature | 10 F57 - Charge-air coolant | 17 B34.1 - Fuel pressure after filter |
| 4 M52 - HP turbine bypass flap | 11 F70 - Water level in fuel pre-filter | 18 M8 - Suction restrictor (HP pump) |
| 5 M55 - EGR dispenser cylinder flap | 12 F33 - Coolant | 19 F46 - Leak fuel level |
| 6 M53 - EGR shutoff flap | 13 Y39 - Injector (A1-A8) | |
| 7 B10.1 - Charge-air pressure, A side | 14 B34.3 - Fuel pressure before optional filter | |



09601117

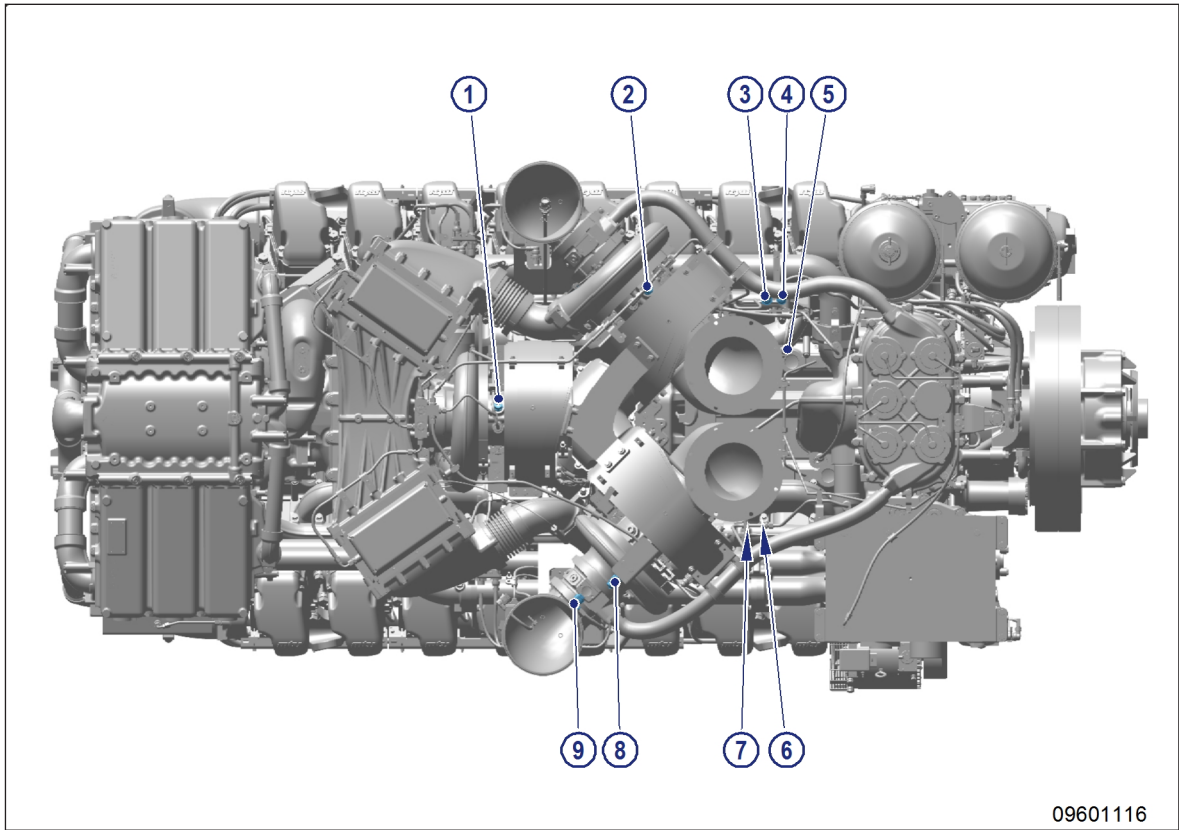
- | | | |
|------------------------------|--|----------------------------|
| 1 B50 - Crankcase pressure | 4 B1 - Camshaft speed | 7 B6 - Coolant temperature |
| 2 Y44 - Fan control valve | 5 B43 - Charge-air coolant pressure | |
| 3 B48 - Fuel pressure (Rail) | 6 B26 - Charge-air coolant temperature | |



09601118

- 1 B13 - Crankshaft speed

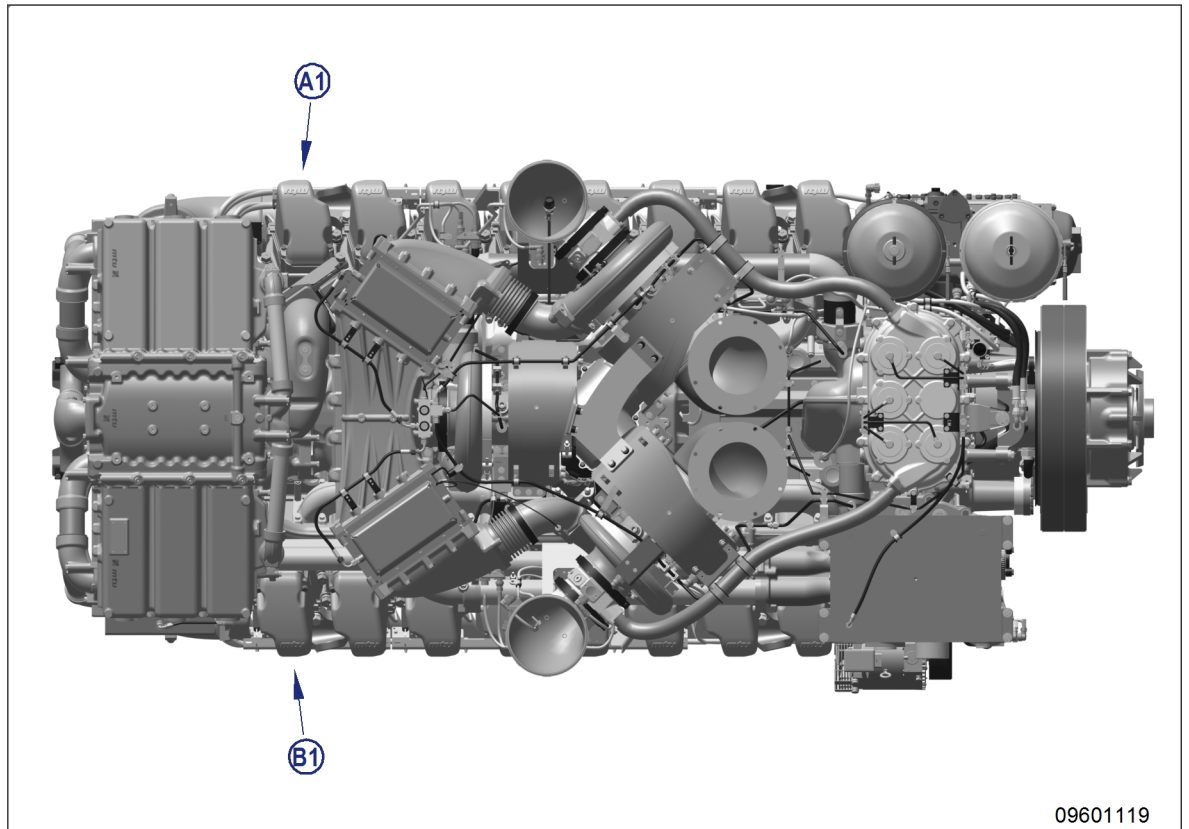
TIM-ID: 000.000.63596 - 001



09601116

- | | | |
|--|----------------------------------|---|
| 1 B44.3 - Turbocharger speed (high pressure) | 4 B89 - LAMBDA (Bosch) | 7 B88.2 - LAMBDA NOx (Conti) B side |
| 2 B44.1 - Turbocharger speed (low pressure) A side | 5 B4 - Exhaust temperature | 8 B44.2 - Turbocharger speed (low pressure) B side |
| 3 B88.1 - LAMBDA NOx (Conti) A side | 6 B91.3 - Exhaust pressure LAMDA | 9 B90 - Intake-air humidity (pressure, temperature) |

Injectors



09601119

A1 Injector Y39A1
A2 Injector Y39A2
A3 Injector Y39A3
A4 Injector Y39A4
A5 Injector Y39A5
A6 Injector Y39A6

A7 Injector Y39A7
A8 Injector Y39A8
B1 Injector Y39B1
B2 Injector Y39B2
B3 Injector Y39B3
B4 Injector Y39B4

B5 Injector Y39B5
B6 Injector Y39B6
B7 Injector Y39B7
B8 Injector Y39B8

The injectors are numbered in ascending order and located below the cylinder head covers. Injector replacement and necessary activities (→ Page 114).

4 Technical Data

4.1 Product data 12V4000C15 12V4000C25 12V4000C35

Legend

- DL Ref. value: Continuous power. Continuously attainable power at standard conditions.
- BL Ref. value: Fuel stop power. Maximum engine power. Not continuously attainable in some applications (margin for load fluctuations).
- A Design value. Value is used for the design of an external system (plant).
- R Guideline value. Typical average value for information, limited suitability for design purposes.
- L Limit value. Value which must not be fallen short of (lower limit, min. value) or exceeded (upper limit, max. value), not suitable for design purposes.
- N Not yet defined value. Value has not yet been defined or will not be defined.
 - Not applicable. Assembly is not applicable to the given product type
 - X Applicable. Assembly is applicable to the given product type
 - > The actual value must be greater than the specified value.
 - < The actual value must be smaller than the specified value.
 - * Not sufficiently validated value (+/- 10% tolerance).
 - ** Not sufficiently validated value (+/- 5% tolerance).

ID	Product type	Application	Engine speed	Effective power	
1	12V4000C15	Industrial / main drive of vehicle 5A continuous operation, unrestricted	1800 rpm	1150 kW 1542 bhp	Ref. 25°C/45°C EPA Nonroad T4 (40CFR1039)
2	12V4000C25	Industrial / main drive of vehicle 5A continuous operation, unrestricted	1800 rpm	1250 kW 1676 bhp	Ref. 25°C/45°C EPA Nonroad T4 (40CFR1039)
3	12V4000C35	Industrial / main drive of vehicle 5A continuous operation, unrestricted	1800 rpm	1500 kW 2012 bhp	Ref. 25°C/45°C EPA Nonroad T4 (40CFR1039)

Reference condition

ID		1	2	3
Intake air temperature	°C	25	25	25
Charge-air coolant temperature	°C	45	45	45
Barometric pressure	mbar	1000	1000	1000
Site altitude above sea level	m	100	100	100

1. Power-related data

ID		1	2	3
Rated engine speed	A rpm	1800	1800	1800
Effective power (w/o fan) (Fuel stop power ISO 3046)	A kW	1150	1250	1500

TIM-ID: 0000065241 - 002

2. General conditions (for maximum power)

ID			1	2	3
Intake depression (new filter)	A	mbar	15	15	15
Intake depression, max.	L	mbar	50	50	50
Exhaust overpressure	A	mbar	30	30	30
Exhaust gas overpressure, max.	L	mbar	85	85	85
Maximum admissible deviation between intake air temperature measured at engine inlet and ambient air temperature (measured in the shadow at a distance of approx. 8 meter or 25 feet)	L	°C	3	3	3
Fuel temperature at engine inlet connection	R	°C	25	25	25
Fuel temperature at engine inlet connection, max (w/o power reduction)	L	°C	70	70	70

4. Model-related data (basic design)

ID			1	2	3
Number of cylinders	-		12	12	12
Cylinder arrangement: V-angle		Degrees (°)	90	90	90
Bore		mm	170	170	170
Stroke		mm	210	210	210
Displacement, cylinder		Liter	4.77	4.77	4.77
Displacement, total		Liter	57.2	57.2	57.2
Number of inlet valves per cylinder	-		2	2	2
Number of exhaust valves, per cylinder	-		2	2	2

5. Air / exhaust

ID			1	2	3
Charge-air pressure before cylinder	R	bar abs	3.5	3.7	3.8

7. Coolant system (high-temperature circuit)

ID			1	2	3
Coolant temperature at ambient temperature up to 40 °C (at engine connection: outlet to cooling equipment)	A	°C	90	90	90
Coolant temperature after engine, limit 1	L	°C	107	107	107
Coolant temperature after engine, limit 2	L	°C	109	109	109
Coolant antifreeze content, max.	L	%	50	50	50
Coolant pump: differential pressure	R	bar	4.8 *	4.8 *	4.8 *
Thermostat: Starts to open	R	°C	79	79	79
Thermostat: Fully open	R	°C	92	92	92

8. Coolant system (low-temperature circuit)

ID			1	2	3
Coolant temperature before intercooler (at engine inlet from cooling equipment)	A	°C	45	45	45
Coolant antifreeze content, max.	L	%	50	50	50
Thermostat: Starts to open	R	°C	38	38	38
Thermostat: Fully open	R	°C	51	51	51

10. Lube-oil system

ID			1	2	3
Lube-oil operating temperature before engine, to	R	°C	95	95	95
Lube-oil temperature before engine, limit 1	L	°C	97	97	97
Lube-oil temperature before engine, limit 2	L	°C	99	99	99
Lube-oil operating pressure before engine, to	R	bar	6.7 *	6.7 *	6.7 *

11. Fuel system

ID			1	2	3
Fuel pressure at engine inlet connection, min. (when engine is starting)	L	bar	-0.3	-0.3	-0.3
Fuel pressure at engine inlet connection, min. (when engine is running)	L	bar	-0.5	-0.5	-0.5
Fuel pressure at engine inlet connection, max. (when engine is starting)	L	bar	1.5	1.5	1.5

16. Inclinations - standard oil system (reference: waterline)

ID			1	2	3
Longitudinal inclination, continuous max. driving end down (option: max. operating inclinations)	L	Degrees (°)	30	30	30
Longitudinal inclination, continuous max. driving end up (option: max. operating inclinations)	L	Degrees (°)	30	30	30
Transverse inclination; continuous max. (option: max. operating inclinations)	L	Degrees (°)	30	30	30

18. Capacity

ID			1	2	3
Engine coolant capacity, engine side (w/o cooling equipment)	R	Liter	220	220	220
Charge-air coolant, engine side	R	Liter	69	69	69
Oil pan capacity at dipstick mark "min." (standard oil system) (option: max. operating inclinations)	L	Liter	250 **	250 **	250 **
Oil pan capacity at dipstick mark "max." (standard oil system) (option: max. operating inclinations)	L	Liter	290 **	290 **	290 **

19. Weights / main dimensions

ID			1	2	3
Engine dry weight (standard scope of supply)	R	kg	8320 **	8320 **	8320 **

22. Acoustics

ID			1	2	3
Exhaust noise, silenced - BL (free-field sound-pressure level Lp, 1 m distance, ISO 6798, +3 dB(A) tolerance)	R	dB(A)	108	109	109
Exhaust noise, silenced - BL (sound power level LW, ISO 6798, +3 dB(A) tolerance)	R	dB(A)	121	121	121

4.2 Product data 12V4000C55 12V4000C65

Legend

- DL Ref. value: Continuous power. Continuously attainable power at standard conditions.
- BL Ref. value: Fuel stop power. Maximum engine power. Not continuously attainable in some applications (margin for load fluctuations).
- A Design value. Value is used for the design of an external system (plant).
- R Guideline value. Typical average value for information, limited suitability for design purposes.
- L Limit value. Value which must not be fallen short of (lower limit, min. value) or exceeded (upper limit, max. value), not suitable for design purposes.
- N Not yet defined value. Value has not yet been defined or will not be defined.
- Not applicable. Assembly is not applicable to the given product type.
- X Applicable. Assembly is applicable to the given product type.
- > The actual value must be greater than the specified value.
- < The actual value must be smaller than the specified value.
- * Not sufficiently validated value (+/- 10% tolerance).
- ** Not sufficiently validated value (+/- 5% tolerance).

ID	Product type	Application	Engine speed	Effective power	
1	12V4000C55	Industrial / main drive of vehicle 5B continuous operation, variable	1900 rpm	1750 kW 2347 bhp	Ref. 25°C/45°C EPA Nonroad T4 (40CFR1039)
2	12V4000C65	Industrial / main drive of vehicle 5B continuous operation, variable	1800 rpm	1864 kW 2500 bhp	Ref. 25°C/45°C EPA Nonroad T4 (40CFR1039)
3	12V4000C65	Industrial / main drive of vehicle 5B continuous operation, variable	1900 rpm	1864 kW 2500 bhp	Ref. 25°C/45°C EPA Nonroad T4 (40CFR1039)

Reference condition

ID		1	2	3
Intake air temperature	°C	25	25	25
Charge-air coolant temperature	°C	45	45	45
Barometric pressure	mbar	1000	1000	1000
Site altitude above sea level	m	100	100	100

1. Power-related data

ID		1	2	3
Rated engine speed	A rpm	1900	1800	1900
Effective power (w/o fan) (Fuel stop power ISO 3046)	A kW	1750	1864	1865

2. General conditions (for maximum power)

ID		1	2	3
Intake depression (new filter)	A mbar	15	15	15
Intake depression, max.	L mbar	50	50	50
Exhaust overpressure	A mbar	30	30	30

ID			1	2	3
Exhaust gas overpressure, max.	L	mbar	85	85	85
Maximum admissible deviation between intake air temperature measured at engine inlet and ambient air temperature (measured in the shadow at a distance of approx. 8 meter or 25 feet)	L	°C	3	3	3
Fuel temperature at engine inlet connection	R	°C	25	25	25
Fuel temperature at engine inlet connection, max (w/o power reduction)	L	°C	70	70	70

4. Model-related data (basic design)

ID			1	2	3
Number of cylinders	-		12	12	12
Cylinder arrangement: V-angle		Degrees (°)	90	90	90
Bore		mm	170	170	170
Stroke		mm	210	210	210
Displacement, cylinder		Liter	4.77	4.77	4.77
Displacement, total		Liter	57.2	57.2	57.2
Number of inlet valves per cylinder	-		2	2	2
Number of exhaust valves, per cylinder	-		2	2	2

5. Air / exhaust

ID			1	2	3
Charge-air pressure before cylinder	R	bar abs	4.7 *	4.5	4.7

7. Coolant system (high-temperature circuit)

ID			1	2	3
Coolant temperature at ambient temperature up to 40 °C (at engine connection: outlet to cooling equipment)	A	°C	90	90	90
Coolant temperature after engine, limit 1	L	°C	107	107	107
Coolant temperature after engine, limit 2	L	°C	109	109	109
Coolant antifreeze content, max.	L	%	50	50	50
Coolant pump: differential pressure	R	bar			5.4
Thermostat: Starts to open	R	°C	79	79	79
Thermostat: Fully open	R	°C	92	92	92

8. Coolant system (low-temperature circuit)

ID			1	2	3
Coolant temperature before intercooler (at engine inlet inlet from cooling equipment)	A	°C	45	45	45
Coolant antifreeze content, max.	L	%	50	50	50
Thermostat: Starts to open	R	°C	38	38	38
Thermostat: Fully open	R	°C	51	51	51

10. Lube-oil system

ID			1	2	3
Lube-oil operating temperature before engine, to	R	°C	95	95	95
Lube-oil temperature before engine, limit 1	L	°C	97	97	97
Lube-oil temperature before engine, limit 2	L	°C	99	99	99
Lube-oil operating pressure before engine, to	R	bar	6.7 *	6.7 *	6.7 *

11. Fuel system

ID			1	2	3
Fuel pressure at engine inlet connection, min. (when engine is starting)	L	bar	-0.3	-0.3	-0.3
Fuel pressure at engine inlet connection, min. (when engine is running)	L	bar	-0.5	-0.5	-0.5
Fuel pressure at engine inlet connection, max. (when engine is starting)	L	bar	1.5	1.5	1.5

16. Inclinations - standard oil system (reference: waterline)

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

18. Capacity

ID			1	2	3
Engine coolant capacity, engine side (w/o cooling equipment)	R	Liter	220	220	220
Charge-air coolant, engine side	R	Liter	69	69	69
Oil change quantity, max. (standard oil system) (option: max. operating inclinations)	R	Liter	195	195	195
Oil pan capacity at dipstick mark "min." (standard oil system) (option: max. operating inclinations)	L	Liter	155	155	155
Oil pan capacity at dipstick mark "max." (standard oil system) (option: max. operating inclinations)	L	Liter	195	195	195

19. Weights / main dimensions

ID			1	2	3
Engine dry weight (standard scope of supply)	R	kg	8320 **	8320 **	8320 **

22. Acoustics

ID			1	2	3
Exhaust noise, silenced - BL (free-field sound pressure level Lp, 1 m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	111	110	111
Exhaust noise, silenced - BL (sound power level LW, ISO 6798, +3dB(A) tolerance)	R	dB(A)	123	122	123

4.3 Product data 16V4000C45 16V4000C55 16V4000C65

Legend

- DL Ref. value: Continuous power. Continuously attainable power at standard conditions.
- BL Ref. value: Fuel stop power. Maximum engine power. Not continuously attainable in some applications (margin for load fluctuations).
- A Design value. Value is used for the design of an external system (plant).
- R Guideline value. Typical average value for information, limited suitability for design purposes.
- L Limit value. Value which must not be fallen short of (lower limit, min. value) or exceeded (upper limit, max. value), not suitable for design purposes.
- N Not yet defined value. Value has not yet been defined or will not be defined.
- Not applicable. Assembly is not applicable to the given product type.
- X Applicable. Assembly is applicable to the given product type.
- > The actual value must be greater than the specified value.
- < The actual value must be smaller than the specified value.
- * Not sufficiently validated value (+/- 10% tolerance).
- ** Not sufficiently validated value (+/- 5% tolerance).

ID	Product type	Application	Engine speed	Effective power	
1	16V4000C45	Industrial / main drive of vehicle 5B continuous operation, variable	1800 rpm	2000 kW 2682 bhp	Ref. 25°C/45°C EPA Nonroad T4 (40CFR1039)
2	16V4000C45	Industrial / main drive of vehicle 5B continuous operation, variable	1900 rpm	2000 kW 2682 bhp	Ref. 25°C/45°C EPA Nonroad T4 (40CFR1039)
3	16V4000C55	Industrial / main drive of vehicle 5B continuous operation, variable	1800 rpm	2240 kW 3004 bhp	Ref. 25°C/45°C EPA Nonroad T4 (40CFR1039)
4	16V4000C55	Industrial / main drive of vehicle 5B continuous operation, variable	1900 rpm	2240 kW 3004 bhp	Ref. 25°C/45°C EPA Nonroad T4 (40CFR1039)
5	16V4000C65	Industrial / main drive of vehicle 5B continuous operation, variable	1800 rpm	2400 kW 3218 bhp	Ref. 25°C/45°C EPA Nonroad T4 (40CFR1039)
6	16V4000C65	Industrial / main drive of vehicle 5B continuous operation, variable	1900 rpm	2400 kW 3218 bhp	Ref. 25°C/45°C EPA Nonroad T4 (40CFR1039)

Reference condition

ID		1	2	3	4	5	6
Intake air temperature	°C	25	25	25	25	25	25
Charge-air coolant temperature	°C	45	45	45	45	45	45
Barometric pressure	mbar	1000	1000	1000	1000	1000	1000
Site altitude above sea level	m	100	100	100	100	100	100

TIM-ID: 00000065267 - 002

1. Power-related data

ID			1	2	3	4	5	6
Rated engine speed	A	rpm	1800	1900	1800	1900	1800	1900
Effective power (w/o fan) (Fuel stop power ISO 3046)	A	kW	2000	2000	2240	2240	2400	2400

2. General conditions (for maximum power)

ID			1	2	3	4	5	6
Intake depression (new filter)	A	mbar	15	15	15	15	15	15
Intake depression, max.	L	mbar	50	50	50	50	50	50
Exhaust overpressure	A	mbar	30	30	30	30	30	30
Exhaust gas overpressure, max.	L	mbar	85	85	85	85	85	85
Maximum admissible deviation between intake air temperature measured at engine inlet and ambient air temperature (measured in the shadow at a distance of approx. 8 meter or 25 feet)	L	°C	3	3	3	3	3	3
Fuel temperature at engine inlet connection	R	°C	40	40	40	40	40	40
Fuel temperature at engine inlet connection, max (w/o power reduction)	L	°C	70	70	70	70	70	70

4. Model-related data (basic design)

ID			1	2	3	4	5	6
Number of cylinders	-		16	16	16	16	16	16
Cylinder arrangement: V-angle		Degrees (°)	90	90	90	90	90	90
Bore		mm	170	170	170	170	170	170
Stroke		mm	210	210	210	210	210	210
Displacement, cylinder		Liter	4.77	4.77	4.77	4.77	4.77	4.77
Displacement, total		Liter	76.3	76.3	76.3	76.3	76.3	76.3
Number of inlet valves per cylinder	-		2	2	2	2	2	2
Number of exhaust valves per cylinder	-		2	2	2	2	2	2

5. Air / exhaust

ID			1	2	3	4	5	6
Charge-air pressure before cylinder	R	bar abs						4.5

7. Coolant system (high-temperature circuit)

ID			1	2	3	4	5	6
Coolant temperature at ambient temperature up to 40 °C (at engine connection: outlet to cooling equipment)	A	°C	90	90	90	90	90	90
Coolant temperature after engine, limit 1	L	°C	107	107	107	107	107	107
Coolant temperature after engine, limit 2	L	°C	109	109	109	109	109	109
Coolant antifreeze content, max.	L	%	50	50	50	50	50	50
Thermostat: Starts to open	R	°C	79	79	79	79	79	79
Thermostat: Fully open	R	°C	92	92	92	92	92	92

8. Coolant system (low-temperature circuit)

ID			1	2	3	4	5	6
Coolant temperature before intercooler (at engine inlet from cooling equipment)	A	°C	45	45	45	45	45	45
Coolant antifreeze content, max.	L	%	50	50	50	50	50	50
Thermostat: Starts to open	R	°C	38	38	38	38	38	38
Thermostat: Fully open	R	°C	51	51	51	51	51	51

10. Lube-oil system

ID			1	2	3	4	5	6
Lube-oil operating temperature before engine, to	R	°C	95	95	95	95	95	95
Lube-oil temperature before engine, limit 1	L	°C	97	97	97	97	97	97
Lube-oil temperature before engine, limit 2	L	°C	99	99	99	99	99	99

11. Fuel system

ID			1	2	3	4	5	6
Fuel pressure at engine inlet connection, min. (when engine is starting)	L	bar	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
Fuel pressure at engine inlet connection, min. (when engine is running)	L	bar	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Fuel pressure at engine inlet connection, max. (when engine is starting)	L	bar	1.5	1.5	1.5	1.5	1.5	1.5

16. Inclinations - standard oil system (reference: waterline)

ID			1	2	3	4	5	6
Longitudinal inclination, continuous max. driving end down (option: max. operating inclinations)	L	Degrees (°)	15	15	15	15	15	15
Longitudinal inclination, continuous max. driving end up (option: max. operating inclinations)	L	Degrees (°)	15	15	15	15	15	15
Transverse inclination, continuous max. (option: max. operating inclinations)	L	Degrees (°)	15	15	15	15	15	15

19. Weights / main dimensions

ID			1	2	3	4	5	6
Engine dry weight (standard scope of supply)	R	kg	11090 *	11090 *	11090 *	11090 *	11090 *	11090 *

22. Acoustics

ID			1	2	3	4	5	6
Exhaust noise, unsilenced - BL (free-field sound-pressure level L _p , 1 m distance, ISO 6798, +3 dB(A) tolerance)	R	dB(A)	119 *	119 *	119 *	119 *	119 *	119 *
Exhaust noise, unsilenced - BL (sound power level LW, ISO 6798, +3 dB(A) tolerance)	R	dB(A)	132 *	132 *	132 *	132 *	132 *	132 *

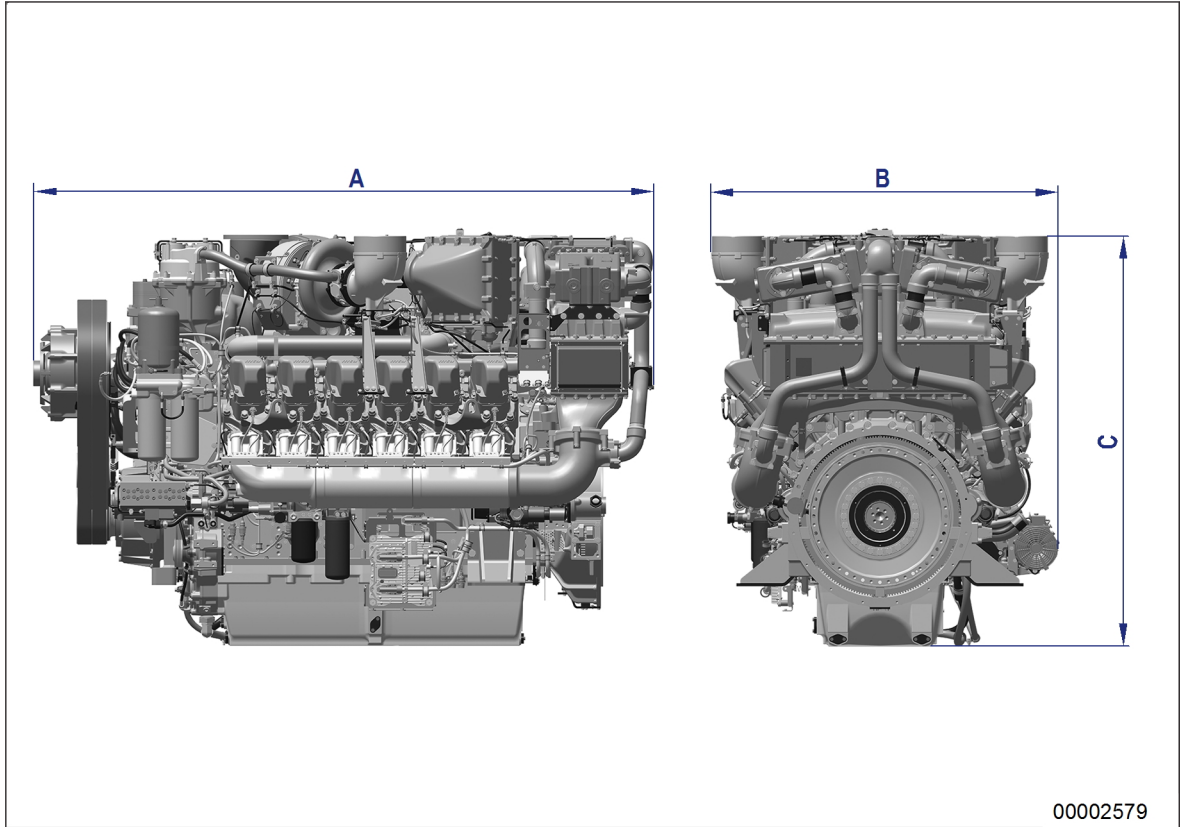
4.4 Firing order

Firing order

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

4.5 Main engine dimensions - 12V4000Cx5

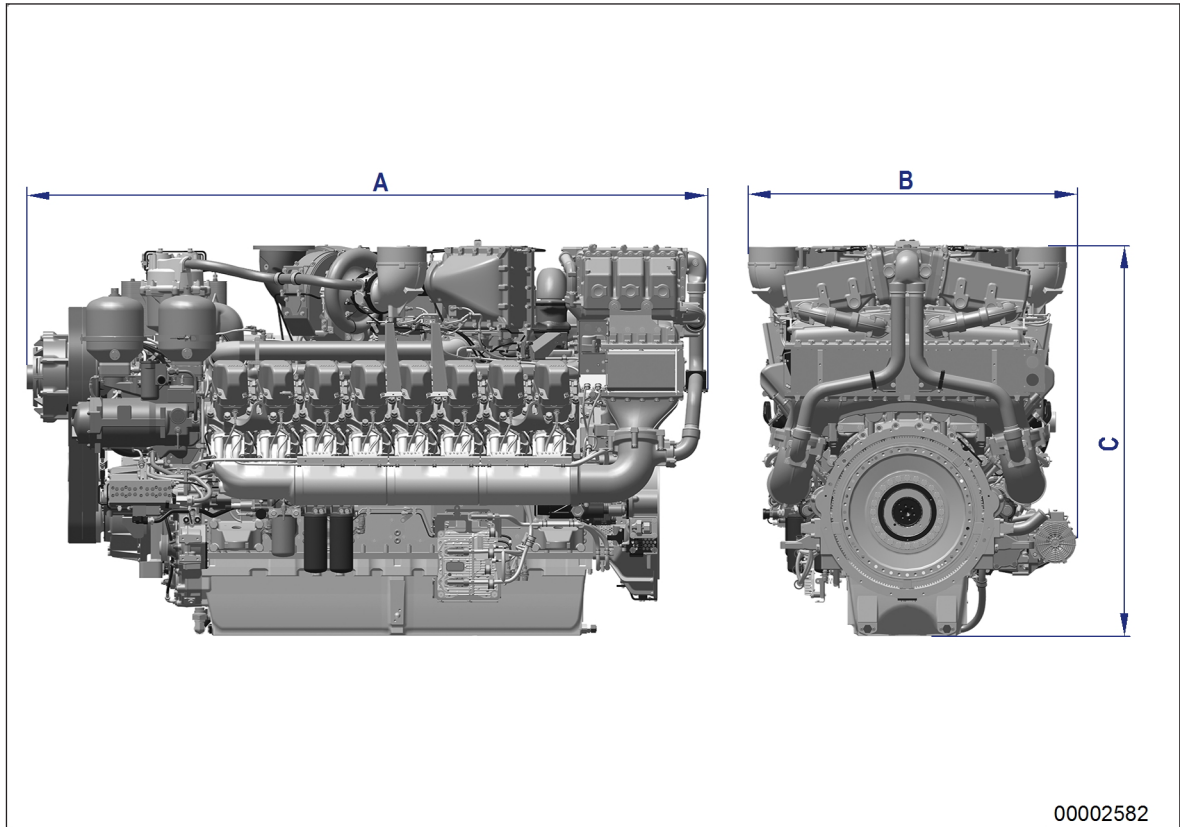
Main engine dimensions



Item	Dimensions
Length (A)	approx. 2878 mm
Width (B)	approx. 1685.5 mm
Height (C)	approx. 1992 mm

4.6 Main engine dimensions - 16V4000Cx5

Main engine dimensions



Item	Dimensions
Length (A)	approx. 3348 mm
Width (B)	approx. 1685.5 mm
Height (C)	approx. 1992 mm

5 Operation

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

Item	Action
Engine	Depreserve (→ Preservation and Represervation Specifications A001070/..).
Cylinder liner	Perform endoscopic examination of cylinder liner (→ Page 97).
Valve drive	Lubricate valve gear every ≥ 6 months (→ Page 103).
Lube oil system	Check engine oil level (→ Page 135). Bar engine using starting system (→ Page 93).
Fuel prefilter	Fill with fuel (if fitted).
Coolant circuit	If engine has been out of service for more than 1 year, change engine coolant (→ Page 153). Change charge-air coolant (→ Page 163).
Coolant circuit	Check engine coolant level (→ Page 152); Check charge-air coolant level (→ Page 162).
Coolant circuit	Preheat coolant with coolant preheating unit (if available).
Engine governor	Check electrical connections (→ Page 190).
Engine management	Read out fault memory using DiaSys, see (→ manufacturer's documentation). Check all active fault messages, eliminate faults as necessary (→ Page 64).

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

Preconditions

- Engine is stopped and starting disabled.

WARNING



In case of out-of-service periods of more than one week: Possible corrosion of components carrying air or exhaust gas due to weather conditions, e.g. rain or snow.

Risk of injury by flying debris when putting the engine into operation!

- Check the components carrying air and exhaust for corrosion.
- Do not put the engine in operation if corrosion was detected.

Putting into operation

Item	Measure
Engine oil system	Check engine oil level (→ Page 135).
Coolant circuit	Check engine coolant level (→ Page 152); Check charge-air coolant level (→ Page 162).
Coolant circuit	Heat coolant with coolant preheater (if available; see manufacturer's documentation).
Engine control system	Put into operation (see manufacturer's documentation).

5.3 Operational checks

DANGER	<p>Rotating and moving engine parts.</p> <p>Risk of crushing, danger of parts of the body being caught or pulled in!</p> <ul style="list-style-type: none"> • Only run the engine at low power. Keep away from the engine's danger zone.
WARNING	<p>High level of engine noise when the engine is running.</p> <p>Risk of damage to hearing!</p> <ul style="list-style-type: none"> • Wear ear protectors.

Operational checks

Item	Action
Control and display panels	Check readings of operational data (speed, temperature, pressures).
Engine oil	Check engine oil level (→ Page 135).
Engine operation	Visually inspect engine for leaks and general condition. Check engine for abnormal running noises, exhaust color and vibrations.
Air filter	Check signal ring position of maintenance indicator on air filter (if applicable).
Battery-charging generator	Check battery-charging generator for contamination, clean as necessary (→ Page 172).
Exhaust gas system	Check exhaust color (→ Page 61).
Fuel prefilter	Drain water and contaminants at the drain cock of the fuel prefilter, if fitted. Check vacuum gage setting on fuel prefilter, if installed.
Engine coolant pump	Check relief bore (→ Page 159).
Charge-air coolant pump	Check relief bore (→ Page 170).

5.4 Emission label – Check

Checking emission label

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

1. Check that emission labels are present (several are possible).
2. Does the label on the engine match the label document in the Business Portal/Equipment?
3. Check emission label for intactness.
4. Check content of emission label for complete readability
5. Does the engine number on the emission label match the engine identification plate?
6. Does the Manufacturing Date match the year of manufacture on the identification plate?

5.5 Engine – Starting in manual mode

Preconditions

- Engine is not under load.
- External start interlock is not activated.

DANGER	<p>Rotating and moving engine parts.</p> <p>Risk of crushing, danger of parts of the body being caught or pulled in!</p> <ul style="list-style-type: none">• Before cranking the engine with starter system, make sure that there are no persons in the engine's danger zone.
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WARNING	<p>High level of engine noise when the engine is running.</p> <p>Risk of damage to hearing!</p> <ul style="list-style-type: none">• Wear ear protectors.
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Preparation

Item	Measure
Operating mode switch (if applicable).	Switch to manual mode.
Coolant preheating unit (if applicable).	Switch ON

Start engine

Item	Measure
Switchgear cabinet, operator station etc. (depending on manufacturer).	<ol style="list-style-type: none">1. If no coolant preheater is fitted, make sure that the coolant temperature is > 40 °C.2. Press start button.<ul style="list-style-type: none">• Automatic starting procedure is performed.• Engine speed instrument indicates increasing speed.• After the starting sequence is completed, engine is running at idle speed.

5.6 Engine - Stopping in manual mode

Preconditions

- Engine is not under load.
- Engine is running in manual mode.

NOTICE



Stopping the engine when it is running at full load subjects it to extreme thermal and mechanical stresses.

Overheating of and, therefore, damage to components is possible!

- Before shutting down the engine, allow it to idle until the engine temperatures decrease and constant levels are indicated.

Preparation

Item	Measure
Engine	Operate engine at idling speed for approx. 5 minutes.

Stop engine

Item	Measure
Switch cabinet, operator station etc. (depending on manufacturer)	Press stop button. <ul style="list-style-type: none">• Automatic stopping sequence is executed.

5.7 After stopping the engine - Putting the engine out of operation

Preconditions

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

NOTICE



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

Risk of sensor damage!

- Remove pressure sensors and shake off residual water.

After stopping the engine

Item	Measure
Coolant circuit	Drain engine coolant (→ Page 154) and Drain charge-air coolant (→ Page 164) if <ul style="list-style-type: none">• freezing temperatures are expected, the engine is to remain out of service for an extended period, but engine coolant has no antifreeze additive.• the engine room is not heated.• the coolant is not kept at a suitable temperature.• the antifreeze concentration is insufficient for the engine-room temperature.• the antifreeze concentration is 50% and the engine room temperature is below -40 °C.
Engine control system	Switch off (see manufacturer's documentation).
Air intake and exhaust system	If the equipment is to remain out of service for more than one week, seal the engine's air and exhaust sides. Otherwise, components carrying air or exhaust gas are at risk of corrosion. If the equipment is to remain out of service for more than one month, preserve the engine (→ MTU Preservation and Represervation Specifications A001070/..).





5.8 Plant – Cleaning

Preconditions

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

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
High-pressure cleaning unit	-	1
Cleaner (Hakupur 50/136)	X00056700	1

WARNING	 <p>Compressed air gun ejects a jet of pressurized air. Risk of injury to eyes and damage to hearing, risk of rupturing internal organs!</p> <ul style="list-style-type: none"> • Never direct air jet at people. • Always wear safety goggles/face mask and ear defenders.
WARNING	 <p>Water jet from high-pressure cleaning unit. Risk of eye injury, risk of scalding!</p> <ul style="list-style-type: none"> • Do not direct water jet at persons. • Wear protective clothing, protective gloves, and goggles/safety mask.
NOTICE	 <p>Cleaning agents should not be left to take effect for too long. Damage to components is possible!</p> <ul style="list-style-type: none"> • Observe manufacturer's instructions.
NOTICE	 <p>Blowing down product with compressed air. Entry of dirt and damage to components is possible!</p> <ul style="list-style-type: none"> • Do not aim compressed air gun directly at seals or electronic components such as connectors or ECUs.

Plant – Cleaning

1. Carry out plant cleaning only in areas where an appropriate oil separator is provided (environmental protection).
 2. Prior to putting the cleaning unit into operation, read the operating instructions of the high-pressure cleaning units carefully and observe the safety precautions.
 3. The following requirements apply for cleaning the plant outside with a high-pressure cleaning unit:
 - The pressure of the high-pressure jet (cleaning jet) must not exceed 50 bar.
 - A minimum distance between spray nozzle and plant of 1 m must be observed.
 - The temperature of the cleaning medium must not exceed 80 °C.
 4. For external cleaning with high-pressure jet, use a flat-mouth nozzle only.
- Note: Never direct compressed air directly at electronic components.
5. Carry out external cleaning as follows:
 - a) Seal all openings in a suitable way.
 - b) Remove coarse dirt.
 - c) Spray on cleaner sparingly and leave it for 1 to 5 minutes.
 - d) Use the high-pressure jet to remove the loosened dirt.
 - e) Dry engine with compressed air.

6 Maintenance

6.1 Maintenance task reference table [QL1]

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

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

Task	Option	Maintenance tasks	
W0500		Check engine oil level.	(→ Page 135)
W0501		Visually inspect engine for leaks and general condition.	(→ Page 53)
W0505		Check relief bores of coolant pump(s).	(→ Page 159) (→ Page 170)
W0506		Check engine for abnormal running noises, exhaust color and vibrations.	(→ Page 61)
W0507		Drain water and contaminants from fuel prefilter.	(→ Page 53)
W0508		Check reading on differential pressure gauge of fuel prefilter.	(→ Page 53) (→ Page 197) (→ Page 209)
W0800		Check emissions label for presence, readability and content.	(→ Page 54)
W1001		Replace fuel filter or fuel filter element.	(→ Page 122)
W1003		Check belt condition and tension, replace if necessary.	(→ Page 171)
W1006		Replace fuel injection valves/injectors.	(→ Page 114)
W1008	X	Replace engine oil filter when changing engine oil, or when the interval (years) is reached, at the latest.	(→ Page 140)
W1009		Measure thickness of oil residue layer, clean out and replace filter sleeve, together with every engine oil change, at the latest.	(→ Page 148)
W1011		Perform endoscopic examination.	(→ Page 97)
W1055		Replace oil separator.	(→ Page 101)
W1207		Check valve clearance, adjust if necessary. ATTENTION! First adjustment after 1,000 operating hours on a new engine and after 1,000 operating hours following each overhaul of the cylinder heads.	(→ Page 106)
W1296	X	Replace valve.	(→ Page 161)
W1463		Check general condition of engine mounting (visual inspection).	(→ Page 183)
W1481		Replace intermediate fuel filter or its filter element.	(→ Page 123)
W1525		Replace sensor.	(→ Page 191)
W1526		Replace sensor.	(→ Page 193)
W1551		Check function of exhaust flap actuators.	(→ Page 128) (→ Page 187)
W1575		Check general condition of trunnion mounts (visual inspection).	(→ Page 181)
W1610		Check securing screws of trunnion mounts for secure seating.	(→ Page 181)
W1636		Reset drift compensation parameter (CDC) and enter injection codes (IIG).	(→ Page 186)

Task	Option	Maintenance tasks	
W1675		Replace fuel prefilter or its filter element.	(→ Page 53) (→ Page 197) (→ Page 209)
W1689		Measure valve stem end to cylinder head top distance.	(→ Page 104)
W1716		Clean battery-charging generator.	(→ Page 172)
W1817		Check coupling rods of EGR flaps for clearance.	(→ Page 128)
W1864	X	Check and clean oil indicator filter.	(→ Page 146)
W1940		Replace auxiliary PTO of battery-charging generator.	(→ Page 173)

Table 2: Maintenance task reference table [QL1]

7 Troubleshooting

7.1 Troubleshooting

Engine does not turn when starter is actuated

Cause	Corrective action
Battery/UltraCaps low or defective	▶ Charge or replace (→ manufacturer's documentation).
Cable connections defective	▶ Check cable connections for secure seating (→ manufacturer's documentation).
Starter: Engine cabling, POM or starter defective	▶ Check cable connections for secure seating, contact Service
Engine cabling defective	▶ Check (→ Page 185)
Engine / generator control: Assemblies or plug-in connections loose	▶ Perform visual inspection (→ manufacturer's documentation)
Engine governor: Plug-in connections loose	▶ Check plug-connection cables (→ Page 190)
Running gear blocked (engine cannot be barred manually)	▶ Contact Service

Engine turns but does not fire

Cause	Corrective action
Engine: Too cold	▶ Preheat (25 °C)
Poor rotation by starter: Battery/UltraCaps low or defective	▶ Charge or replace battery/UltraCaps (→ manufacturer's documentation).
Engine cabling defective.	▶ Check (→ Page 185)
Air in fuel system	▶ Vent fuel system (→ Page 120)
Engine governor defective	▶ Contact Service

Engine fires unevenly

Cause	Corrective action
Injector defective	▶ Check, replace if necessary (→ Page 115)
Engine cabling defective	▶ Check (→ Page 185)
Air in fuel system	▶ Vent fuel system (→ Page 120)
Engine governor defective	▶ Contact Service

Engine does not reach rated speed

Cause	Corrective action
Fuel prefilter clogged	▶ Replace (→ manufacturer's documentation)
Fuel filter clogged	▶ Replace (→ Page 122) (→ manufacturer's documentation)
Additional fuel filter clogged	▶ Replace (→ Page 123)
Air filter clogged	▶ Check, replace if necessary (→ manufacturer's documentation)
Injector defective	▶ Check, replace if necessary (→ Page 115)
Engine cabling defective	▶ Check (→ Page 185)
Engine: Overloaded	▶ Contact Service

Engine speed not steady

Cause	Corrective action
Injector defective	▶ Check, replace if necessary (→ Page 115)
Speed sensor defective	▶ Contact Service
Air in fuel system	▶ Vent fuel system (→ Page 120)
Engine governor defective	▶ Contact Service

Charge-air temperature too high

Cause	Corrective action
Incorrect coolant concentration	▶ Check (→ MTU test kit)
Intercooler clogged	▶ Contact Service
Engine room: Air-intake temperature too high	▶ Check fans and air supply/exhaust ducts

Charge-air pressure too low

Cause	Corrective action
Air filter clogged	▶ Check, clean if necessary (→ manufacturer's documentation)
Intercooler clogged	▶ Contact Service
Exhaust turbocharger defective	▶ Contact Service

Coolant discharge at intercooler

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

Blue exhaust gas

Cause	Corrective action
Too much engine oil in engine	▶ Drain engine oil (→ Page 136)
Oil separator of crankcase breather contaminated	▶ Replace filter (→ Page 101)
Exhaust turbocharger, cylinder head, piston rings or cylinder liner defective	▶ Contact Service

White exhaust gas

Cause	Corrective action
Engine is not at operating temperature	▶ Preheat/run up to operating temperature
Water in fuel	▶ Check fuel system at fuel prefilter (→ manufacturer's documentation) ▶ Drain water from fuel prefilter (→ manufacturer's documentation)
Intercooler leaky	▶ Contact Service

7.2 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

3 – HI T-Fuel

Cause	Corrective action
The fuel temperature at sensor B33 has exceeded limit value 1. Fuel temperature is too high.	<ol style="list-style-type: none">1. Reduce power.2. Check fuel recooling system (if available).3. Contact Service.

4 – SS T-Fuel

Cause	Corrective action
The fuel temperature at sensor B33 has exceeded limit value 2. Fuel temperature is too high.	<ol style="list-style-type: none">1. Reduce power.2. Check fuel recooling system (if available).3. Contact Service.

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.	<ol style="list-style-type: none">1. Reduce power.2. Check whether alarms 9 and 10 are pending.3. 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.	<ol style="list-style-type: none">1. Reduce power.2. Check whether alarms 9 and 10 are pending.3. Contact Service.

9 – HI T-Coolant Intercooler

Cause	Corrective action
The coolant temperature in the intercooler at sensor B26 has exceeded limit value 1. Coolant temperature in intercooler too high.	<ol style="list-style-type: none">1. Reduce power.2. Check whether alarm 23 is pending.3. Check cooler (plant side) for contamination.4. Check operation of fan (plant side).5. Contact Service.

10 – SS T-Coolant Intercooler

Cause	Corrective action
The coolant temperature in the intercooler at sensor B26 has exceeded limit value 2. Coolant temperature in intercooler too high.	<ol style="list-style-type: none">1. Reduce power.2. Check whether alarm 23 is pending.3. Check cooler (plant side) for contamination.4. Check operation of fan (plant side).5. Contact Service.

15 – LO P-Lube Oil

Cause	Corrective action
The lube oil pressure at sensor B5.1 has undershot limit value 1. The lube oil pressure is too low.	<ol style="list-style-type: none">1. Check engine oil level (→ Page 134).2. Contact Service.

16 – SS P-Lube Oil

Cause	Corrective action
The lube oil pressure at sensor B5.1 has undershot limit value 2. The lube oil pressure is too low.	<ol style="list-style-type: none">1. Check engine oil level (→ Page 134).2. Contact Service.

23 – LO Coolant Level

Cause	Corrective action
Coolant level at switch F33 is too low.	<ol style="list-style-type: none">1. Check engine coolant level (→ Page 152).2. Check relief bore of charge-air coolant pump (→ Page 170).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.	<ol style="list-style-type: none">1. Automatic oil filter - replace oil filter candles (→ Page 142).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.	<ol style="list-style-type: none">1. Automatic oil filter - replace oil filter candles (→ Page 142).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 speed of the LP turbocharger, A-side, at sensor B44.1 has exceeded limit value 1. The turbocharger speed is too high. Cause: Defect or malfunction of another turbocharger.	<ol style="list-style-type: none">1. Reduce power.2. Contact Service.

32 – SS ETC1 Overspeed

Cause	Corrective action
The speed of the LP turbocharger, A-side, at sensor B44.1 has exceeded limit value 1. The turbocharger speed is too high. Cause: Defect or malfunction of another turbocharger.	<ol style="list-style-type: none">1. Reduce power.2. Contact Service.

33 – HI P-Diff-Fuel

Cause	Corrective action
The differential pressure at sensors B34.1 and B34.2 has exceeded limit value 1. The differential pressure is too high.	<ol style="list-style-type: none">1. Replace fuel filter (→ Page 122).2. Contact Service.

34 – SS P-Diff-Fuel

Cause	Corrective action
The differential pressure at sensors B34.1 and B34.2 has exceeded limit value 2. The differential pressure is too high.	<ol style="list-style-type: none">1. Replace fuel filter (→ Page 122).2. Contact Service.

36 – HI ETC2 Overspeed

Cause	Corrective action
The speed of the LP turbocharger, B-side, at sensor B44.2 has exceeded limit value 1. The turbocharger speed is too high. Cause: Defect or malfunction of another turbocharger.	<ol style="list-style-type: none">1. Reduce power.2. Contact Service.

37 – SS ETC2 Overspeed

Cause	Corrective action
The speed of the LP turbocharger, B-side, at sensor B44.2 has exceeded limit value 2. The turbocharger speed is too high. Cause: Defect or malfunction of another turbocharger.	<ol style="list-style-type: none">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 152).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 152).3. Contact Service.

57 – LO P-Coolant

Cause	Corrective action
The coolant pressure at sensor B16.has undershot limit value 1. Coolant pressure is too low.	<ol style="list-style-type: none">1. Check relief bore of engine coolant pump (→ Page 159).2. Check engine coolant level (→ Page 152).3. Contact Service.

58 – SS P-Coolant

Cause	Corrective action
The coolant pressure at sensor B16.has undershot limit value 2. Coolant pressure is too low.	<ol style="list-style-type: none">1. Check relief bore of engine coolant pump (→ Page 159).2. Check engine coolant level (→ Page 152).3. Contact Service.

63 – HI P-Crankcase

Cause	Corrective action
The crankcase pressure at sensor B50.has exceeded limit value 1. Crankcase pressure is too high.	<ol style="list-style-type: none">1. Reduce power.2. Check air filter (plant side) for contamination.3. Replace oil mist fine separator (→ Page 101).4. Contact Service.

64 – SS P-Crankcase

Cause	Corrective action
The crankcase pressure at sensor B50.has exceeded limit value 2. Crankcase pressure is too high.	<ol style="list-style-type: none">1. Check air filter (plant side) for contamination.2. Replace oil mist fine separator (→ Page 101).3. Contact Service.

65 – LO P-Fuel

Cause	Corrective action
The fuel pressure at sensor B34.1 has undershot limit value 1. Fuel pressure is too low.	<ol style="list-style-type: none">1. Replace additional fuel filter (→ Page 123).2. Replace fuel filter (→ Page 122).3. Replace fuel prefilter (→ Page 209).4. Contact Service.

66 – SS P-Fuel

Cause	Corrective action
The fuel pressure at sensor B34.1 has undershot limit value 2. Fuel pressure is too low.	<ol style="list-style-type: none">1. Replace additional fuel filter (→ Page 123).2. Replace fuel filter (→ Page 122).3. Replace fuel prefilter (→ Page 209).4. Contact Service.

67 – HI T-Coolant

Cause	Corrective action
The coolant temperature at sensor B6 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 152).4. Contact Service.

68 – SS T-Coolant

Cause	Corrective action
The coolant temperature at sensor B6 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 152).3. Contact Service.

82 – HI P-Fuel (Common Rail)

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

83 – LO P-Fuel (Common Rail)

Cause	Corrective action
The HP fuel pressure at sensor B48 has undershot the limit value. Fuel pressure is too low.	► Contact Service.

89 – SS Engine Speed too Low

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

90 – SS Idle Speed Not Reached

Cause	Corrective action
Engine speed has not reached idling speed within the specified time after starter disengagement speed was reached.	<ol style="list-style-type: none">1. Check additional fuel filter, replace if necessary (→ Page 123).2. Check fuel filter, replace if necessary (→ Page 122).3. Check fuel prefilter, replace if necessary (→ Page 209).4. Check for additional messages.5. Contact Service.

91 – SS Release Speed Not Reached

Cause	Corrective action
Engine speed has not reached starter disengagement speed within the specified time after starter speed was reached.	► Contact Service.

92 – SS Starter Speed Not Reached

Cause	Corrective action
Engine speed has not reached the specified speed threshold within the specified time.	► Contact Service.

93 – SS T-Preheat

Cause	Corrective action
Engine coolant temperature has not reached the specified limit value 2. Preheating is not functioning. Start interlock	► Contact Service.

94 – LO T-Preheat

Cause	Corrective action
Engine coolant temperature has not reached the specified limit value 1. Preheating is not functioning.	► Contact Service.

118 – LO ECU Power Supply Voltage

Cause	Corrective action
The supply voltage of the ECU has undershot the specified limit value 1.	<ol style="list-style-type: none">1. Check state of charge of batteries (plant side).2. Check plug connectors for engine governor (→ Page 190).3. Check battery-charging generator (→ Page 172).4. Contact Service.

119 – LOLO ECU Power Supply Voltage

Cause	Corrective action
The supply voltage of the ECU has undershot the specified limit value 2.	<ol style="list-style-type: none">1. Check state of charge of batteries (plant side).2. Check plug connectors for engine governor (→ Page 190).3. Check battery-charging generator (→ Page 172).4. 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 state of charge of batteries (plant side).2. Check plug connectors for engine governor (→ Page 190).3. Check battery-charging generator (→ Page 172).4. 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 state of charge of batteries (plant side).2. Check plug connectors for engine governor (→ Page 190).3. Check battery-charging generator (→ Page 172).4. Contact Service.

186 – AL CAN1 Bus Off

Cause	Corrective action
CAN bus 1 for MTU automation (e.g. ECU/MAU/SAM) disrupted or defective.	<ol style="list-style-type: none">1. Check plug connectors for engine governor (→ Page 190).2. Contact Service.

187 – AL CAN1 Error Passive

Cause	Corrective action
CAN bus 1 for MTU automation (e.g. ECU/MAU/SAM) disrupted or defective.	<ol style="list-style-type: none">1. Check plug connectors for engine governor (→ Page 190).2. Contact Service.

188 – AL CAN2 Bus Off

Cause	Corrective action
CAN bus 2 for plant-side automation (e.g. Murphy display) disrupted or defective.	<ol style="list-style-type: none">1. Check connection between plant-side automation and MTU automation.2. Contact Service.

189 – AL CAN2 Error Passive

Cause	Corrective action
CAN bus 2 for plant-side automation (e.g. Murphy display) disrupted or defective.	<ol style="list-style-type: none">1. Check connection between plant-side automation and MTU automation.2. Contact Service.

201 – SD T-Coolant

Cause	Corrective action
The coolant temperature sensor (B6) at the coolant distribution housing supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

202 – SD T-Fuel

Cause	Corrective action
The fuel pressure sensor (B33) at the high-pressure distributor supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

203 – SD T-Charge Air

Cause	Corrective action
The charge-air temperature sensor (B9), A-side, supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

205 – SD T-Coolant Intercooler

Cause	Corrective action
The charge-air coolant temperature sensor (B26) after engine inlet supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

206 – SD T-Exhaust A

Cause	Corrective action
The exhaust gas temperature sensor (B4.21) in the exhaust line, A-side, supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

208 – SD P-Charge Air

Cause	Corrective action
The charge-air pressure sensor (B10.1) after intercooler, A-side, supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

211 – SD P-Lube Oil

Cause	Corrective action
The lube oil pressure sensor after filter (B5) supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

212 – SD P-Coolant

Cause	Corrective action
The coolant pressure sensor after coolant pump (B16) supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

213 – SD P-Coolant Intercooler

Cause	Corrective action
The coolant pressure sensor (B43) supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

214 – SD P-Crankcase

Cause	Corrective action
The crankcase pressure sensor (B50) supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

215 – SD P-HD

Cause	Corrective action
The rail pressure sensor (B48) supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

216 – SD T-Lube Oil

Cause	Corrective action
The lube oil temperature sensor (B7) supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

220 – SD Level Coolant Water

Cause	Corrective action
The coolant level sensor (F33) supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).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 185). 2. Contact Service.

222 – SD Level Leakage Fue

Cause	Corrective action
The fuel leak sensor (F46) supplies incorrect signal or no signal.	1. Check engine wiring (→ Page 185). 2. Contact Service.

227 – SD P- Lube Oil before Filter

Cause	Corrective action
The oil pressure sensor before filter (B5.3) supplies incorrect signal or no signal.	1. Check engine wiring (→ Page 185). 2. Contact Service.

228 – SD P-Fuel before Filter

Cause	Corrective action
The fuel pressure sensor before main fuel filter (B34.2) supplies incorrect signal or no signal.	1. Check engine wiring (→ Page 185). 2. Contact Service.

229 – AL Stop Camshaft Sensor Defect

Cause	Corrective action
Engine emergency stop after failure of crankshaft sensor and camshaft sensor.	▶ Contact Service.

230 – SD Crankshaft Speed

Cause	Corrective action
The crankshaft speed sensor (B13) supplies incorrect signal or no signal.	1. Check engine wiring (→ Page 185). 2. Contact Service.

231 – SD Camshaft Speed

Cause	Corrective action
The camshaft speed sensor (B1) supplies incorrect signal or no signal.	1. Check engine wiring (→ Page 185). 2. Contact Service.

232 – SD Charger 1 Speed

Cause	Corrective action
The speed sensor (B44.1), ETC A-side, supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

233 – SD Charger 2 Speed

Cause	Corrective action
The speed sensor (B44.2), ETC B-side, supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

239 – SD P-Diff Fuel

Cause	Corrective action
The pressure sensors B34.1 and/or B34.2 supply incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

240 – SD P-Fuel

Cause	Corrective action
The fuel pressure sensor after main fuel filter (B34.1) supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

266 – SD Speed Demand

Cause	Corrective action
Signal of analog speed setting missing.	<ol style="list-style-type: none">1. Switch on plant-side automation.2. Contact Service.

321 – AL Wiring Cylinder A1

Cause	Corrective action
Short circuit fault in injector wiring cylinder A1 or injector faulty.	<ol style="list-style-type: none">1. Check wiring of relevant injector (→ Page 185).2. Replace injector (→ Page 114).3. Contact Service.

322 – AL Wiring Cylinder A2

Cause	Corrective action
Short circuit fault in injector wiring cylinder A2 or injector faulty.	<ol style="list-style-type: none">1. Check wiring of relevant injector (→ Page 185).2. Replace injector (→ Page 114).3. Contact Service.

323 – AL Wiring Cylinder A3

Cause	Corrective action
Short circuit fault in injector wiring cylinder A3 or injector faulty.	<ol style="list-style-type: none">1. Check wiring of relevant injector (→ Page 185).2. Replace injector (→ Page 114).3. Contact Service.

324 – AL Wiring Cylinder A4

Cause	Corrective action
Short circuit fault in injector wiring cylinder A4 or injector faulty.	<ol style="list-style-type: none">1. Check wiring of relevant injector (→ Page 185).2. Replace injector (→ Page 114).3. Contact Service.

325 – AL Wiring Cylinder A5

Cause	Corrective action
Short circuit fault in injector wiring cylinder A5 or injector faulty.	<ol style="list-style-type: none">1. Check wiring of relevant injector (→ Page 185).2. Replace injector (→ Page 114).3. Contact Service.

326 – AL Wiring Cylinder A6

Cause	Corrective action
Short circuit fault in injector wiring cylinder A6 or injector faulty.	<ol style="list-style-type: none">1. Check wiring of relevant injector (→ Page 185).2. Replace injector (→ Page 114).3. Contact Service.

327 – AL Wiring Cylinder A7

Cause	Corrective action
Short circuit fault in injector wiring cylinder A7 or injector faulty.	<ol style="list-style-type: none">1. Check wiring of relevant injector (→ Page 185).2. Replace injector (→ Page 114).3. Contact Service.

328 – AL Wiring Cylinder A8

Cause	Corrective action
Short circuit fault in injector wiring cylinder A8 or injector faulty.	<ol style="list-style-type: none">1. Check wiring of relevant injector (→ Page 185).2. Replace injector (→ Page 114).3. Contact Service.

331 – AL Wiring Cylinder B1

Cause	Corrective action
Short circuit fault in injector wiring cylinder B1 or injector faulty.	<ol style="list-style-type: none">1. Check wiring of relevant injector (→ Page 185).2. Replace injector (→ Page 114).3. Contact Service.

332 – AL Wiring Cylinder B2

Cause	Corrective action
Short circuit fault in injector wiring cylinder B2 or injector faulty.	<ol style="list-style-type: none">1. Check wiring of relevant injector (→ Page 185).2. Replace injector (→ Page 114).3. Contact Service.

333 – AL Wiring Cylinder B3

Cause	Corrective action
Short circuit fault in injector wiring cylinder B3 or injector faulty.	<ol style="list-style-type: none">1. Check wiring of relevant injector (→ Page 185).2. Replace injector (→ Page 114).3. Contact Service.

334 – AL Wiring Cylinder B4

Cause	Corrective action
Short circuit fault in injector wiring cylinder B4 or injector faulty.	<ol style="list-style-type: none">1. Check wiring of relevant injector (→ Page 185).2. Replace injector (→ Page 114).3. Contact Service.

335 – AL Wiring Cylinder B5

Cause	Corrective action
Short circuit fault in injector wiring cylinder B5 or injector faulty.	<ol style="list-style-type: none">1. Check wiring of relevant injector (→ Page 185).2. Replace injector (→ Page 114).3. Contact Service.

336 – AL Wiring Cylinder B6

Cause	Corrective action
Short circuit fault in injector wiring cylinder B6 or injector faulty.	<ol style="list-style-type: none">1. Check wiring of relevant injector (→ Page 185).2. Replace injector (→ Page 114).3. Contact Service.

337 – AL Wiring Cylinder B7

Cause	Corrective action
Short circuit fault in injector wiring cylinder B7 or injector faulty.	<ol style="list-style-type: none">1. Check wiring of relevant injector (→ Page 185).2. Replace injector (→ Page 114).3. Contact Service.

338 – AL Wiring Cylinder B8

Cause	Corrective action
Short circuit fault in injector wiring cylinder B8 or injector faulty.	<ol style="list-style-type: none">1. Check wiring of relevant injector (→ Page 185).2. Replace injector (→ Page 114).3. Contact Service.

341 – AL Open Load Cylinder A1

Cause	Corrective action
Disruption fault in injector wiring to cylinder A1.	1. Check wiring of relevant injector (→ Page 185). 2. Contact Service.

342 – AL Open Load Cylinder A2

Cause	Corrective action
Disruption fault in injector wiring cylinder A2.	1. Check wiring of relevant injector (→ Page 185). 2. Contact Service.

343 – AL Open Load Cylinder A3

Cause	Corrective action
Disruption fault in injector wiring cylinder A3.	1. Check wiring of relevant injector (→ Page 185). 2. Contact Service.

344 – AL Open Load Cylinder A4

Cause	Corrective action
Disruption fault in injector wiring cylinder A4.	1. Check wiring of relevant injector (→ Page 185). 2. Contact Service.

345 – AL Open Load Cylinder A5

Cause	Corrective action
Disruption fault in injector wiring cylinder A5.	1. Check wiring of relevant injector (→ Page 185). 2. Contact Service.

346 – AL Open Load Cylinder A6

Cause	Corrective action
Disruption fault in injector wiring cylinder A6.	1. Check wiring of relevant injector (→ Page 185). 2. Contact Service.

347 – AL Open Load Cylinder A7

Cause	Corrective action
Disruption fault in injector wiring cylinder A7.	1. Check wiring of relevant injector (→ Page 185). 2. Contact Service.

348 – AL Open Load Cylinder A8

Cause	Corrective action
Disruption fault in injector wiring cylinder A8.	1. Check wiring of relevant injector (→ Page 185). 2. Contact Service.

351 – AL Open Load Cylinder B1

Cause	Corrective action
Disruption fault in injector wiring cylinder B1.	1. Check wiring of relevant injector (→ Page 185). 2. Contact Service.

352 – AL Open Load Cylinder B2

Cause	Corrective action
Disruption fault in injector wiring cylinder B2.	1. Check wiring of relevant injector (→ Page 185). 2. Contact Service.

353 – AL Open Load Cylinder B3

Cause	Corrective action
Disruption fault in injector wiring cylinder B3.	1. Check wiring of relevant injector (→ Page 185). 2. Contact Service.

354 – AL Open Load Cylinder B4

Cause	Corrective action
Disruption fault in injector wiring cylinder B4.	1. Check wiring of relevant injector (→ Page 185). 2. Contact Service.

355 – AL Open Load Cylinder B5

Cause	Corrective action
Disruption fault in injector wiring cylinder B5.	1. Check wiring of relevant injector (→ Page 185). 2. Contact Service.

356 – AL Open Load Cylinder B6

Cause	Corrective action
Disruption fault in injector wiring cylinder B6.	1. Check wiring of relevant injector (→ Page 185). 2. Contact Service.

357 – AL Open Load Cylinder B7

Cause	Corrective action
Disruption fault in injector wiring cylinder B7.	1. Check wiring of relevant injector (→ Page 185). 2. Contact Service.

358 – AL Open Load Cylinder B8

Cause	Corrective action
Disruption fault in injector wiring cylinder B8.	1. Check wiring of relevant injector (→ Page 185). 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.	<ol style="list-style-type: none">1. Check wiring (→ Page 185).2. Restart engine.3. Contact Service.

415 – LO P-Coolant Intercooler

Cause	Corrective action
The charge-air coolant pressure in the intercooler at sensor B43 has undershot limit value 1. The charge-air coolant pressure is too low.	<ol style="list-style-type: none">1. Check relief bore of charge-air coolant pump (→ Page 170).2. Check intercooler for coolant discharge (→ Page 124).3. Contact Service.

416 – SS P-Coolant Intercooler

Cause	Corrective action
The charge-air coolant pressure in the intercooler at sensor B43 has undershot limit value 2. The charge-air coolant pressure is too low.	<ol style="list-style-type: none">1. Check relief bore of charge-air coolant pump (→ Page 170).2. Check intercooler for coolant discharge (→ Page 124).3. Contact Service.

440 – AL L1 P-Aux1

Cause	Corrective action
The pressure measurement sensor in the pressure measurement channel has undershot limit value 1. The pressure value in the pressure measurement channel is too low.	▶ Contact Service.

442 – AL- L2 P-Aux1

Cause	Corrective action
The pressure measurement sensor in the pressure measurement channel has undershot limit value 2. The pressure value in the pressure measurement channel is too low.	▶ Contact Service.

454 – SS Power Reduction Active

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

480 – AL Ext. Engine Protection

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

488 – HI ETC3 Overspeed

Cause	Corrective action
The speed of the HP turbocharger at sensor B44.3 has exceeded limit value 1. The turbocharger speed is too high. Cause: Defect or malfunction of another turbocharger.	<ol style="list-style-type: none">1. Reduce power.2. Contact Service.

489 – SS ETC3 Overspeed

Cause	Corrective action
The speed of the HP turbocharger at sensor B44.3 has exceeded limit value 1. The turbocharger speed is too high. Cause: Defect or malfunction of another turbocharger.	<ol style="list-style-type: none">1. Reduce power.2. Contact Service.

536 – AL Wiring PWM_CM1

Cause	Corrective action
The M8 HP fuel control block of the HP fuel pump can not be activated.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

549 – AL Power Cut-Off detected

Cause	Corrective action
ECU operating voltage was switched off while the engine was running. Only disconnect the voltage supply when the engine is stationary.	<ol style="list-style-type: none">1. If the voltage supply was not disconnected manually, check engine wiring (→ Page 185).2. Contact Service.

582 – AL Emergency Stop Failed

Cause	Corrective action
The emergency stop failure alarm is raised if the engine fails to come to a standstill during a programmable time after the emergency stop signal is received.	► Contact Service.

609 – AL Wiring PWM_CM7

Cause	Corrective action
Cable break or short circuit at voltage supply of the TRICAN (B90) or the NOx sensor (B88).	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

614 – AL L1 P-Fuel Add.sec.fuelfilt. Diff

Cause	Corrective action
The differential pressure above the intermediate fuel filter at sensors B34.2 and B34.3 has exceeded limit value 1. The differential pressure is too high.	<ol style="list-style-type: none">1. Replace additional fuel filter (→ Page 123).2. Replace fuel filter (→ Page 122).3. Replace fuel prefilter (→ Page 209).4. Contact Service.

615 – AL EIL Protection

Cause	Corrective action
Engine number in EIL does not match the engine number saved in the ECU	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

616 – AL EIL Error

Cause	Corrective action
ECU can not detect EIL.	▶ Contact Service.

625 – SD P-Fuel bef. Add.sec.fuelfilter

Cause	Corrective action
The fuel pressure sensor (B34.3) before the additional filter supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

626 – AL Wiring PWM_CM8

Cause	Corrective action
Disruption or short circuit in wiring to servomotor of HP turbine bypass flap M52.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

627 – AL Wiring PWM_CM9

Cause	Corrective action
Disruption or short circuit in wiring to servomotor of dispenser flap M55.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

628 – AL Wiring PWM_CM10

Cause	Corrective action
Disruption or short circuit in wiring to servomotor of EGR shutoff flap M53.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

629 – AL EGR Throttle A Defect

Cause	Corrective action
The EGR shutoff flap (M53) is faulty.	<ol style="list-style-type: none">1. Check operation of EGR shutoff flap (→ Page 128), (→ Page 187).2. Contact Service.

631 – AL Bypass Throttle Defect

Cause	Corrective action
The bypass flap (M52) is faulty.	<ol style="list-style-type: none">1. Check operation of bypass flap (→ Page 128), (→ Page 187).2. Contact Service.

632 – AL Dispenser Throttle Defect

Cause	Corrective action
The dispenser flap (M55) is faulty.	<ol style="list-style-type: none">1. Check operation of dispenser flap (→ Page 128), (→ Page 187).2. Contact Service.

633 – SD P-Ambient Air (HDT2800)

Cause	Corrective action
The air pressure sensor (B90) supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

634 – SD T0-Ambient Air (HDT2800)

Cause	Corrective action
The temperature sensor (B90) supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

635 – SD Air Humidity (HDT2800)

Cause	Corrective action
The humidity sensor (B90) supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

647 – SD P-Exhaust Lambda

Cause	Corrective action
The exhaust gas sensor (B91.3) supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

648 – SD P-Charge Air B

Cause	Corrective action
The charge-air pressure sensor (B10.11) after intercooler, B-side, supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

727 – AL L1 Delta T-NT Intercooler

Cause	Corrective action
The differential temperature at sensors B26 and B90 has exceeded the limit value. The LT coolant inlet temperature is too high in relation to the ambient air temperature.	<ol style="list-style-type: none">1. Check cooler (plant side) for contamination.2. Check operation of fan (plant side).3. Contact Service.

728 – AL L2 Delta T-NT Intercooler

Cause	Corrective action
The differential temperature at sensors B26 and B90 has exceeded the limit value. The LT coolant inlet temperature is too high in relation to the ambient air temperature.	<ol style="list-style-type: none">1. Check cooler (plant side) for contamination.2. Check operation of fan (plant side).3. Contact Service.

745 – AL Emission Fault 1

Cause	Corrective action
Emission fault summary alarm	<ol style="list-style-type: none">1. Check for additional messages.2. Contact Service.

754 – SD Bosch LSU Lambda Sensor

Cause	Corrective action
The lambda sensor (B89) supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check lambda sensor and replace if necessary (→ Page 193).2. Contact Service.

806 – SD Charger 3 Speed

Cause	Corrective action
The speed sensor (B44.3) HP turbocharger supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

833 – AL Emission Warning

Cause	Corrective action
Emission fault summary alarm	<ol style="list-style-type: none">1. Check for additional messages.2. Contact Service.

834 – AL Gas Path Warning

Cause	Corrective action
Emission fault summary alarm	<ol style="list-style-type: none">1. Check for additional messages.2. Contact Service.

835 – AL Gas Path Fault

Cause	Corrective action
Emission fault summary alarm	<ol style="list-style-type: none">1. Check for additional messages.2. Contact Service.

857 – AL NO_x ATO1 Sensor Defect

Cause	Corrective action
The NO _x sensor (B88) in the exhaust line after LP turbocharger, B-side, supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Check NO_x sensor and replace if necessary (→ Page 191).3. Contact Service.

871 – AL NO_x ATO1 Communication Lost

Cause	Corrective action
The ECU can no longer detect the NO _x sensor (B88) after LP turbocharger, B-side, on the bus.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Check NO_x sensor and replace if necessary (→ Page 191).3. Contact Service.

872 – AL EGR FlpA Wear Limit3

Cause	Corrective action
Fast reference run of EGR shutoff flap (M53) faulty (executed after every ECU restart).	<ol style="list-style-type: none">1. Check state of charge of batteries (plant side).2. Check operation of EGR shutoff flap (→ Page 128), (→ Page 187).3. Contact Service.

877 – AL Bypass FlpA Wear Limit3

Cause	Corrective action
Fast reference run of bypass flap (M52) faulty (executed after every ECU restart).	<ol style="list-style-type: none">1. Check state of charge of batteries (plant side).2. Check operation of bypass flap (→ Page 128), (→ Page 187).3. Contact Service.

879 – AL Dispenser Flp Wear Limit3

Cause	Corrective action
Fast reference run of dispenser flap (M55) faulty (executed after every ECU restart).	<ol style="list-style-type: none">1. Check state of charge of batteries (plant side).2. Check operation of dispenser flap (→ Page 128), (→ Page 187).3. Contact Service.

953 – AL Lambda value invalid

Cause	Corrective action
Status information of lambda sensor (B89); is generated in case of short-term implausible measured values or with faulty lambda sensor.	<ol style="list-style-type: none">1. Acknowledge alarm.2. Replace lambda sensor (→ Page 193).3. Contact Service.

954 – AL NOx value invalid

Cause	Corrective action
Status information of NOx sensor (B88); is generated in case of short-term implausible measured values or with faulty NOx sensor.	<ol style="list-style-type: none">1. Acknowledge alarm.2. Replace NOx sensor (→ Page 191).3. Contact Service.

956 – AL p5 ctrlvar limit min active

Cause	Corrective action
The charge-air pressure regulator attempts to adjust its set value but has reached its lower limit. The bypass flap (M52) is fully open.	<ol style="list-style-type: none">1. Check operation of bypass flap (→ Page 128), (→ Page 187).2. Contact Service.

957 – AL p5 ctrlvar max BOI min active

Cause	Corrective action
Emission-related alarm. The charge-air pressure regulator attempts to adjust its set value but has reached its upper limit. The bypass flap (M52) is fully closed. The retardation of the start of injection (BOI) has reached its maximum value.	<ol style="list-style-type: none">1. Check air filter (plant side) for contamination.2. Check operation of bypass flap (→ Page 128), (→ Page 187).3. Contact Service.

958 – AL Lambda ctrlvar limit min active

Cause	Corrective action
The lambda regulator attempts to adjust its set value but has reached its lower limit. The EGR shutoff flap (M53) is fully closed. The dispenser flap (M55) is fully open.	<ol style="list-style-type: none">1. Check operation of dispenser flap (→ Page 128), (→ Page 187).2. Contact Service.

959 – AL Lambda ctrlvar max BOI min act

Cause	Corrective action
<p>Emission-related alarm. This fault is a strong indication of serious soot contamination in the EGR cooler (sooting). However, it can also be caused by a mechanical defect in the exhaust flap before the cooler and/or the dispenser flap (broken linkage, but servomotor electrically OK). A signal error of the lambda sensor can also result in this alarm.</p>	<ol style="list-style-type: none">1. Check operation of EGR shutoff flap and dispenser flap (→ Page 128), (→ Page 187).2. Contact Service.

960 – AL NOx p5 min BOI max active

Cause	Corrective action
<p>Emission-related alarm. The charge-air pressure has reached the minimum value defined in the performance map. The advanced start of injection has reached its maximum value.</p>	<ol style="list-style-type: none">1. Check operation of bypass flap (→ Page 128), (→ Page 187).2. Contact Service.

961 – AL NOx p5 max BOI min active

Cause	Corrective action
<p>Emission-related alarm. This fault is a strong indication of serious soot contamination in the EGR cooler (sooting). The charge-air pressure has reached the maximum value defined in the performance map. The retardation of the start of injection (BOI) has reached its maximum value.</p>	<p>► Contact Service.</p>

962 – AL GPS Lambda ctrlvar max active

Cause	Corrective action
<p>This fault is a strong indication of serious soot contamination in the EGR cooler (sooting). The lambda regulator attempts to adjust its set value but has reached its upper limit. The EGR shutoff flap (M53) is fully opened. The dispenser flap (M55) is fully closed.</p>	<ol style="list-style-type: none">1. Check operation of EGR shutoff flap, dispenser flap and bypass flap (→ Page 128), (→ Page 187).2. Check EGR cooler for coolant leaks.3. Contact Service.

963 – AL GPS p5 ctrlvar max active

Cause	Corrective action
The required charge-air pressure could not be reached.	<ol style="list-style-type: none">1. Check air filter (plant side) for contamination.2. Check operation of bypass flap (→ Page 128), (→ Page 187).3. Contact Service.

964 – AL GPS p5 ctrlvar min active

Cause	Corrective action
The required charge-air pressure could not be reached.	<ol style="list-style-type: none">1. Check operation of bypass flap (→ Page 128), (→ Page 187).2. Contact Service.

970 – SD P-Exhaust

Cause	Corrective action
The exhaust gas sensor (B91.3) supplies incorrect signal or no signal.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

974 – AL CAN3 Bus Off

Cause	Corrective action
The first engine CAN (CAN 3) for engine-side sensor / actuator system is disrupted or faulty.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

975 – AL CAN3 Error Passive

Cause	Corrective action
The first engine CAN (CAN 3) for engine-side sensor / actuator system is faulty.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

976 – AL CAN4 Bus Off

Cause	Corrective action
The second engine CAN (CAN 4) for engine-side sensor / actuator system is disrupted or faulty.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

977 – AL CAN4 Error Passive

Cause	Corrective action
The second engine CAN (CAN 4) for engine-side sensor / actuator system is faulty.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

983 – AL Stop on Trigger Crashrecorder

Cause	Corrective action
The alarm indicates that the crash recorder has been triggered and, as a result, a start interlock has been activated.	► Contact Service.

1097 – AL Flap Egr A Communication Lost

Cause	Corrective action
The ECU can no longer detect the EGR shutoff flap (M53) on the bus.	1. Check engine wiring (→ Page 185). 2. Contact Service.

1098 – AL Flap Egr A Temperature too high

Cause	Corrective action
The internal electronics of the servomotor of the EGR shutoff flap (M53) signals that temperature is too high.	► Contact Service.

1099 – AL Flap Egr A Targetposition

Cause	Corrective action
The servomotor of the EGR shutoff flap (M53) has not reached the target position within the specified time.	► Contact Service.

1103 – AL Flap BypassA Communication Lost

Cause	Corrective action
The ECU can no longer detect the bypass flap (M52) on the bus.	1. Check engine wiring (→ Page 185). 2. Contact Service.

1104 – AL Flap BypassA Temperature too high

Cause	Corrective action
The internal electronics of the servomotor of the bypass flap (M52) signals that temperature is too high.	► Contact Service.

1105 – AL Flap Bypass A Targetposition

Cause	Corrective action
The servomotor of the bypass flap (M52) has not reached the target position within the specified time.	► Contact Service.

1109 – AL Flap Dispens Communication Lost

Cause	Corrective action
The ECU can no longer detect the dispenser flap (M55) on the bus.	<ol style="list-style-type: none">1. Check engine wiring (→ Page 185).2. Contact Service.

1110 – AL Flap DispensTemperature too high

Cause	Corrective action
The internal electronics of the servomotor of the dispenser flap (M55) signals that temperature is too high.	▶ Contact Service.

1111 – AL Flap Dispenser Targetposition

Cause	Corrective action
The servomotor of the dispenser flap (M55) has not reached the target position within the specified time.	▶ Contact Service.

1115 – AL Difference P0 P1 Intake Air L1

Cause	Corrective action
The differential pressure at sensor B90 and the ambient air pressure sensor integrated in the ECU have exceeded limit value 1. The intake air differential pressure is too high.	<ol style="list-style-type: none">1. Check air filter (plant side) for contamination.2. Contact Service.

1116 – AL Difference P0 P1 Intake Air L2

Cause	Corrective action
The differential pressure at sensor B90 and the ambient air pressure sensor integrated in the ECU have exceeded limit value 2. The intake air differential pressure is too high.	<ol style="list-style-type: none">1. Check air filter (plant side) for contamination.2. Contact Service.

1120 – AL Flap Egr A Calibration Drive Err

Cause	Corrective action
The ECU has detected a calibration run error in the EGR shutoff flap (M53). Cause: The learned rotation range (angle) during the calibration run was not plausible. The learned angle is not between a minimum and maximum permissible limit.	▶ Contact Service.

1122 – AL Flap BypassA Calibr. Drive Err

Cause	Corrective action
The ECU has detected a calibration run error in the bypass flap (M52). Cause: The learned rotation range (angle) during the calibration run was not plausible. The learned angle is not between a minimum and maximum permissible limit.	► Contact Service.

1124 – AL Flap Dispenser Calibr Drive Err

Cause	Corrective action
The ECU has detected a calibration run error in the dispenser flap (M55). Cause: The learned rotation range (angle) during the calibration run was not plausible. The learned angle is not between a minimum and maximum permissible limit.	► Contact Service.

1167 – AL Inplausible NOx High Limit1

Cause	Corrective action
NOx emissions too high. The NOx emissions from the engine have exceeded limit value 1 cumulatively.	► Contact Service.

1172 – AL Inplausible NOx High Limit2

Cause	Corrective action
NOx emissions too high. The NOx emissions from the engine have exceeded limit value 2 cumulatively.	► Contact Service.

1186 – AL EGR FlpA Wear Limit2

Cause	Corrective action
Fast reference run of EGR shutoff flap (M53) faulty (executed after every ECU restart). Limit value 2.	1. Check state of charge of batteries (plant side). 2. Check operation of EGR shutoff flap (→ Page 128), (→ Page 187). 3. Contact Service.

1188 – AL Bypass FlpA Wear Limit2

Cause	Corrective action
Fast reference run of bypass flap (M52) faulty (executed after every ECU restart). Limit value 2.	1. Check state of charge of batteries (plant side). 2. Check operation of bypass flap (→ Page 128), (→ Page 187). 3. Contact Service.

1190 – AL Dispenser Flp Wear Limit2

Cause	Corrective action
Fast reference run of EGR dispenser flap (M55) faulty (executed after every ECU restart). Limit value 2.	<ol style="list-style-type: none">1. Check state of charge of batteries (plant side).2. Check operation of dispenser flap (→ Page 128), (→ Page 187).3. Contact Service.

8 Task Description

8.1 Engine

8.1.1 Engine - Barring manually

Preconditions

- Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Barring tool	F6787910	1
Ratchet with extension	F30006212	1

DANGER



Rotating and moving engine parts.

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

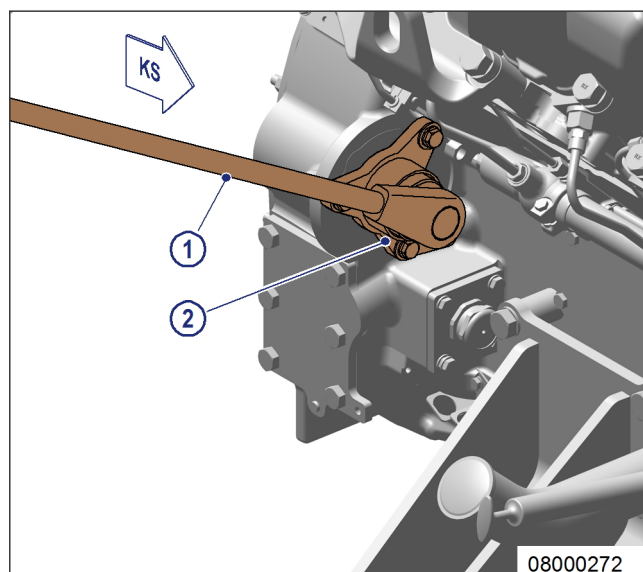
- Before cranking the engine with starter system, make sure that there are no persons in the engine's danger zone.

Barring engine manually (lateral installation)

1. Remove cover from flywheel housing.
2. Engage barring tool (2) in ring gear and install on flywheel housing.
 - Use barring tool F6787910.
3. Set ratchet (1) onto barring tool (2).
4. Rotate crankshaft in engine direction of rotation. Apart from the normal compression resistance, there should be no resistance.

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

5. Remove barring tool in reverse order.



8.1.2 Engine – Barring with starting system

DANGER



Rotating and moving engine parts.

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

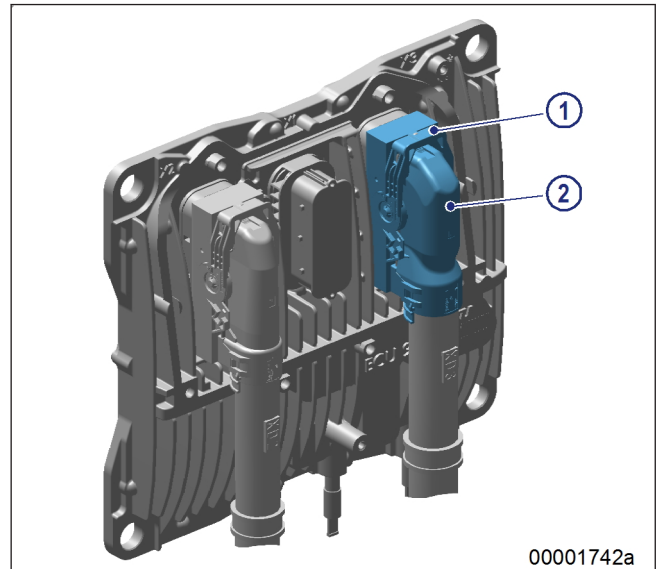
- Before barring the engine, make sure that there are no persons in the engine's danger zone.
- After finishing work on the engine, make sure that all safety devices are put back in place and all tools are removed from the engine.

Engine – Barring with starting system

1. Release latch (1) of connector X3 (2).

Note: Seal unused connectors with the supplied protective cap.

2. Remove connector from engine governor.
3. Turn engine in unloaded condition: Press START button.
4. Let the crankshaft rotate until oil pressure is indicated.
5. Engine start is interrupted automatically after the maximum permissible time.
6. Repeat this procedure after approximately 20 seconds if required.
7. Fit connector X3 (2) on engine governor and close latch (1).



8.1.3 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 55).
2. Perform test run not below 1/3 load and at least until steady-state temperature is reached.
3. Carry out operational checks (→ Page 53).
4. Stop engine (→ Page 56).

8.2 Auxiliary PTO

8.2.1 Auxiliary PTO - Replacement

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Grease(Kluthe Hakuform 30-15)	X00067260	1
Engine oil		
O-ring	(→ Spare Parts Catalog)	
Screw	(→ Spare Parts Catalog)	

NOTICE



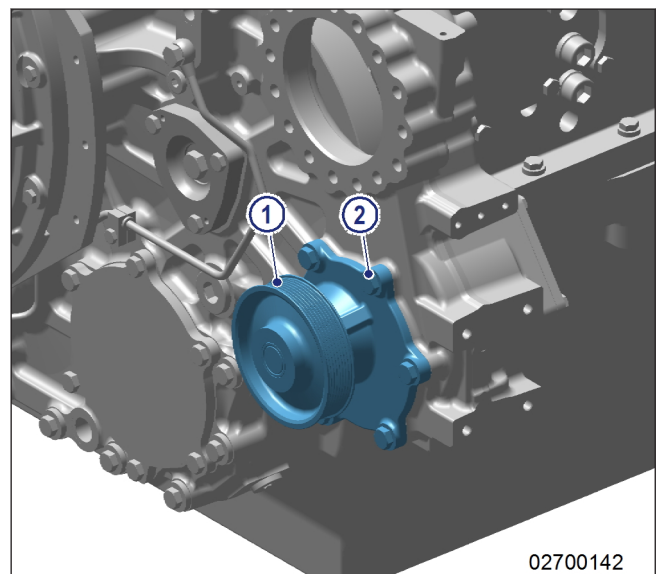
Contamination of components.

Damage to component!

- Observe manufacturer's instructions.
- Check components for special cleanliness.

Replacing auxiliary PTO for general purposes

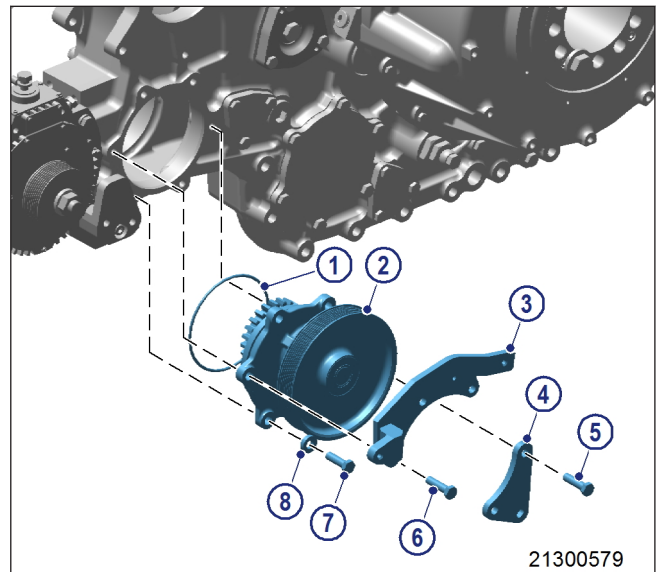
1. Remove auxiliary PTO (1) by loosening screws (2) on the gearcase.
2. Before installing the new PTO, thoroughly clean the contact surfaces and coat with grease.
3. Insert auxiliary PTO (1) with new O-ring in gearcase bore.
4. Insert screws (2) and tighten crosswise.



Auxiliary PTO for battery-charging generator – Replacement

1. Remove protective cover.
2. Remove generator drive (→ Page 173).

3. Remove screws (5, 6) and take off retainers (3, 4).
4. Remove screws (7) together with washers (8).
5. Remove auxiliary PTO (2) with O-ring (1).
6. Install new auxiliary PTO (2) with new O-ring (1).
7. Install screws (8) with washers (7).
8. Install retainers (3, 4) with screws (5, 6).
9. Tighten screws (5, 6, 8) crosswise.
10. Install drive belt (→ Page 173).
11. Install protective cover.



8.3 Cylinder Liner

8.3.1 Cylinder liner – Endoscopic examination

Preconditions

- Engine is stopped and starting disabled

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Barring device	F6555766	1
Ratchet with extension	F30006212	1
Endoscope	Y20097353	1

Preparatory steps

1. Remove cylinder head cover (→ Page 110).
2. Remove injector (→ Page 115).

Positioning crankshaft at BDC

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

Endoscopic examination of cylinder liner

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

1. Compile endoscopic report using the table.
2. Use technical terms to describe the liner surface (→ Page 99).
3. Depending on findings:
 - Do not take any action or
 - carry out a further endoscopic examination as part of maintenance work or
 - contact Service; cylinder liner must be replaced.

Final steps

1. Install injector (→ Page 115).
2. Install cylinder head cover (→ Page 110).

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

Terms used for endoscopic examination

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

Findings	Explanations/Action
Minor dirt scores	Minor dirt scores can occur during the assembly of a new engine (honing products, particles, broken-off burrs). Removed cylinders clearly show such scoring on the running surface under endoscope magnification. Cannot be felt with the fingernail. Findings not critical.
Single scores	Clearly visible scores caused by hard particles. They usually start in the TDC area and cross through the hone pattern in the direction of stroke. Findings not critical.
Scored area	These areas consist of scores of different length and depth next to one another. In most cases, they are found at the 6-o'clock and 12-o'clock positions (inlet/exhaust) along the transverse engine axis. Findings not critical.
Smoothened area	Smoothened areas are on the running surface but almost the whole honing pattern is still visible. Smoothened areas appear brighter and more brilliant than the surrounding running surface. Findings not critical.
Bright area	Bright areas are on the running surface and show local removal of the honing pattern. Grooves from honing process are not visible any more.
Discoloration	This is caused by oxidation (surface discoloration through oil or fuel) and temperature differences around the liner. It appears rather darker within the honed structure in contrast to the bright metallic running surface. The honing pattern is undisturbed. Discolorations extend in stroke direction and may be interrupted. Findings not critical.
Corrosion fields / spots	Corrosion fields / spots result from water (condensed water) with the valves in the overlap (open) position. They are clearly visible due to the dark color of the honing groove bottom. This corrosion is not critical unless there is corrosion pitting.
Black lines	Black lines are a step towards heat discoloration. They are visible as a clear discoloration from TDC to BDC in the running surface and the start of localized damage to the honing pattern. Cylinder liners with a large number of black lines around the running surface have limited service life and should be replaced.
Burn mark	This is caused by a malfunction in the liner / ring tribosystem. Usually they run over the whole ring-travel area (TDC/BDC), starting at the first TDC-ring and becoming more visible from the second TDC-ring 2 onwards and less pronounced from TDC-ring 1. The honing pattern is usually no longer visible and displays a clearly defined (straight) edge to the undisturbed surface. The damaged surface is usually discolored. The circumferential length varies. Liners with burn marks, or heat discoloration, starting in TDC-ring 1 have to be replaced.
Seizure marks, scuffing	Irregular circumference lengths and depths. Can be caused either by the piston skirt or the piston crown. Material deposits on the liner (smear), heavy discoloration. Severe, visible scoring. Replace liner.

Evaluation of findings and further measures

The findings in the start phase of oxidation discoloration and heat discoloration are similar. A thorough investigation and compliance with the above evaluation criteria allow an unambiguous evaluation. To avoid unnecessary disassembly work, it is recommended that another inspection be carried out after further operation of the engine.

8.4 Crankcase Breather

8.4.1 Oil mist fine 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
Engine oil		
Oil mist fine separator	(→ Spare Parts Catalog)	
Sealing ring	(→ Spare Parts Catalog)	
Locknut	(→ Spare Parts Catalog)	
Washer	(→ Spare Parts Catalog)	

WARNING



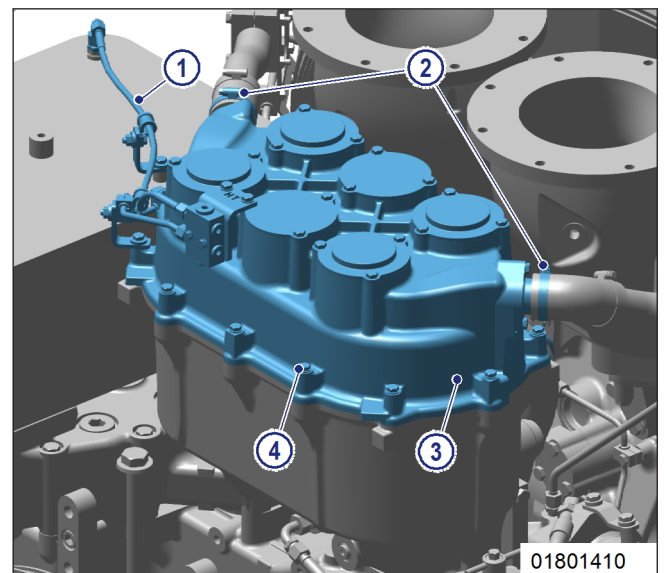
Hot oil.
Oil can contain combustion residues which are harmful to health.

Risk of injury and poisoning!

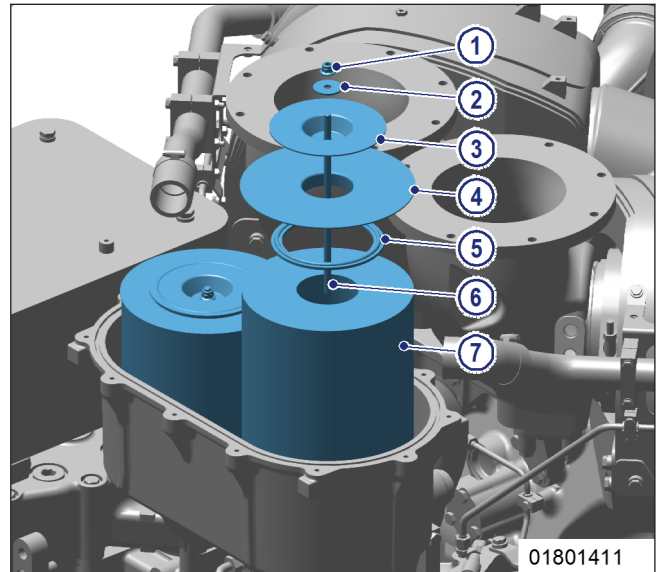
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

Oil mist fine separator - Replacement

1. Remove line (1) from oil heat exchanger.
2. Remove pipe clamps (2).
3. Remove screws with washers (4).
4. Remove diaphragm housing (3).



5. Unscrew locknut (1) and remove together with washer (2).
6. Remove filter cover (3), cover (4) and sealing ring (5).
7. Remove threaded rod (6).
8. Replace oil mist fine separator (7).
9. Replace sealing ring (5) if necessary.
10. Install sealing ring (5), cover (4) and filter cover (3).



11. Fit new locknut (1) and new washer (2) and tighten locknut (1) with torque wrench to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Locknut	M10	Tightening torque		10 Nm \pm 2 Nm

12. Replace further oil mist fine separators in the same way.

8.5 Valve Drive

8.5.1 Valve gear - Lubrication

Preconditions

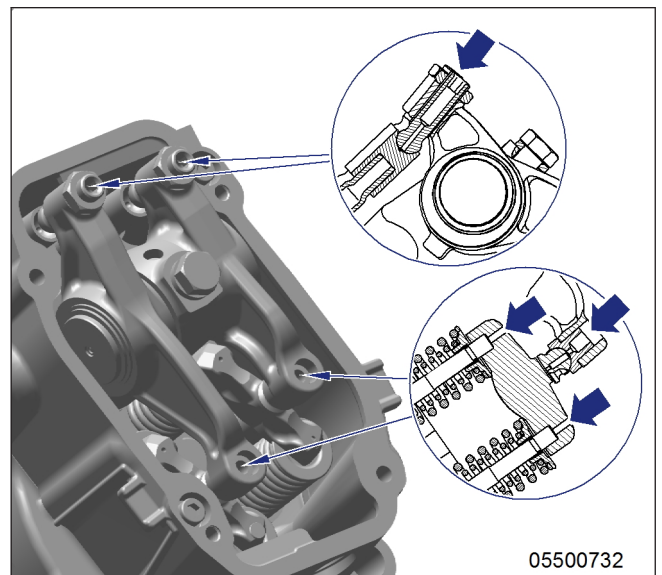
- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine oil		

Valve gear - Lubrication

1. Remove cylinder head upper section
(→ Page 110).
2. Fill oil chambers of valve bridges with oil.
3. Fill oil chambers of rocker arms and adjusting screws with oil.
4. Install cylinder head upper section
(→ Page 110).



8.5.2 Valve protrusion – Measurement

Preconditions

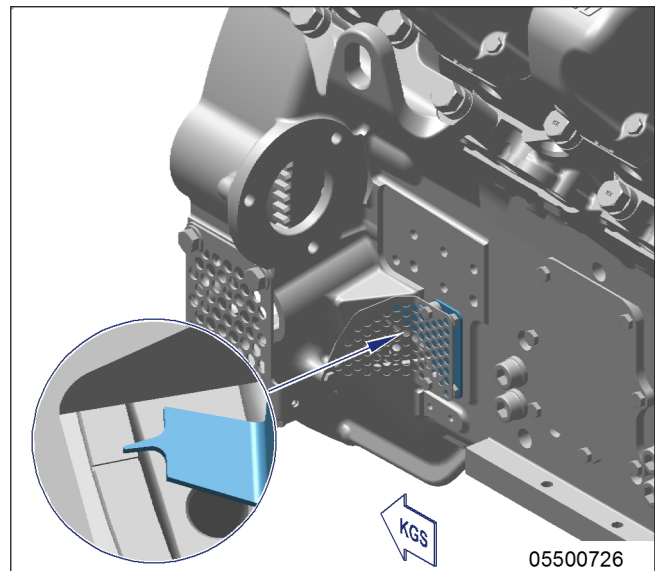
- Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Depth gauge, 200 mm	Y20000918	1

Preparatory steps

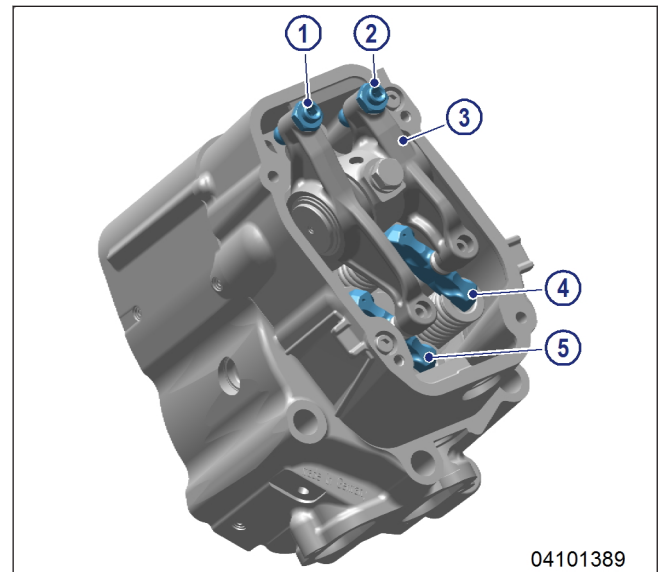
1. Remove cylinder-head cover upper section (→ Page 110).
2. Remove injector (→ Page 115).
3. Install barring device (→ Page 92).
4. Rotate crankshaft with barring device in engine direction of rotation until marking “OT” and pointer are aligned.



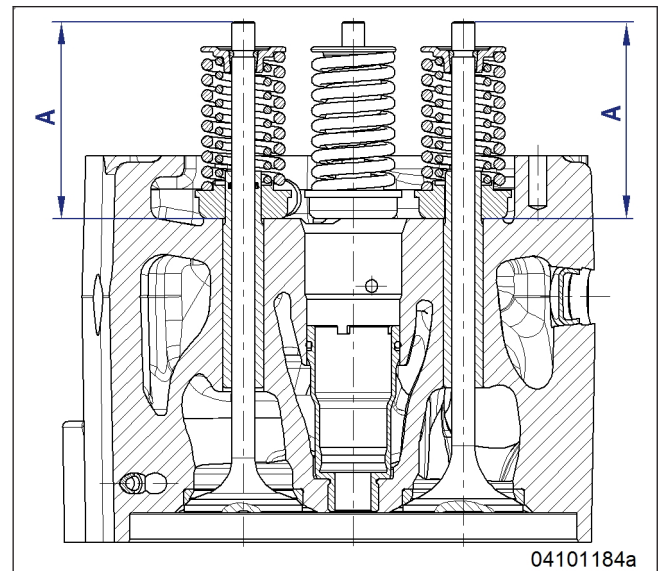
Valve protrusion – Measurement

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. Measure valve protrusion for each valve in two crankshaft positions (firing TDC and overlap TDC for cylinder A1) according to the diagram. Diagram (→ Page 106).

- Loosen adjusting screw (1, 2) and take off valve bridges (4, 5). Do not remove rocker arm (3).



- Measure distance between valve stem end and cylinder head top at the injector bore with depth gauge (see figure).
 - Specified value for a new cylinder head: 93.8 mm.
 - Admissible wear: 2 mm.
 - If the measured value is > 95.8 mm, have the relevant cylinder head replaced by specialist personnel ahead of schedule.
- Install valve bridge.
- Adjusting valve clearance (→ Page 106)



Final steps

- Remove barring device (→ Page 92).
- Install injector (→ Page 115).
- Install cylinder-head cover upper section (→ Page 110).

8.5.3 Valve clearance – Check and adjustment

Preconditions

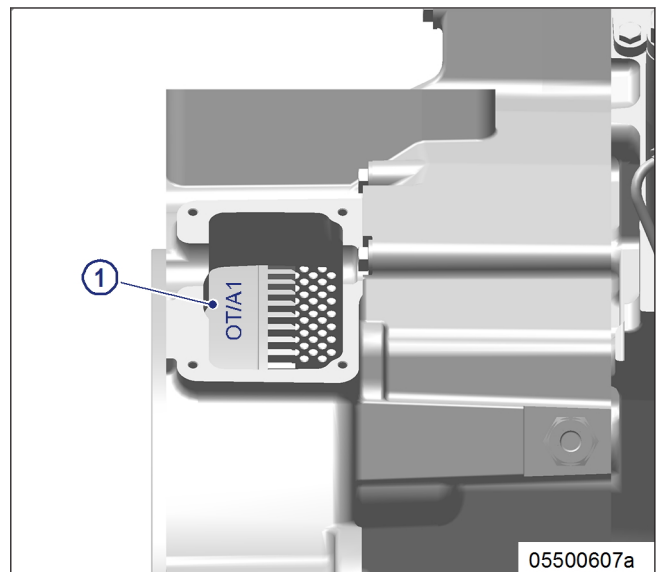
- Engine is stopped and starting disabled.
- Coolant temperature is max. 40 °C.
- Valves are closed.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Feeler gauge	Y20098771	1
Valve adjusting gauge	Y4349603	1
Allen key	F30002815	1
Torque wrench, 60–320 Nm	F30452768	1
Socket wrench, 24 mm	F30039526	1
Engine oil		

Preparatory steps

1. Remove cylinder head cover upper section (→ Page 110).
2. Install barring device (→ Page 92).
3. The "OT" marking (1) (if fitted) on the flywheel outer circumference must not be used for reference.



- Note: Pointer (1) in lower opening of flywheel housing (arrow).
- Use barring device to turn crankshaft in engine direction of rotation until marking OT-A1 on the rear side of the flywheel and pointer (1) are aligned.

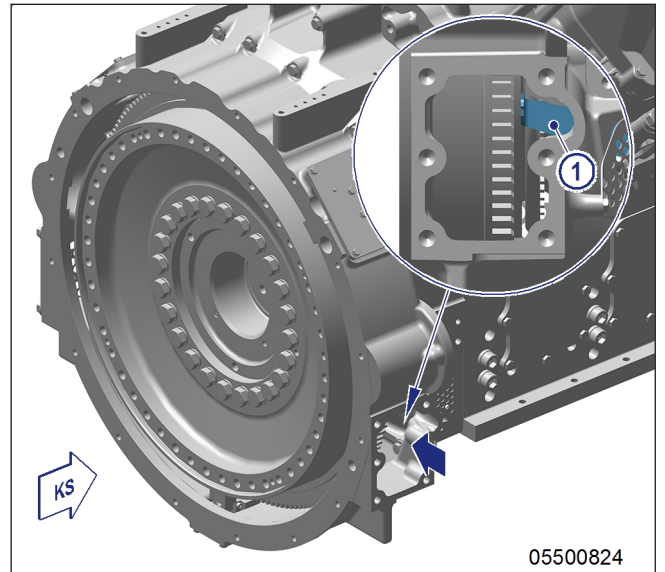


Diagram for 12V engines – Two crankshaft positions

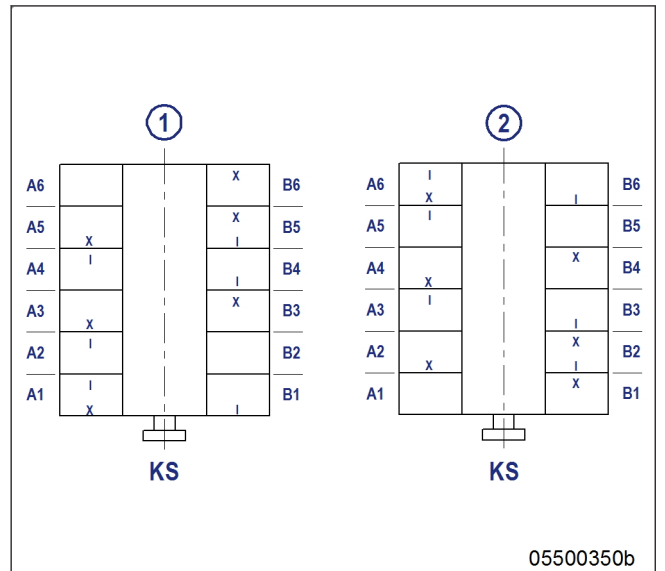


Diagram for 16V engines – Two crankshaft positions

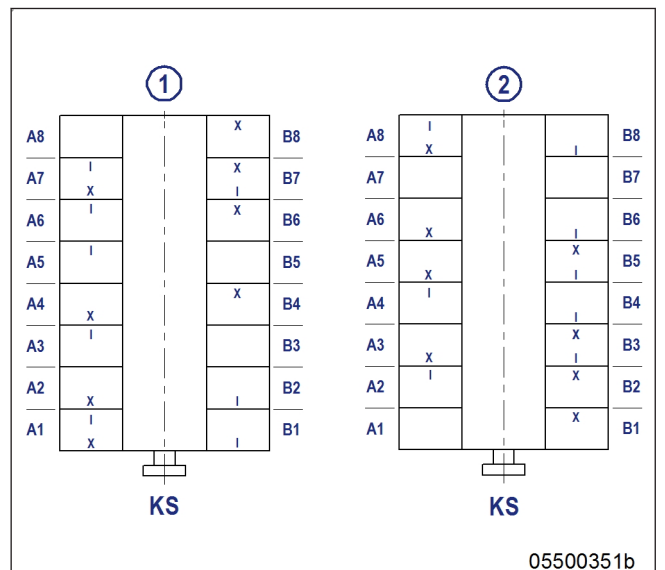
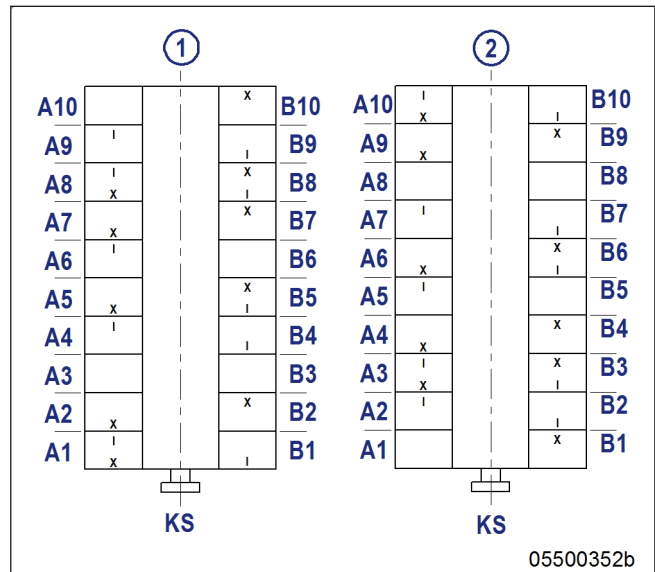


Diagram for 20V engines – Two crankshaft positions



Valve clearance at two crankshaft positions – Check

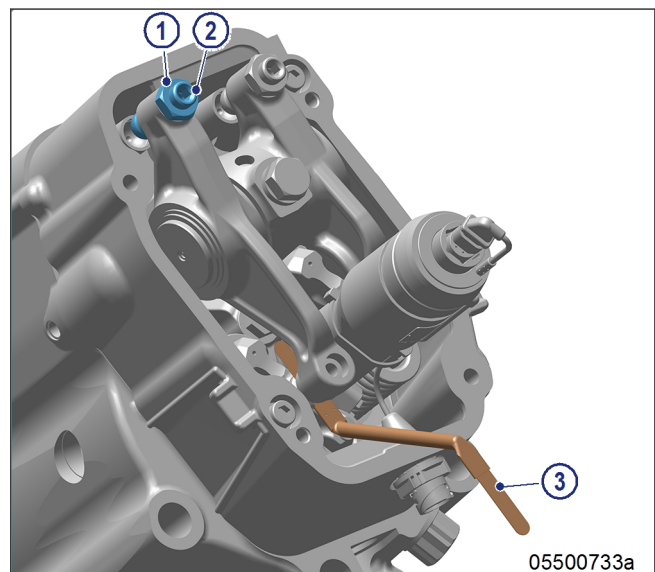
- Check TDC position of piston in cylinder A1:
 - If rocker arms on cylinder A1 are unloaded, the piston is in firing TDC.
 - If rocker arms on cylinder A1 are loaded, the piston is in overlap TDC.
- Check valve clearance with cold engine:
 - Inlet (long rocker arm) = 0.2 mm \pm 0.05 mm
 - Exhaust (short rocker arm) = 0.5 mm \pm 0.05 mm
- Check all valve clearances in two crankshaft positions (firing TDC and overlap TDC of cylinder A1) as per diagram.
 - Cylinder A1 is in firing TDC
 - Cylinder A1 is in overlap TDC
 - Inlet valve
 - Exhaust valve
- Use feeler gauge to determine distance between valve bridge and rocker arm.
- If the deviation from the specified value exceeds 0.1 mm, adjust valve clearance.

Valve clearance – Adjustment

- Release locknut (1).
- Insert valve adjusting gauge (3) between valve bridge and rocker arm.
- Use Allen key to set adjusting screw (2) so that the specified valve clearance is provided.

Note: Valve adjusting gauge must just pass through the gap.

- Insert valve adjusting gauge (3) between valve bridge and rocker arm.



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

Name	Size	Type	Lubricant	Value/Standard
Locknut	M16x1.5	Tightening torque	(Engine oil)	90 Nm +9 Nm <u>hand tightening</u>
Locknut	M16x1.5	Tightening torque	(Engine oil)	95 Nm ±9 Nm <u>machine tightening</u>

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

Final steps

- Remove barring device (→ Page 92).
- Install cylinder head cover upper section (→ Page 110).
- Enable engine start.

8.5.4 Cylinder head cover – Removal and installation

Preconditions

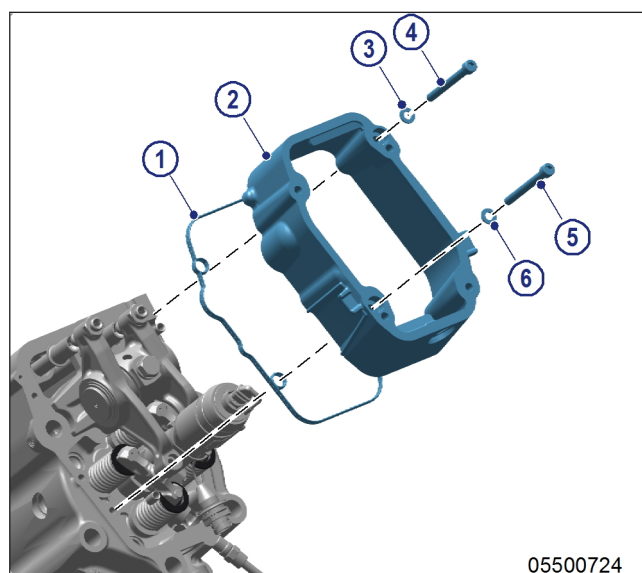
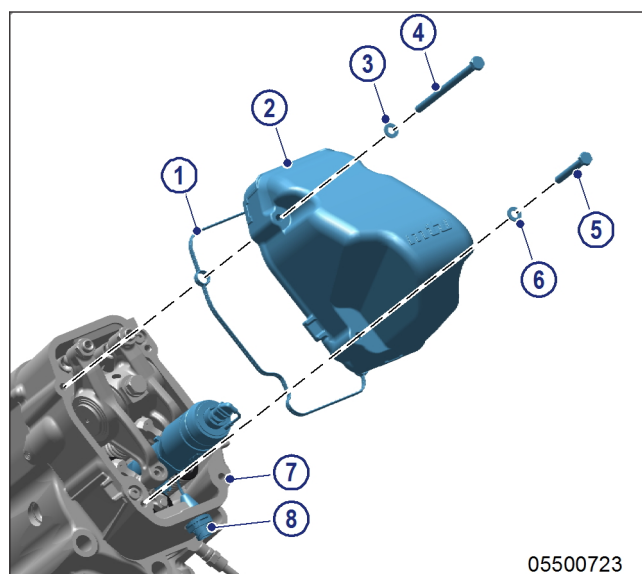
- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 4–20 Nm	F30044239	1
Assembly compound (Kluthe Hakuform 30-15)	X00067260	1
Sealing ring	(→ Spare Parts Catalog)	

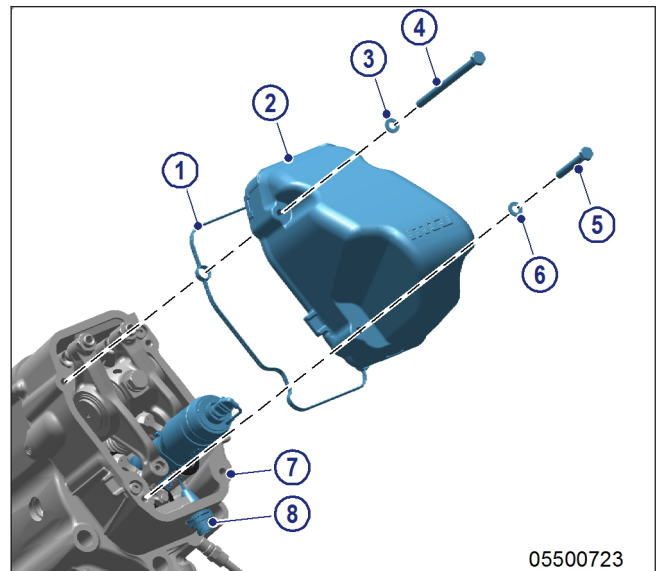
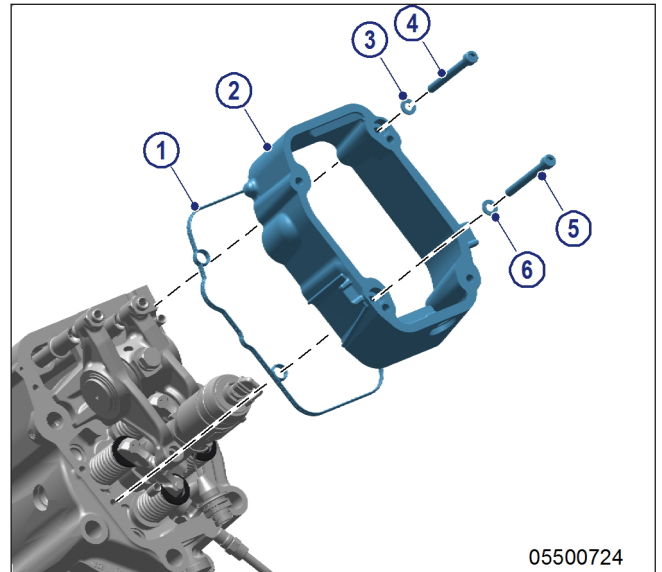
Removing cylinder head cover

1. Clean very dirty cylinder head cover upper section (2) prior to removal.
 2. Remove screws (4, 5) with washers (3, 6).
 3. Take off cylinder head cover upper section (2) with sealing ring (1) from cylinder head cover lower section (7).
 4. Screw out ESD connector (8) from cylinder head cover lower section (7).
-
5. Remove screws (4, 5) with washers (3, 6).
 6. Take off cylinder head cover lower section (2) with sealing ring (1) from cylinder head.



Installing cylinder head cover

1. Clean mounting surface.
2. Check sealing ring (1) for damage, replace if necessary.
3. Coat sealing ring (1) with assembly compound.
4. Place sealing ring (1) and cylinder head cover lower section (2) onto cylinder head.
5. Install cylinder head cover lower section (2) with screws (4, 5) and washers (3, 6).



6. Screw in ESD connector (8) in cylinder head cover lower section (7) and use torque wrench to tighten it to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Nut		Tightening torque		6 Nm + 1 Nm

7. Check sealing ring (1) for damage, replace if necessary.
8. Coat sealing ring (1) with assembly compound.
9. Place sealing ring (1) and cylinder head cover upper section (2) onto cylinder head cover lower section (7).
10. Install cylinder head cover upper section (2) with screws (4, 5) and washers (3, 6).

8.6 Injection Pump / HP Pump

8.6.1 HP fuel pump - Filling with engine oil

Preconditions

- Engine is stopped and starting disabled.
- HP pump is installed.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 10–60 Nm	F30452769	1
Fuel suction device	F30378207	1
Engine oil		

WARNING



Fuels are combustible and explosive.

Risk of fire and explosion!

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

WARNING



Oils/oil vapors are combustible/explosive.

Risk of fire and explosion!

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

NOTICE



HP fuel pump not filled with engine oil.

Damage to components, major material damage!

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

NOTICE



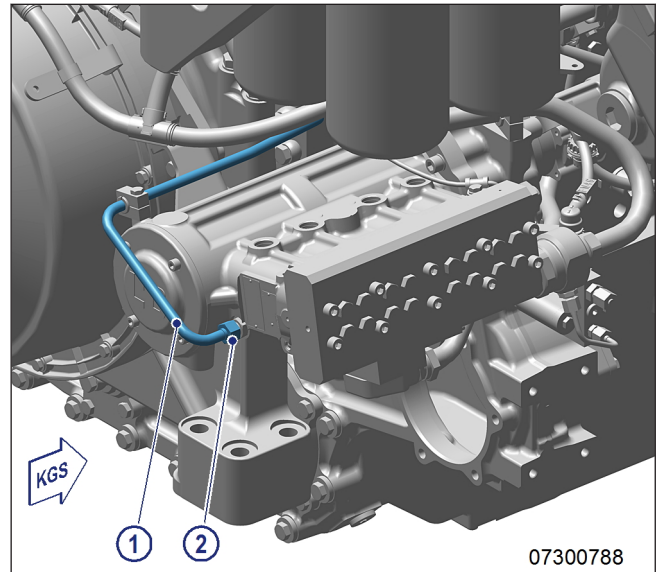
Contaminated components.

Risk of damage to component!

- Check components for special cleanliness and clean if necessary.

Preparatory steps

- ▶ Loosen nut (2) and remove oil line (1) from HP pump.

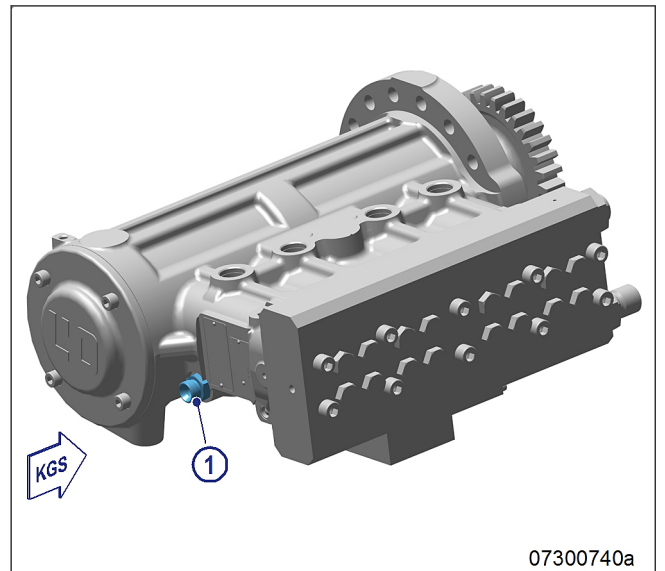


HP pump – Filling

1. Remove union (1).

Note: Excess engine oil runs into gear box.

2. Use fuel suction device to fill HP pump with 2 liters of clean engine oil.



3. Screw in union (1) and use torque wrench to tighten to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Union	M16x1.5	Tightening torque		40 Nm

Final steps

- ▶ Install oil line.

8.7 Injector

8.7.1 Injector - Replacement

Special tools, Material, Spare parts

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

Injector - Replacement

- ▶ Remove injector and install new one (→ Page 115).

8.7.2 Injector – Removal and installation

Preconditions

- Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Installation/removal jig	F6796646	1
Milling cutter	F30452739	1
Torque wrench, 4–20 Nm	F30044239	1
Torque wrench, 10–60 Nm	F30452769	1
Torque wrench, 60–320 Nm	F30452768	1
Assembly paste (Optimoly Paste White T)	40477	1
Assembly compound (Kluthe Hakuform 30-15)	X00067260	1
Engine oil		
O-ring	(→ Spare Parts Catalog)	

WARNING



Fuels are combustible and explosive.

Risk of fire and explosion!

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

NOTICE



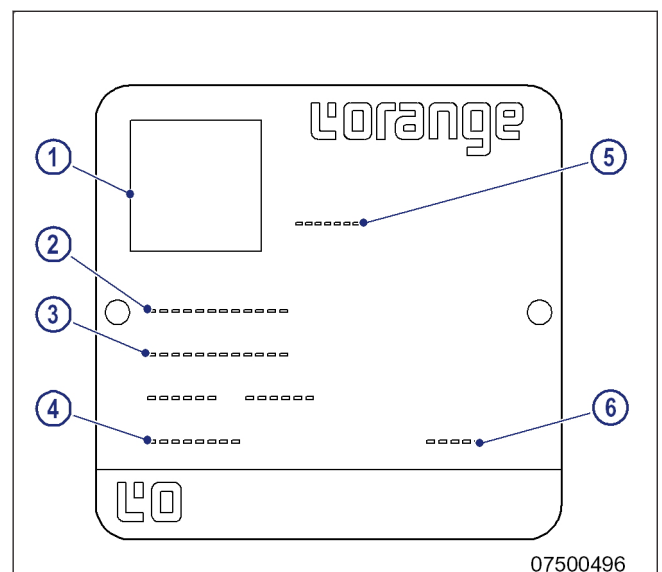
Contamination of components.

Risk of damage to component!

- Seal off components with suitable covers.
- Check components for special cleanliness prior to installation/assembly and clean if necessary.

Label

- 1 DMC - Data Matrix Code
- 2 L'Orange part number
- 3 MTU part number
- 4 EMI-ID
- 5 Serial number
- 6 Date of manufacture



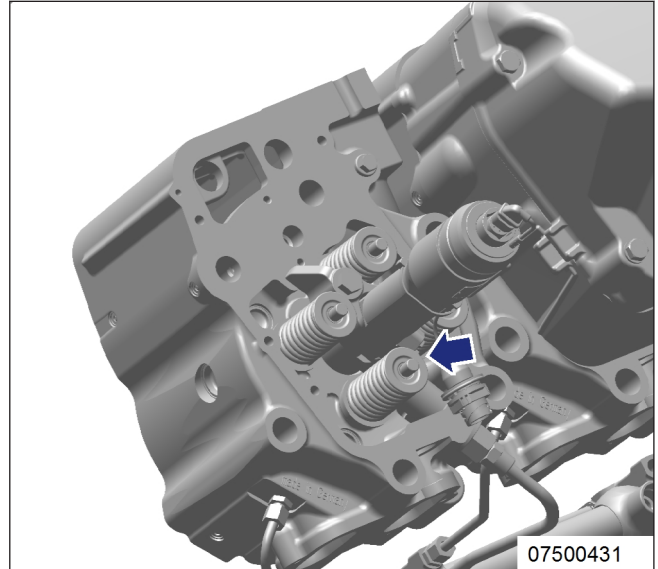
Preparatory steps

1. Close off fuel supply to engine.
2. Remove cylinder head cover (→ Page 110).

Removing injector

Note: The cable connectors feature a latch, which is released by pulling the black connector housing backwards.

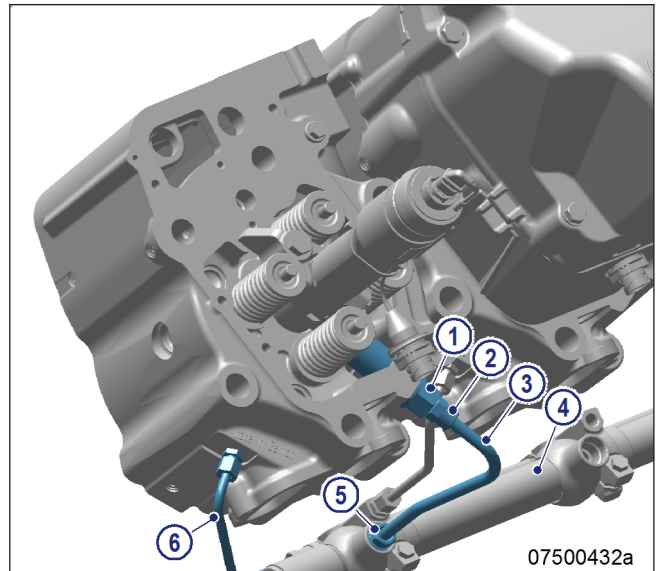
1. Disconnect connectors on injector (arrowed).



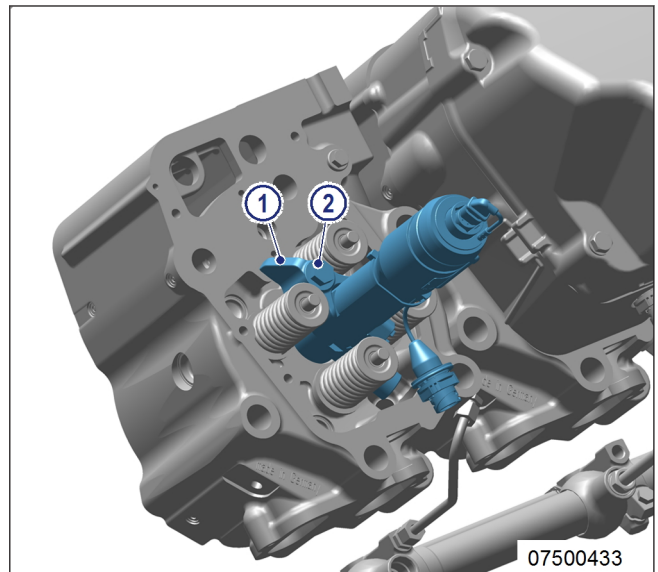
2. Unscrew union nuts (2, 5) and remove HP line (3) from rail (4) and cylinder head.

Note: When the adapter is unscrewed, the stored volume of the injector is emptied.

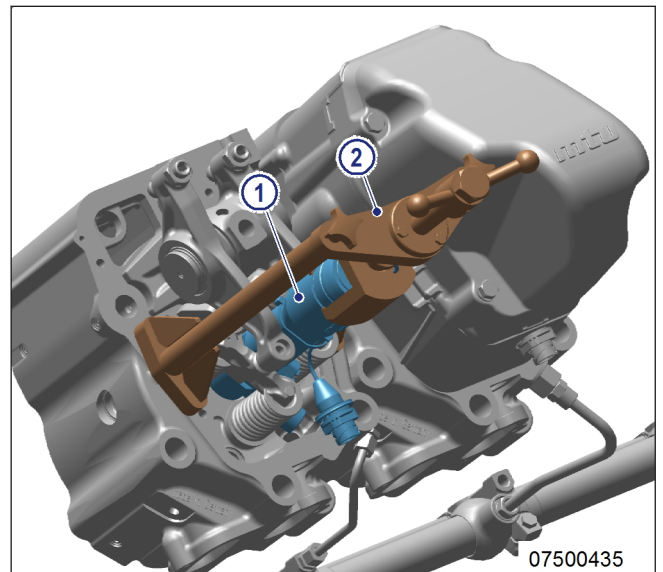
3. Provide suitable container to collect escaping fuel.
4. Remove adapter (1).
5. Loosen union nuts and remove return line (6).



6. Remove screw (2) from hold-down clamp (1).



7. Install installation/removal jig (2) on cylinder head.
8. Remove injector (1) and hold-down clamp with installation/removal jig (2).
9. Remove installation/removal jig (2).
10. Clean all mating and sealing surfaces.
11. If carbon residue is present, clean sealing face on cylinder head and protective sleeve with milling cutter.
12. Seal old injector with plug and cap of new injector.
13. Cover all connections and bores, or seal with suitable plugs.



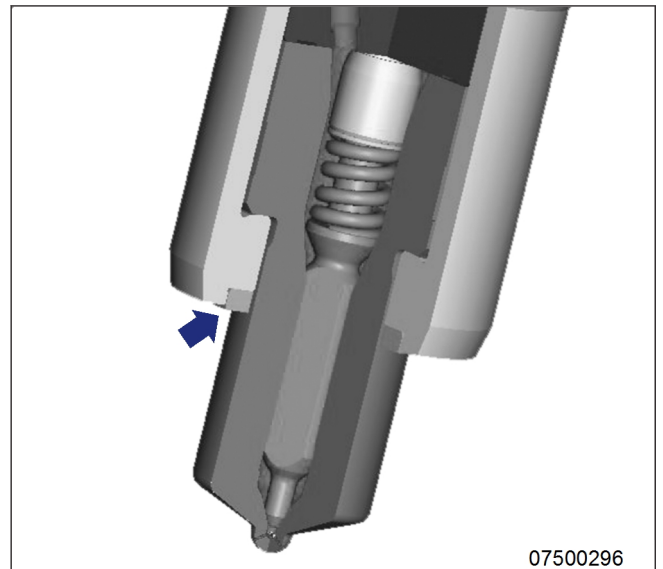
Installing injector

Note: Do not remove plug for HP line until directly before assembly of the adapter.

1. Prior to installation, remove plug.
2. Coat injector with assembly paste at the seat of the nozzle retaining nut.

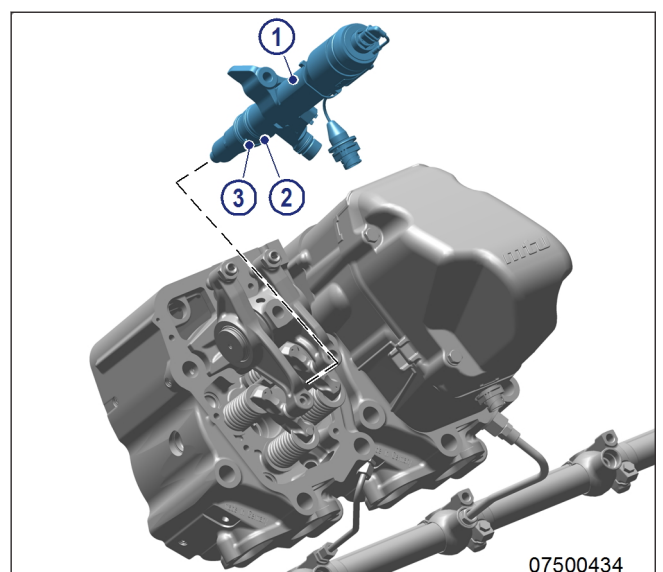
Note: A new sealing ring is included in the scope of delivery of the injector.

3. Insert new sealing ring (arrowed).

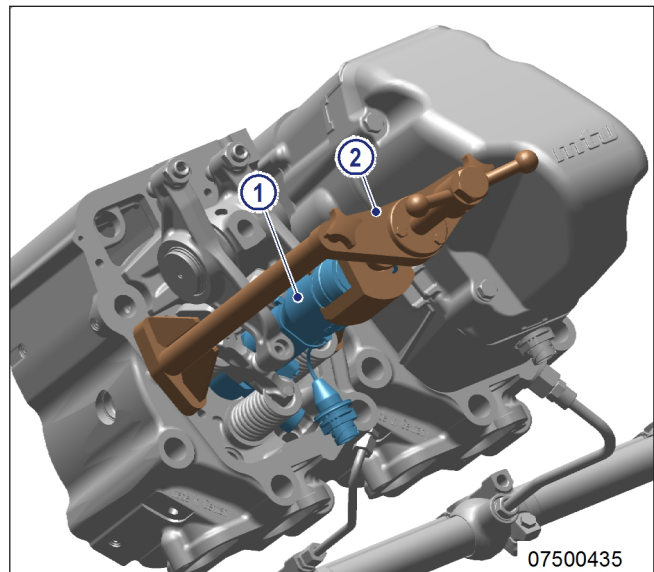


Note: New O-rings and damping ring are included in the scope of delivery of the injector and are pre-assembled.

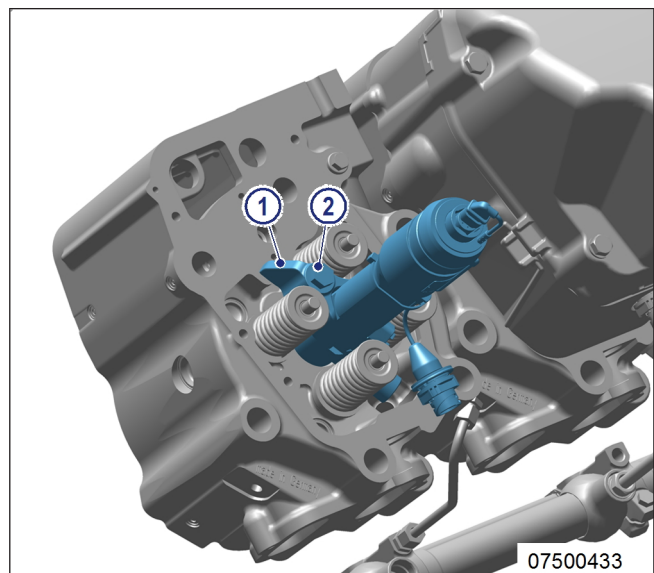
4. Coat O-rings (2, 3) and damping ring on new injector (1) with assembly compound.
5. Insert injector (1) together with hold-down clamp into cylinder head, ensuring that the high-pressure fuel line connection is aligned correctly.



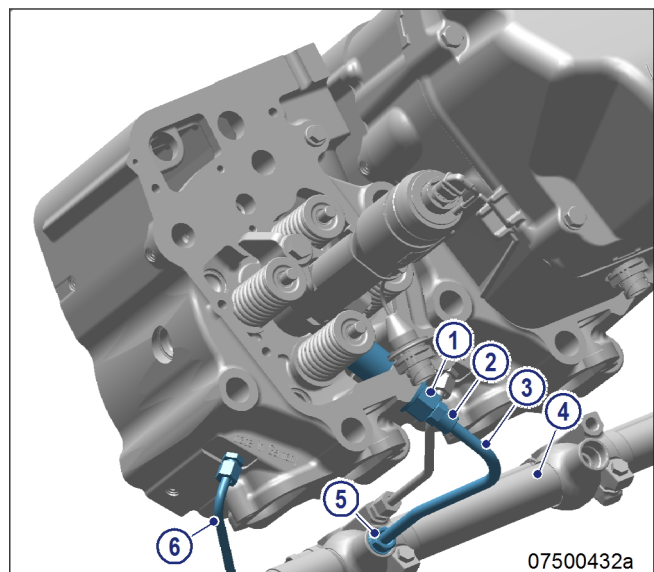
6. Press in injector (1) and hold-down clamp with installation/removal jig (2).
7. Remove the installation/removal jig.



8. Coat screw head mating face on hold-down clamp (1) and screw head mating face and thread of screw (2) with engine oil.
9. Insert screw (2) and tighten hand-tight.



- Note: Ensure immaculate cleanliness.
10. Coat thread and sealing cone of adapter (1) with engine oil.
 11. Coat O-ring on injector and adapter (1) with assembly compound.
 12. Install adapter (1) and tighten hand-tight.



13. Tighten screw on hold-down clamp (→ Step 9) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw	M12	Tightening torque	(Engine oil)	100 Nm + 10 Nm

14. Tighten adapter (1) tighten to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Adapter	M18	Tightening torque	(Engine oil)	100 Nm + 10 Nm

Note: Ensure immaculate cleanliness.

15. Coat thread and sealing cone of HP line (3) with engine oil.
16. Tighten union nuts (2, 5) on HP line (3) to specified torque using a torque wrench. Tightening sequence:
- 1 Nut on adapter (2), counterhold on adapter (1)
 - 2 Nut on rail (5)

Name	Size	Type	Lubricant	Value/Standard
Union nut / thrust screw	M12	Tightening torque	(Engine oil)	40 Nm +5 Nm

17. Release union nuts (2, 5) on HP line (3) approx. 45° angle of rotation while counterholding adapter (1) in relation to injector.

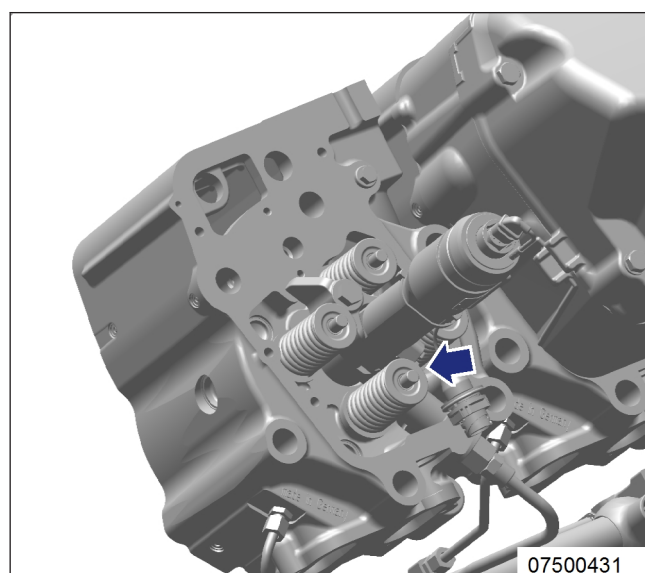
18. Tighten union nuts (2, 5) on HP line (3) without interruption once again to specified final tightening torque using a torque wrench. Tightening sequence:
- 1 Nut on adapter (2), counterhold on adapter (1)
 - 2 Nut on rail (5)

Name	Size	Type	Lubricant	Value/Standard
Union nut / thrust screw	M12	Tightening torque	(Engine oil)	40 Nm +5 Nm

19. Install return line (6) and tighten union nuts.
20. Fit connectors on injector (arrowed).

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

21. Reset drift correction (CDC) with DiaSys® (→ Dialog system DiaSys® E531920/..). If DiaSys® is not available, contact Service.



Final steps

1. Install cylinder head cover (→ Page 110).
2. Open fuel supply to engine.

8.8 Fuel System

8.8.1 Fuel system - Venting

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Diesel fuel		

WARNING



Fuels are combustible and explosive.

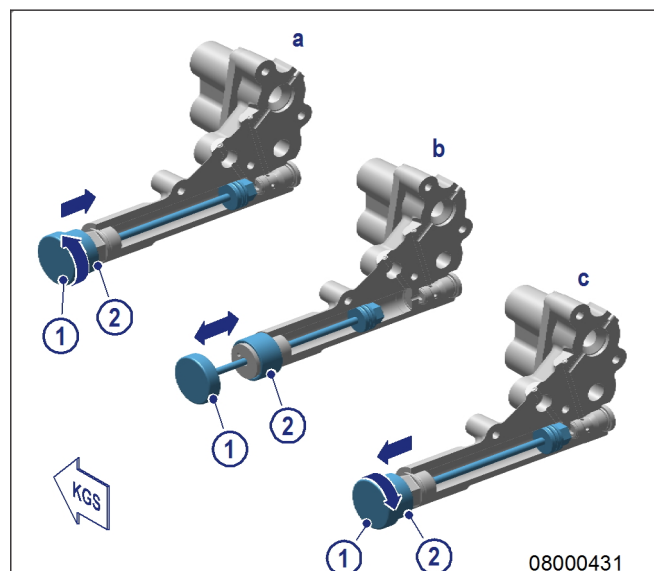
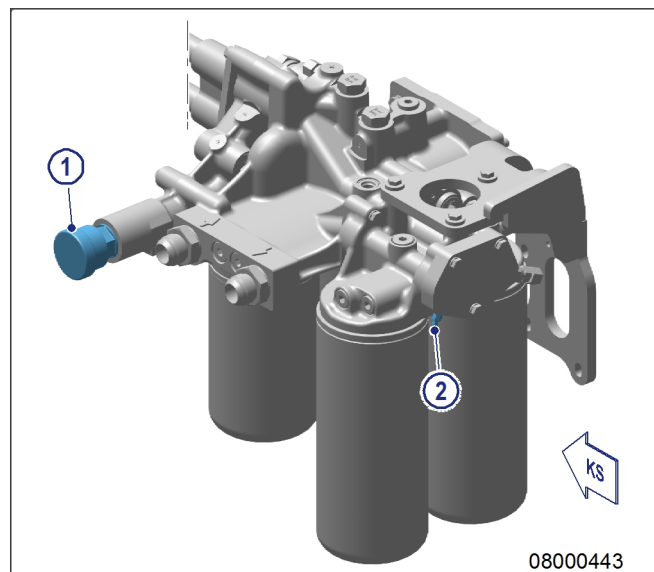
Risk of fire and explosion!

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

Venting LP fuel system - 12V

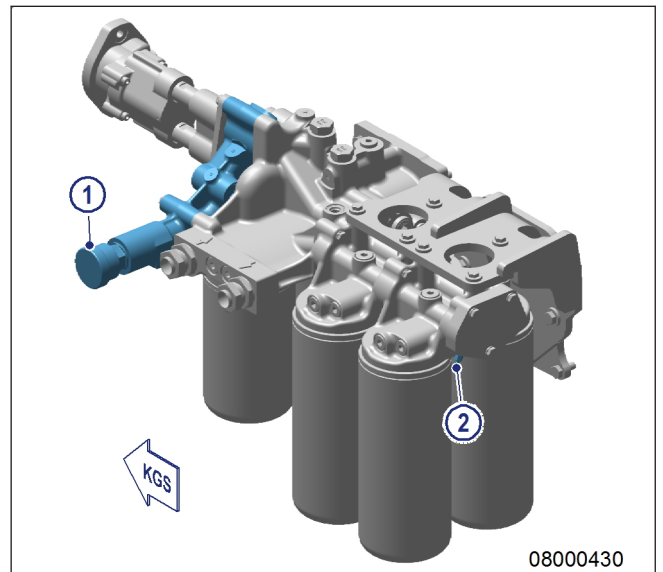
1. Open threaded vent plug (2) and connect a suitable hose.
2. Provide suitable container to collect escaping fuel.

3. Follow the procedure described here to operate the hand pump:
 - a Hold sleeve (2) firmly. Turn handle (1) counterclockwise until the sleeve can be pushed backwards (arrow).
 - b Operate the pump with the handle (1) until bubble-free fuel escapes from the vent plug. Close vent plug.
 - c Push sleeve (2) forward and hold it. Turn handle (1) clockwise until both parts are screwed together hand-tight.
4. Remove hose from vent plug.
5. Verify that the fuel hand pump is securely locked: Handle (1) must be tightened hand-tight.

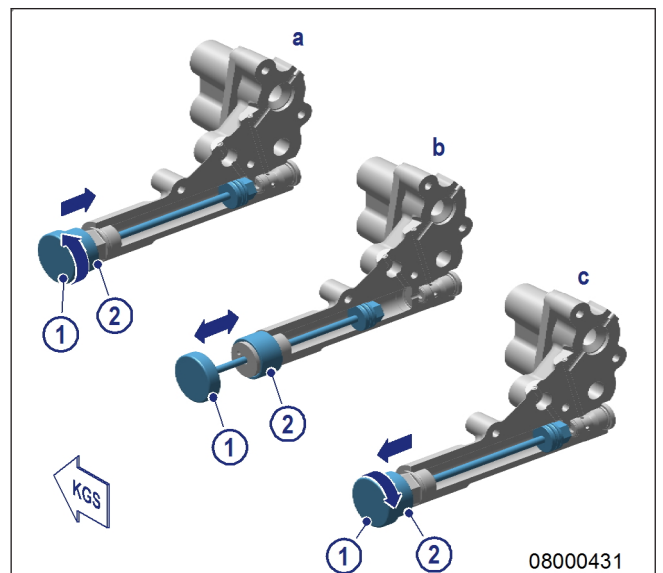


Venting LP fuel system – 16V and 20V

1. Open threaded vent plug (2) and connect a suitable hose.
2. Provide suitable container to collect escaping fuel.



3. Follow the procedure described here to operate the hand pump:
 - a Hold sleeve (2) firmly. Turn handle (1) counterclockwise until the sleeve can be pushed backwards (arrow).
 - b Operate the pump with the handle (1) until bubble-free fuel escapes from the vent plug. Close vent plug.
 - c Push sleeve (2) forward and hold it. Turn handle (1) clockwise until both parts are screwed together hand-tight.
4. Remove hose from vent plug.
5. Verify that the fuel hand pump is securely locked: Handle (1) must be tightened hand-tight.



8.9 Fuel Filter

8.9.1 Fuel filter - Replacement

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Filter wrench	F30379104	1
Engine oil		
Easy-change filter	(→ Spare Parts Catalog)	2

WARNING



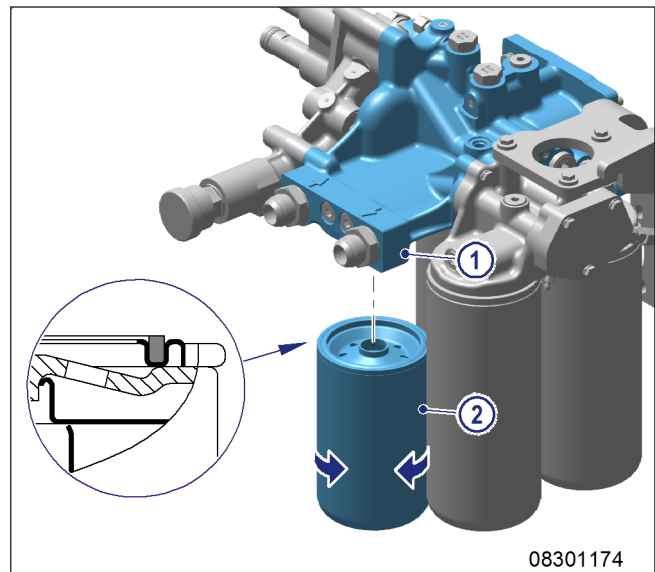
Fuels are combustible and explosive.

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 filter – Replacement

1. Provide suitable container to collect escaping fuel.
2. Remove easy-change filter (2) with filter wrench.
3. Clean sealing face on filter head (1).
4. Apply a thin film of engine oil to the seal (arrow) on easy-change filter (2).
5. Screw on easy-change filter (2) by hand until the seal makes contact with the filter head and tighten by hand.
6. Replace other easy-change filters in the same way.
7. Vent fuel system (→ Page 120).



8.9.2 Additional fuel filter – Replacement

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Filter wrench	F30379104	1
Engine oil		
Easy-change filter	(→ Spare Parts Catalog)	2

WARNING



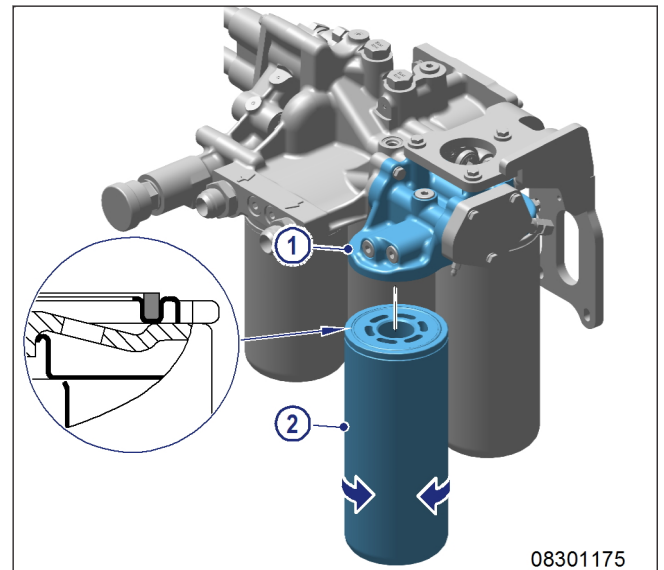
Fuels are combustible and explosive.

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.





Additional fuel filter – Replacement

1. Provide suitable container to collect escaping fuel.
2. Remove easy-change filter (2) with filter wrench.
3. Clean sealing face on filter head (1).
4. Coat gasket on easy-change filter (2) with thin layer of engine oil (arrow).
5. Screw on easy-change filter (2) by hand until the seal makes contact with the filter head and tighten manually.
6. Replace other easy-change filters in the same way.
7. Vent fuel system (→ Page 120).



8.10 Charge-Air Cooling

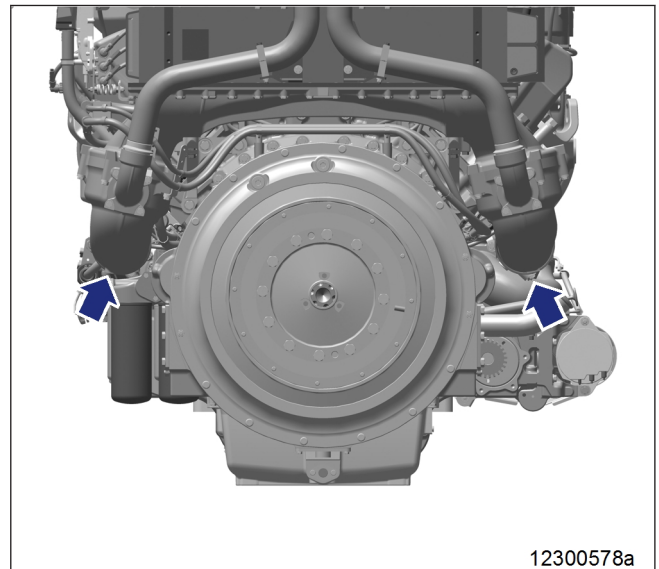
8.10.1 Charge-air cooler – Leak check

DANGER 	Rotating and moving engine parts. Risk of crushing, danger of parts of the body being caught or pulled in! <ul style="list-style-type: none">• 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! <ul style="list-style-type: none">• Wear ear protectors.
WARNING 	Compressed air gun ejects a jet of pressurized air. Risk of injury to eyes and damage to hearing, risk of rupturing internal organs! <ul style="list-style-type: none">• Never direct air jet at people.• Always wear safety goggles/face mask and ear defenders.
WARNING 	Condensation contains acid. Risk of chemical burns! <ul style="list-style-type: none">• Wear protective goggles.• Wear protective gloves.

Charge-air cooler leak check

1. With the engine at standstill, open the plug screws in the charge-air elbows on the left and right engine sides on driving end (arrows).
2. If necessary, use a suitable tool to remove obstructions and check the openings for coolant discharge.

Result: If a large amount of coolant is discharged, contact Service.



Emergency measures prior to engine start with a leaking charge-air cooler

1. Remove injector (→ Page 115).
2. Bar engine manually (→ Page 92).
3. Bar engine with starting system to blow out combustion chambers (→ Page 93).

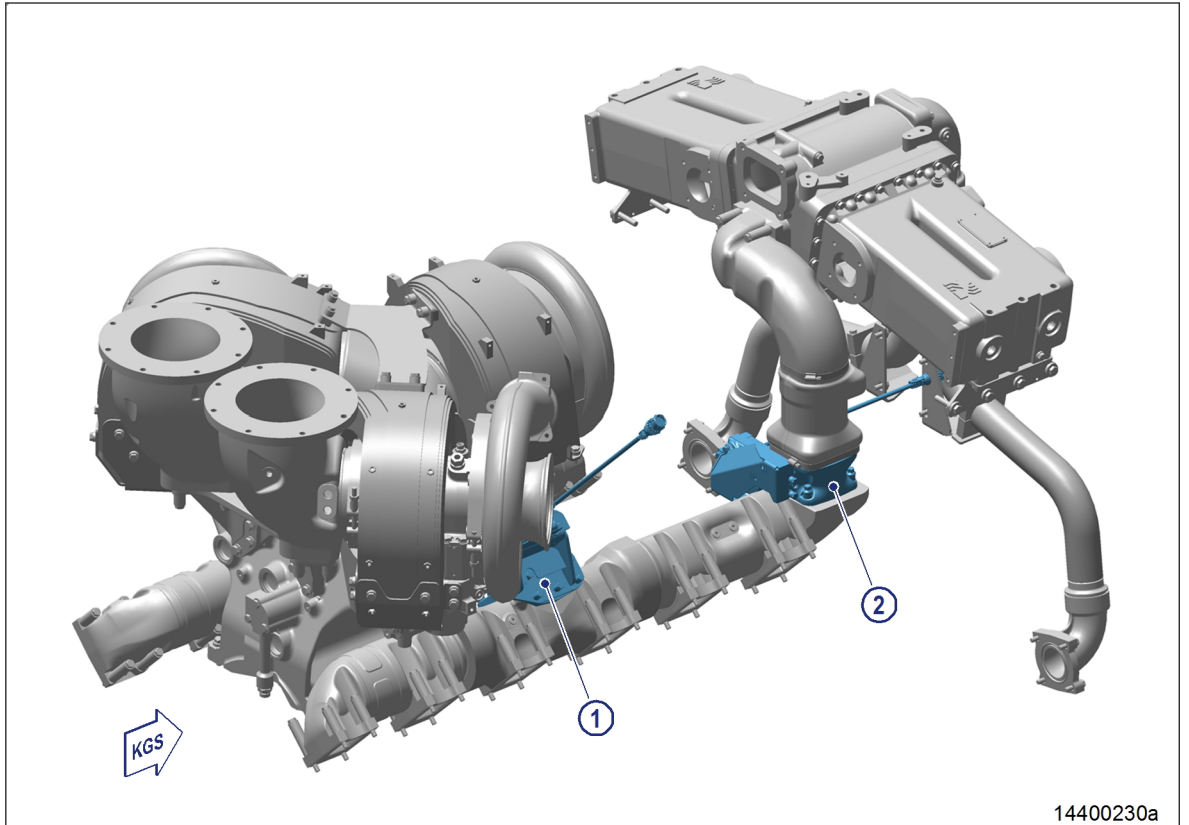
Note: Install injectors in their original fitting position.

4. Install injector (→ Page 115).

8.11 Exhaust Gas Recirculation

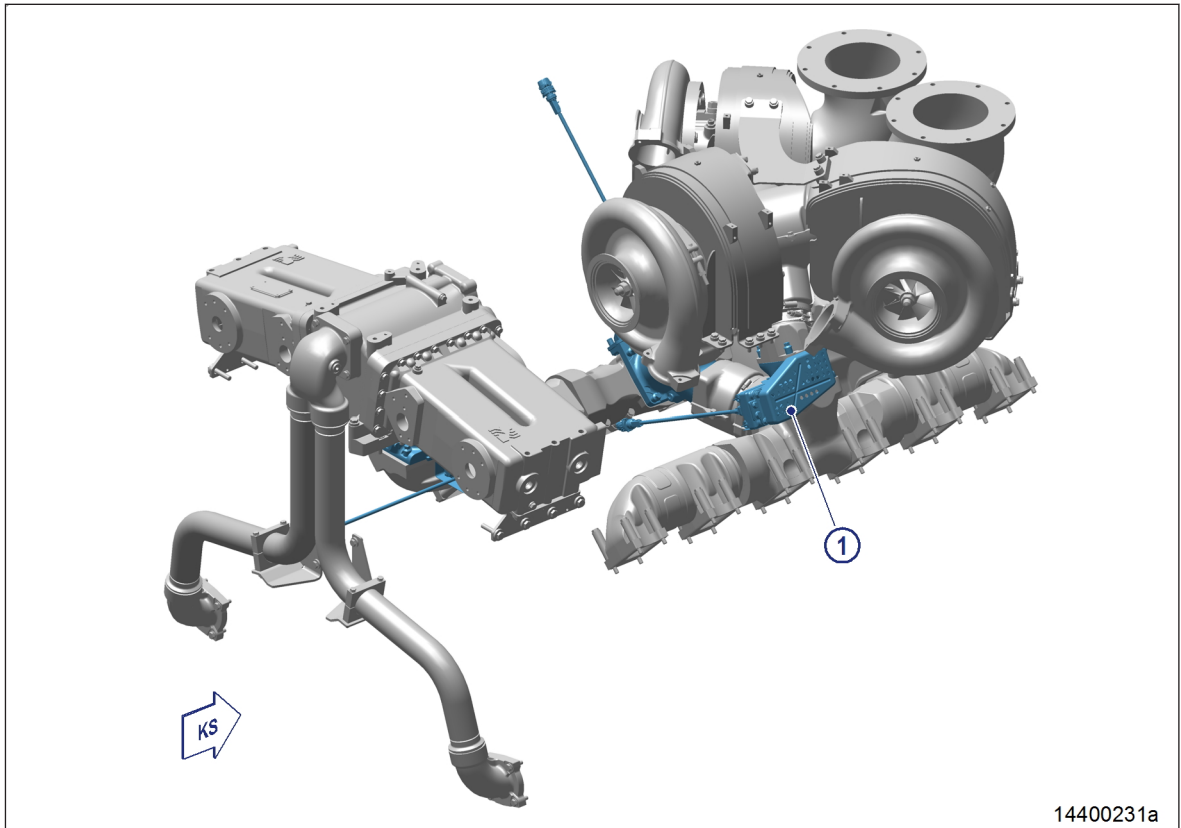
8.11.1 Exhaust flaps overview - 12V and 16V

Exhaust flaps overview - 12V



1 Dispenser cylinder flap

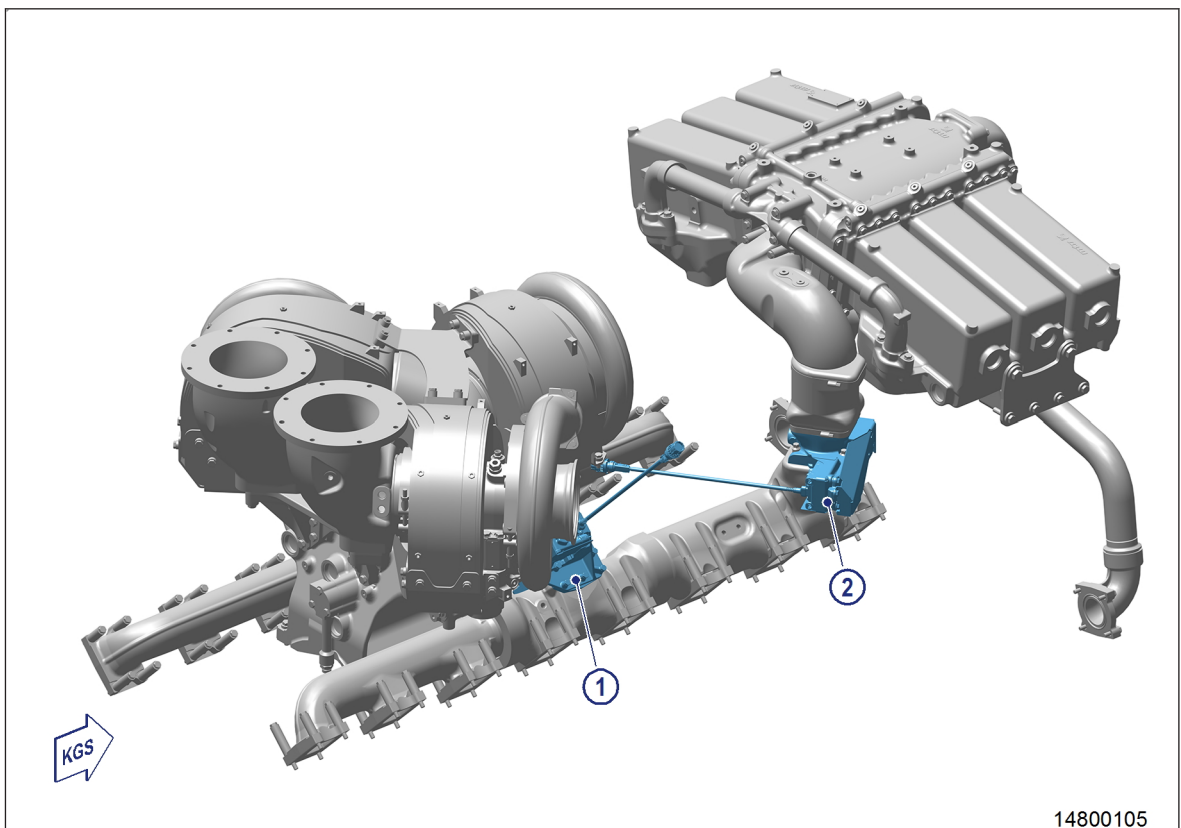
2 EGR shutoff flap



14400231a

1 Bypass flap

Exhaust flaps overview - 16V

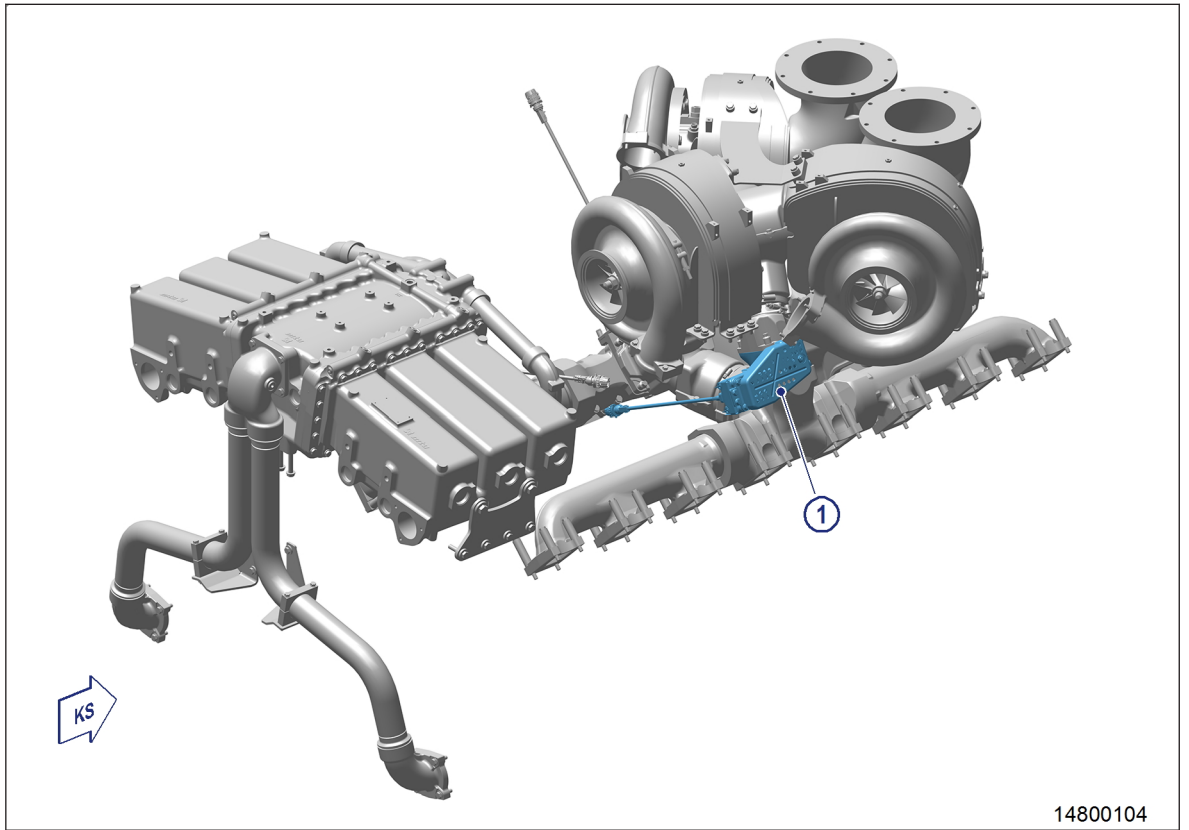


14800105

1 Dispenser cylinder flap

2 EGR shutoff flap

TIM-ID: 0000063475 - 002



1 Bypass flap

8.11.2 Exhaust flaps – Checking coupling rod clearance and function

Preconditions

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

WARNING



Actuation mechanism in the exhaust and intake area closes automatically.

Risk of crushing hands!

- To carry out the teach-in routine, keep clear of the safety zone of the actuation mechanism in the intake and exhaust area.
- Switch off the operating voltage of the engine governor before starting the mechanical test.
- Wear protective goggles.

WARNING



Hot components/surfaces.

Risk of burns!

- Allow the engine to cool down to below 50 °C before beginning work.
- Wear suitable protective equipment/thermal gloves.
- Avoid unprotected contact with hot surfaces.

Checking coupling rods (bypass and EGR flap) – mechanical

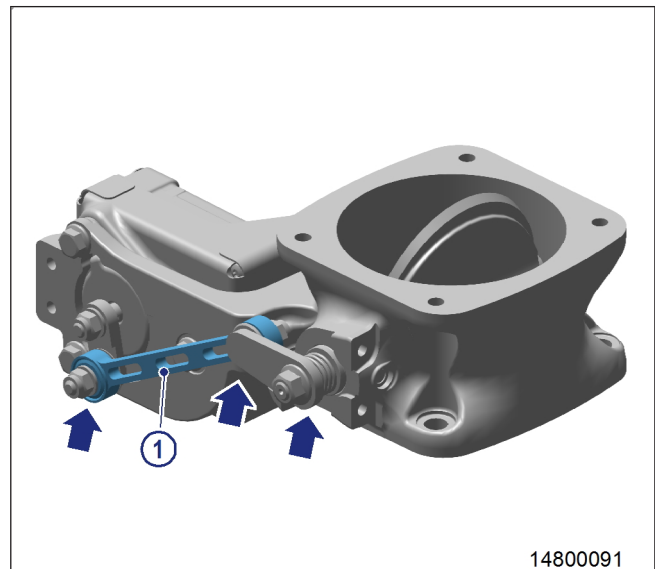
Note: For installation position of exhaust flaps, refer to overview (→ Page 125).

1. Remove guard plates of exhaust flaps (→ Page 130).
2. Check operability and ease of movement of coupling rod (1) by moving it at the specified points (arrows) and make sure that there is no excessive play.

Result: Replace coupling rod (1) if it is jamming, sluggish or features excessive play (→ Page 130).

3. Check whether the internal spring pulls the flap into the F-position:
 - Fail-safe position for bypass flap and EGR shutoff flap: opened.
 - Fail-safe position for donor cylinder flap: closed.

Result: If the bypass flap/EGR shutoff flap is closed or the donor cylinder flap is opened, contact Service.



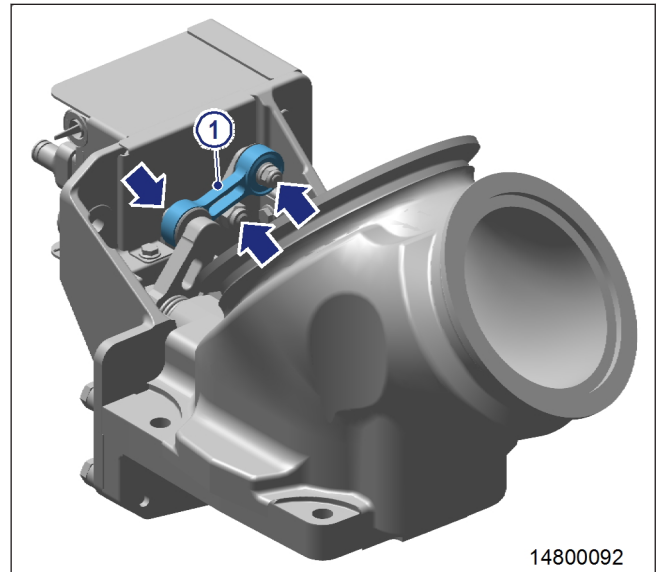
Checking coupling rod (donor cylinder flap) – mechanical

Note: For installation position of exhaust flaps, refer to overview (→ Page 125).

1. Remove guard plates of exhaust flaps.

2. Check operability and ease of movement of coupling rod (1) by moving it at the specified points (arrows) and make sure that there is no excessive play.

Result: Replace coupling rod (1) if it is jamming, sluggish or features excessive play (→ Page 130).



8.11.3 Exhaust flaps – Coupling rod replacement

Preconditions

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

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 6–50 Nm	F30027336	1
Ratchet adapter	F30027340	1
Assembly paste (Ultra-Therm MTU)	50547	
Coupling rod	(→ Spare Parts Catalog)	1
Coupling rod	(→ Spare Parts Catalog)	2
Locknut	(→ Spare Parts Catalog)	
Locking screw	(→ Spare Parts Catalog)	
Washer	(→ Spare Parts Catalog)	

WARNING



Actuation mechanism in the exhaust and intake area closes automatically.

Risk of crushing hands!

- To carry out the teach-in routine, keep clear of the safety zone of the actuation mechanism in the intake and exhaust area.
- Switch off the operating voltage of the engine governor before starting the mechanical test.
- Wear protective goggles.

WARNING



Hot components/surfaces.

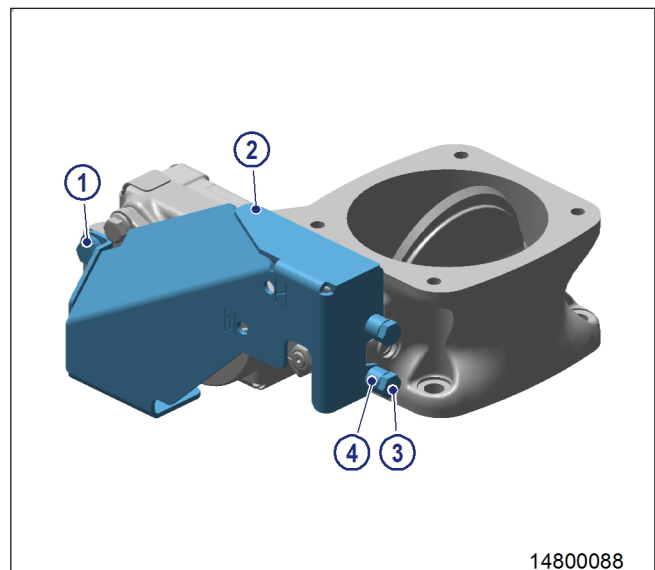
Risk of burns!

- Allow the engine to cool down to below 50 °C before beginning work.
- Wear suitable protective equipment/thermal gloves.
- Avoid unprotected contact with hot surfaces.

Removing coupling rods (bypass and EGR shutoff flaps)

Note: For installation position of exhaust flaps, refer to overview (→ Page 125).

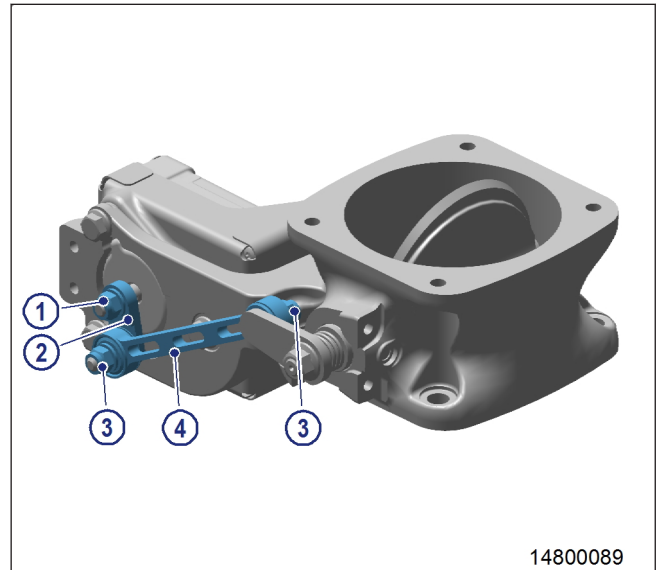
1. Unscrew screws (1, 3) and remove guard plate (2) for exhaust flaps.
2. Remove spacer sleeves (4).



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TIM-ID: 0000060174 - 001

3. Unscrew locknuts (3) with washers.
 4. Unscrew locknut (1) with washer.
- Result: Lever detached from actuator output shaft.
5. Remove coupling rod (4) and lever (2).
 6. Remove washers.



Installing coupling rods (bypass and EGR shutoff flaps)

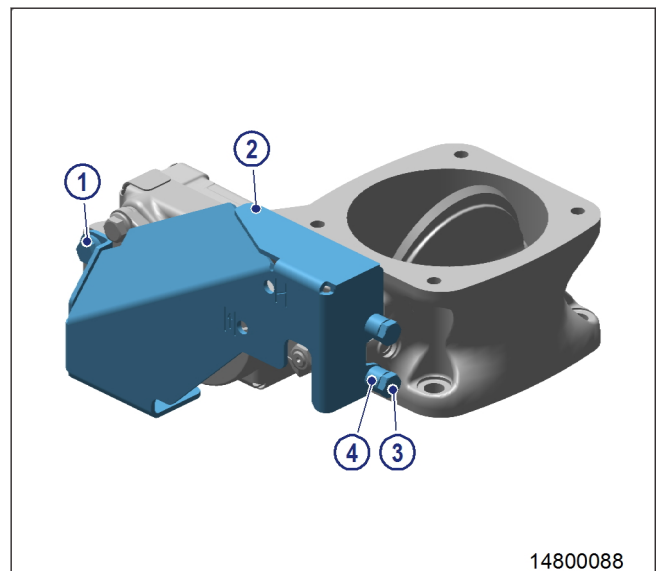
1. Insert coupling rod (4) and washers.
2. Tighten lever (2) with locknut (1) on output shaft to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Nut		Tightening torque	(Assembly paste (Ultra-Therm MTU))	16 Nm \pm 2 Nm

3. Tighten washers and locknuts (3) to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Nut		Tightening torque	(Assembly paste (Ultra-Therm MTU))	16 Nm \pm 2 Nm

4. Mount guard plate (2).



5. Tighten securing screws (1) to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque	(Assembly paste (Ultra-Therm MTU))	35 Nm \pm 2 Nm

- Tighten screws (3) with spacer sleeves (4) to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque	(Assembly paste (Ultra-Therm MTU))	10 Nm ± 1 Nm

Note: After every change to the exhaust gas recirculation mechanical system, the DiaSys® must be used to carry out an actuator test (learning run) (→ Dialog system E531920/..).

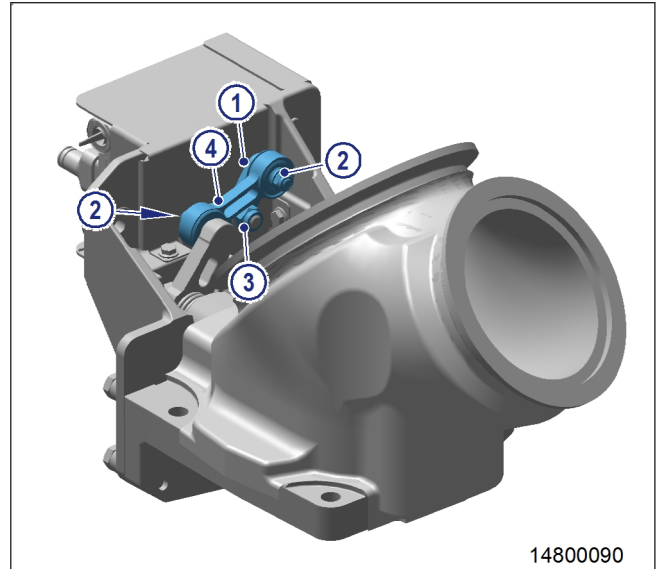
Removing coupling rod (donor cylinder flap)

Note: For installation position of exhaust flaps, refer to overview drawing (→ Page 125).

- Unscrew locknuts (2) with washers.
- Unscrew locknut (3).

Result: Lever detached from actuator output shaft.

- Remove coupling rod (4) and lever (1).
- Remove washers.



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Installing coupling rod (donor cylinder flap)

- Insert coupling rod (4) and washers.
- Tighten lever (1) with locknut (3) on output shaft to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Nut		Tightening torque	(Assembly paste (Ultra-Therm MTU))	16 Nm ± 2 Nm

- Tighten locknuts (2) with washers to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Nut		Tightening torque	(Assembly paste (Ultra-Therm MTU))	10 Nm ± 1 Nm

Note: After every change to the exhaust gas recirculation mechanical system, the DiaSys® must be used to carry out an actuator test (learning run) (→ Dialog system E531920/..).

8.12 Starting Equipment

8.12.1 Starter - Condition check

Preconditions

- Engine is stopped and starting disabled.

Checking starter condition

1. Check securing screws of starter for secure seating and tighten if required.
2. Check wiring (→ Page 185).

8.13 Lube Oil System, Lube Oil Circuit

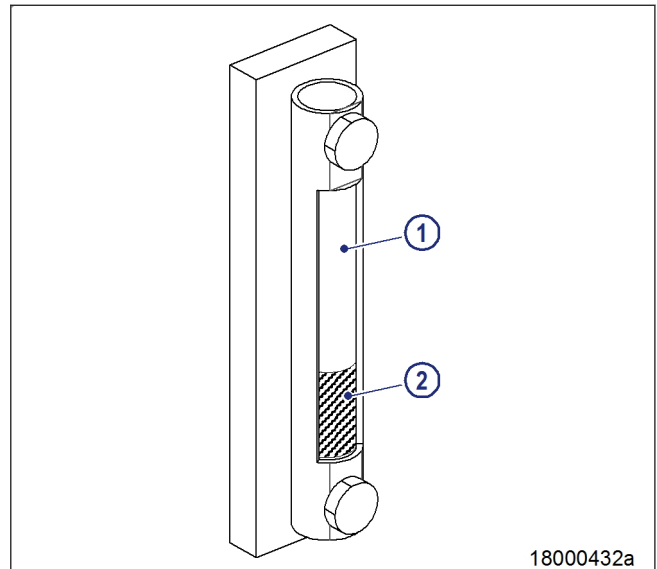
8.13.1 Engine oil level - Check at sight glass

Preconditions

- ☑ Engine is stopped and starting disabled.

Engine oil level check at sight glass

1. Make a preliminary visual check of oil level (2) at the sight glass (1).
2. A proper engine oil level check must always be carried out using the oil dipstick (→ Page 135).



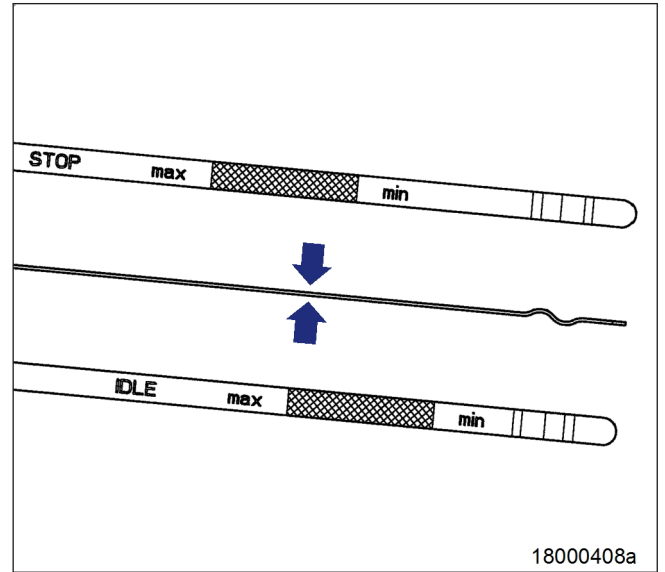
8.13.2 Engine oil – Level check with oil dipstick

Checking oil level prior to engine start

1. Pull out dipstick from guide tube and wipe it.
2. Insert dipstick into guide tube up to the stop, pull out after approx. 10 seconds. Check oil level on oil dipstick side marked "5 Min. after Stop".

Note: After extended out-of-service periods, the oil level may be up to 2 cm above the "max." mark. This might be caused by engine oil flowing from oil filter and heat exchanger back into the oil pan.

3. The oil level must reach the "max." mark or exceed it by up to 2 cm.
4. If necessary, top up to "max." mark (→ Page 136).
5. Insert oil dipstick into guide tube up to the stop.



Checking engine oil level with the engine running

1. After the engine has run for approx. 10 minutes at a constant speed of 600 to 900 rpm, pull out oil dipstick from guide tube and wipe it.
2. Insert dipstick into guide tube up to the stop, pull out after approx. 10 seconds. Check oil level on the dipstick side marked "IDLE".
3. Oil level must not be lower than the "min" mark.
4. If necessary, top up to "max." mark (→ Page 136).

Checking oil level after the engine is stopped

1. 5 minutes after stopping the engine, remove oil dipstick from the guide tube and wipe it.
2. Insert dipstick into guide tube up to the stop, pull out after approx. 10 seconds. Check oil level on oil dipstick side marked "5 Min. after Stop".
3. Oil level must be between "min." and "max." marks.
4. If necessary, top up to "max." mark (→ Page 136).
5. Insert oil dipstick into guide tube up to the stop.

8.13.3 Engine oil - Change

Preconditions

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

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 10-60 Nm	F30452769	1
Torque wrench, 60-320 Nm	F30452768	1
Torque wrench 300-800 Nm	F30047798	1
Ratchet adapter	F30027341	1
Ratchet adapter	F30450902	1
Engine oil		
Sealing ring	(→ Spare Parts Catalog)	

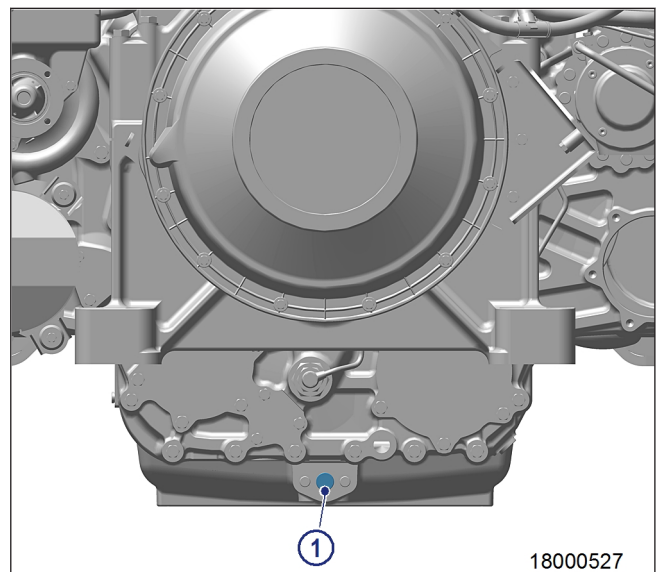
WARNING



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

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

1. Provide a suitable container in which to collect the engine oil.
2. Remove drain plugs (1) on driving end and free end and drain engine oil.
3. Fit new sealing ring on drain plugs (1) on driving end and free end.



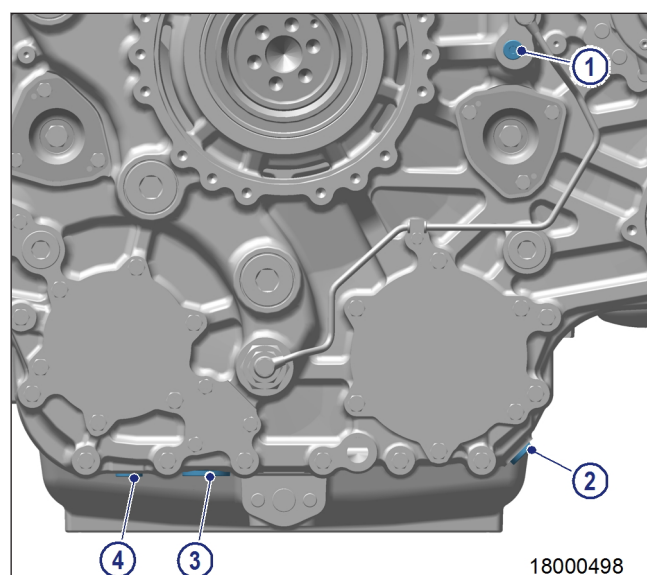
TIM-ID: 0000062897 - 002

Changing oil using semirotary hand pump: Engine oil extraction

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

Draining residual oil from equipment carrier (only with unscheduled engine oil change)

1. Provide a suitable container in which to collect the engine oil.
2. Remove drain plug (1) and drain engine oil from engine oil heat exchanger and from engine oil filter.
3. Remove drain plugs (2, 3, 4) and drain engine oil.
4. Replace engine oil filter (→ Page 140) or automatic oil filter candles (→ Page 142).



- Note: Screw in drain plugs with new sealing rings.
5. Screw in drain plug (1) and tighten to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw	M18 x 1.5	Tightening torque	(Engine oil)	50 Nm + 10 Nm

6. Screw in drain plugs (2, 4) and tighten to specified torque using a torque wrench.

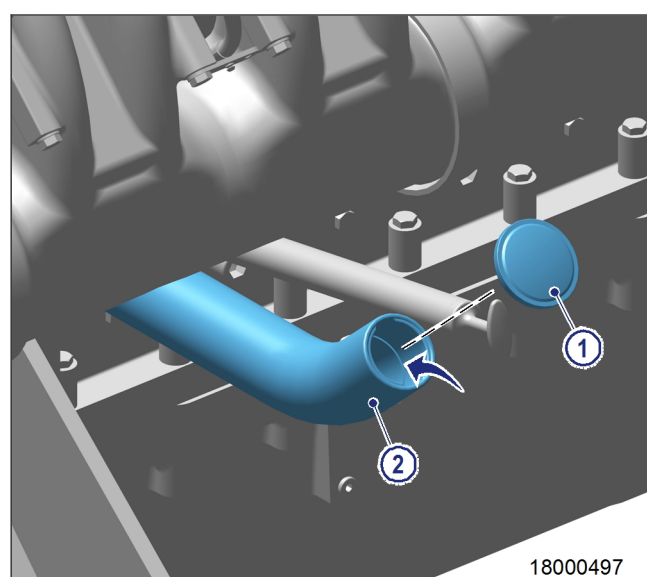
Name	Size	Type	Lubricant	Value/Standard
Screw	M26 x 1.5	Tightening torque	(Engine oil)	100 Nm + 10 Nm

7. Screw in drain plug (3) and tighten to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw	M48 x 1.5	Tightening torque	(Engine oil)	420 Nm + 10 Nm

Filling with new engine oil

1. Open cover (1) on filler neck (2).
2. Fill engine oil into the filler neck (2) up to the “max” mark on the oil dipstick.
3. Close cover (1) on filler neck (2).
4. Check engine oil level (→ Page 135).






8.13.4 Engine oil – Sample extraction and analysis

Preconditions

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

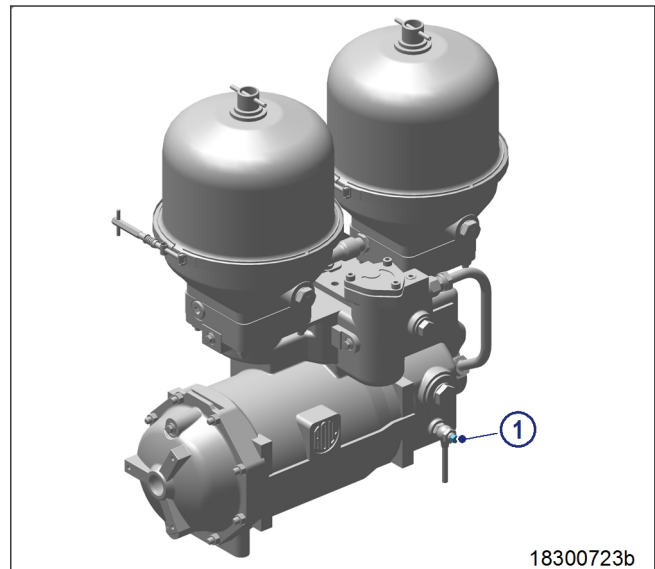
Special tools, Material, Spare parts

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

DANGER 	Rotating and moving engine parts. Risk of crushing, danger of parts of the body being caught or pulled in! <ul style="list-style-type: none">• 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! <ul style="list-style-type: none">• 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! <ul style="list-style-type: none">• Wear ear protectors.

Engine oil sample extraction (variant A: automatic oil filter) and analysis

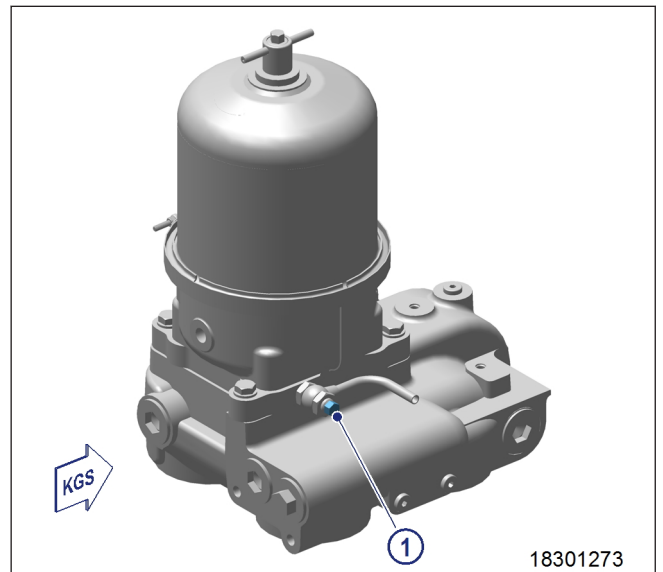
1. With the engine running at operating temperature, open screw (1) on automatic oil filter by 1 to 2 rotations.
2. Drain approx. 2 liters engine oil to flush out the oil sludge.
3. Drain approx. 1 liter engine oil into a clean container.
4. Close screw (1).
5. Using the equipment and chemicals in the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



TIM-ID: 0000002598 - 001

Engine oil sample extraction (variant B: centrifugal oil filter) and analysis

1. With the engine running at operating temperature, open screw (1) on flange of centrifugal oil filter by 1 to 2 rotations.
2. Drain approx. 2 liters engine oil to flush out the oil sludge.
3. Drain approx. 1 liter engine oil into a clean container.
4. Close screw (1).
5. Using the equipment and chemicals of the MTU test kit, examine oil for:
 - Dispersing capacity (spot test);
 - Water content;
 - Dilution by fuel.



8.14 Oil Filtration / Cooling

8.14.1 Engine oil filter - Replacement

Preconditions

- Run engine to reach operating temperature.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Filter wrench	F30379104	
Engine oil		
Oil filter	(→ Spare Parts Catalog)	
Sealing ring	(→ Spare Parts Catalog)	

WARNING



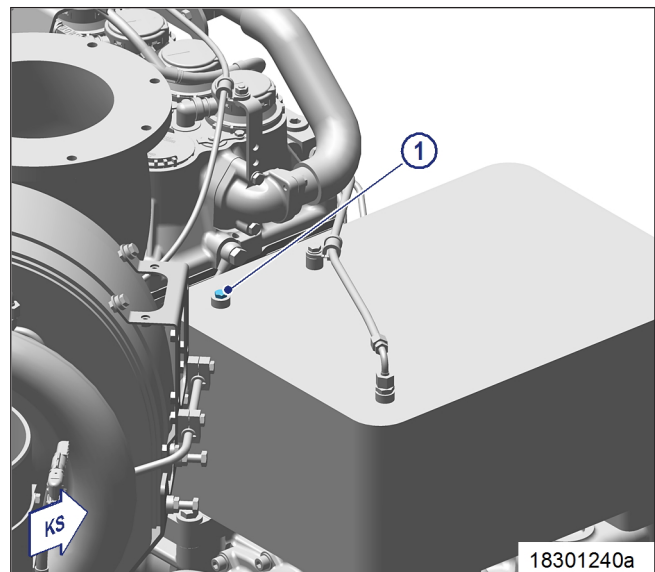
- Hot oil.
Oil can contain combustion residues which are harmful to health.
- Risk of injury and poisoning!**
- Wear protective clothing, gloves, and goggles / safety mask.
 - Avoid contact with skin.
 - Do not inhale oil vapor.

Replacing engine oil filter

1. Stop engine and disable engine start.
2. After warming up and directly stopping the engine, open the vent plug (1) on the oil heat exchanger.
3. Wait 5 minutes until the oil system is vented and the oil has drained off.

Note: Always use a new sealing ring for the vent plug.

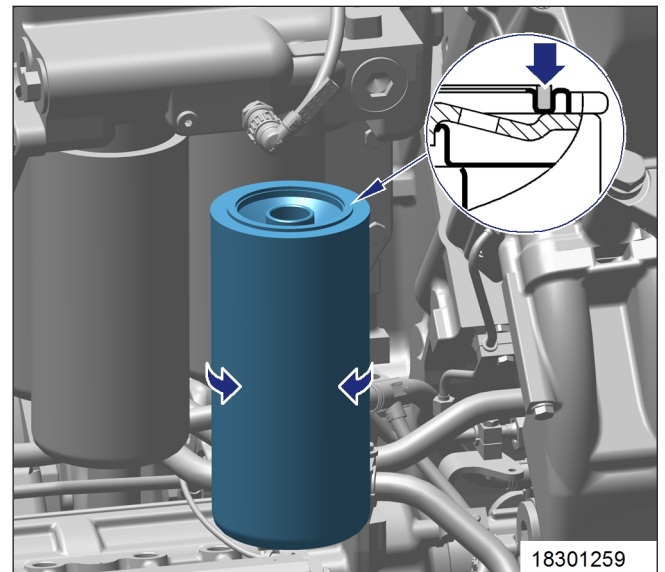
4. Screw the vent plug (1) back in.



5. Remove engine oil filter using the filter wrench.
6. Clean sealing surface on connecting piece.

Note: Only install engine oil filter with an integrated safety valve.

7. Check condition of the new oil filter sealing ring and coat it with engine oil.
8. Screw the engine oil filter on and tighten by hand.
9. Replace other engine oil filters in the same way.
10. Bar the engine using the starting system (→ Page 93).
11. Check engine oil level (→ Page 135).



8.14.2 Automatic oil filter – Oil filter candle replacement W1035

Preconditions

- Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 10–60 Nm	F30452769	1
Torque wrench, 60–320 Nm	F30452768	1
Assembly compound (Hakuform 30–15)	X00067260	1
Engine oil		
Gasket kit	XP52700600009	1
Oil filter candles	XP52618300032	36

WARNING



Hot oil.

Oil can contain combustion residues which are harmful to health.

Risk of injury and poisoning!

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

NOTICE



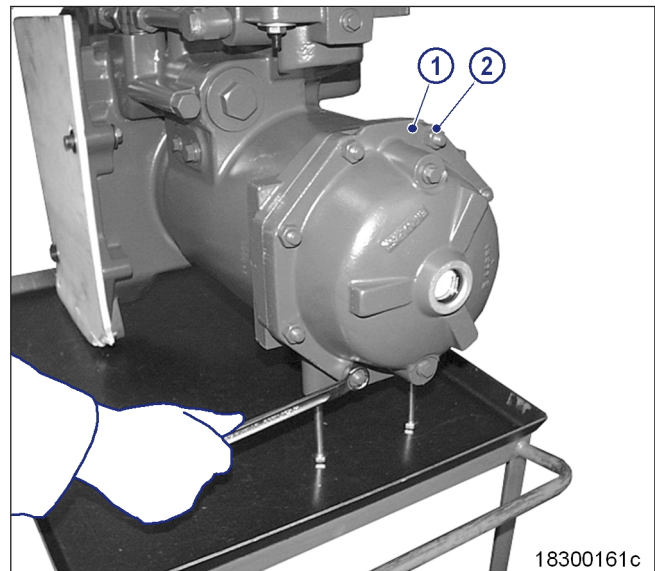
Contamination of components.

Damage to component!

- Observe manufacturer's instructions.
- Check components for special cleanliness.

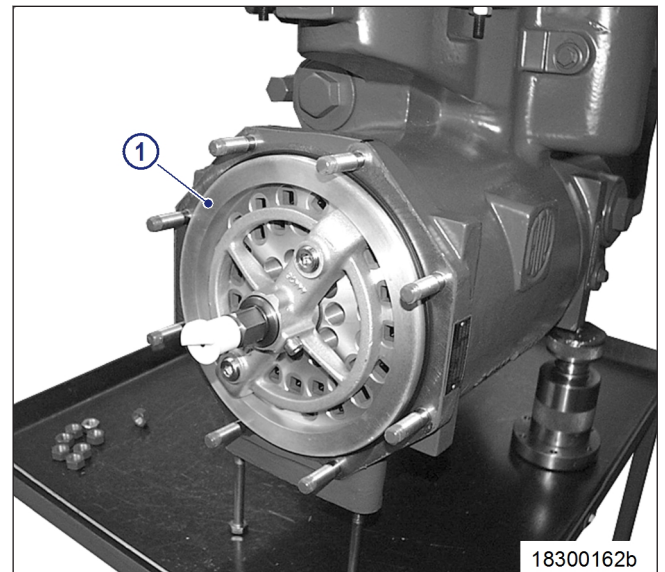
Automatic oil filter element – Removal

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



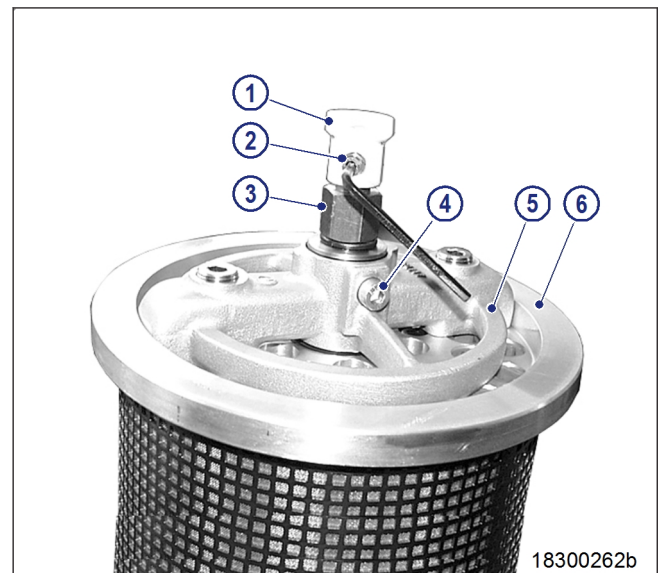
TIM-ID: 0000051167 - 003

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

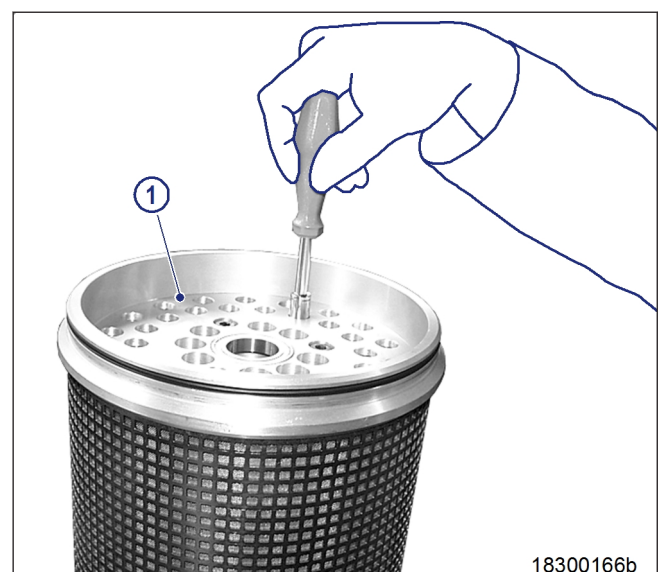


Oil filter candles – Replacement

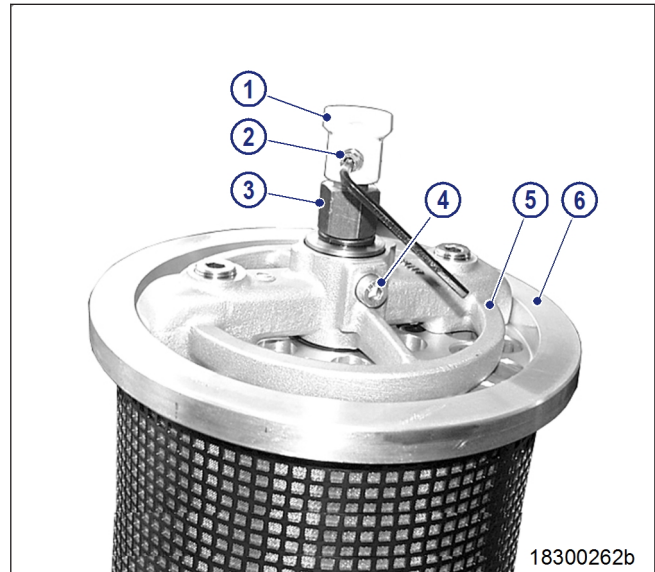
1. Remove screw (2).
2. Withdraw plastic spinner (1) with spring.
3. Remove nut (3).
4. Take off spring washer and washer.
5. Remove screw (4).
6. Remove flushing arm (5) from strainer plate (6).



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



9. Replace all sealing elements.
 10. Insert O-rings in grooves.
 11. Install strainer plate (6) and flushing arm (5).
- Note: Observe position of socket-head cap screw in relation to elongated hole on shaft.
12. Screw in screw (4).
 13. Fit washer and spring washer.



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

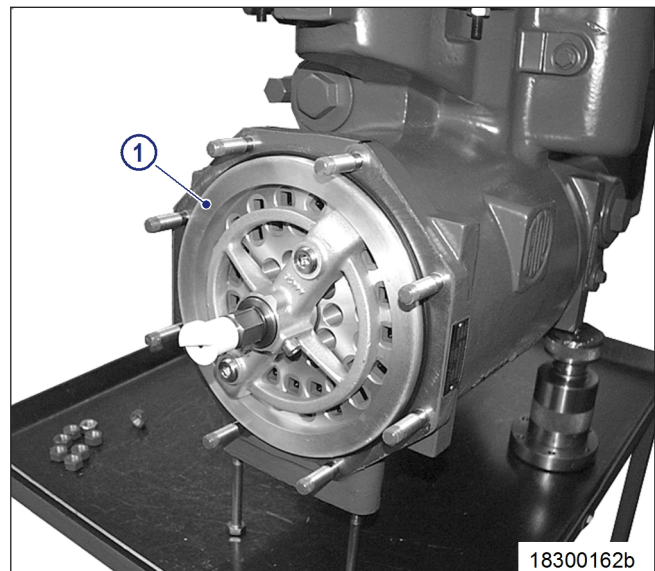
Name	Size	Type	Lubricant	Value/Standard
Nut		Tightening torque	(Engine oil)	80 Nm

15. Fit plastic spinner (1) with spring.
16. Use torque wrench to tighten screw (2) to specified tightening torque.

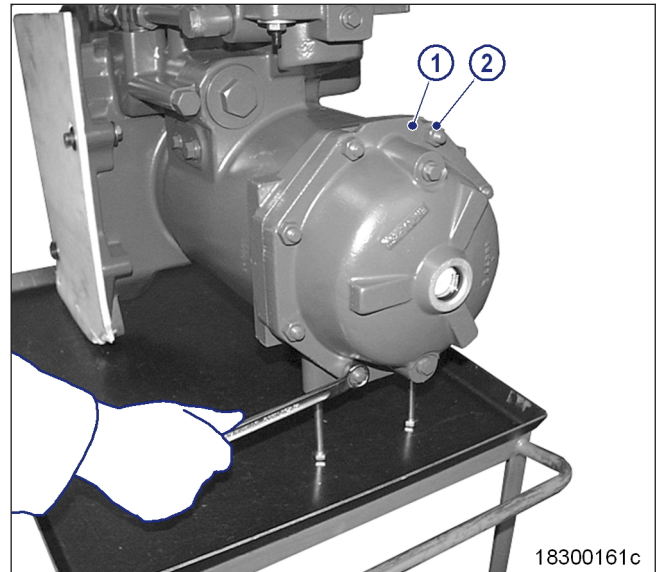
Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque	(Engine oil)	9 Nm

Automatic oil filter element – Installation

1. Insert O-ring into groove.
2. Fit automatic oil filter element (1) on flushing arm shaft.



3. Fit oil filter cover (1).
4. Tighten nuts (2) from oil filter cover (1).



8.14.3 Oil indicator filter – Cleaning and check

Preconditions

- Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Cleaner (Snow-White 11-0)	X00054118	1
Cleaner (Hakupur 50/136)	X00056700	1
Engine oil		
Strainer	(→ Spare Parts Catalog)	
Square-section ring	(→ Spare Parts Catalog)	
O-ring	(→ Spare Parts Catalog)	

WARNING



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

WARNING



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

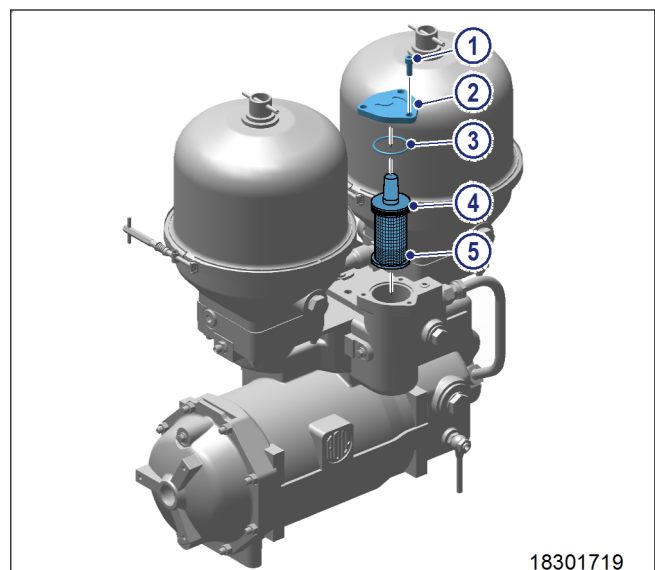
NOTICE



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

Removing strainer

1. Clean oil indicator filter before disassembling it.
2. Remove screws (1).
3. Take off cover (2) and O-ring (3).
4. Remove strainer (5) from housing and allow oil to drip into container.



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Cleaning strainer

1. Shake coarse contamination out of strainer (5).
2. Clean all metallic parts with cleaner (Snow-White 11-0), then rinse with cleaner (Hakupur 50/136).

Note: Do not damage the fabric of the strainer.

3. Use a soft brush to remove stubborn deposits from strainer if required.
4. Blow out strainer (5) with compressed air from outside to inside.

Checking strainer

Item	Findings	Measure
Strainer	Metallic residues	<ul style="list-style-type: none">• Clean• Monitor engine operation• Check strainer daily• Contact Service.
Strainer	Damaged	Replace
Square-section ring	Damaged	Replace
O-ring	Damaged	Replace

Installing strainer

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

8.14.4 Centrifugal oil filter and filter sleeve – Cleaning and replacement

Preconditions

- Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Filter wrench	F30379104	1
Torque wrench, 4–20 Nm	F30044239	1
Cold cleaner (Hakutex 60)	X00056750	1
Assembly compound (Kluth Hakuform 30-15)	X00067260	1
Filter sleeve	(→ Spare Parts Catalog)	
Sealing ring	(→ Spare Parts Catalog)	
Sealing ring	(→ Spare Parts Catalog)	

WARNING



Hot oil.

Oil can contain combustion residues which are harmful to health.

Risk of injury and poisoning!

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

WARNING



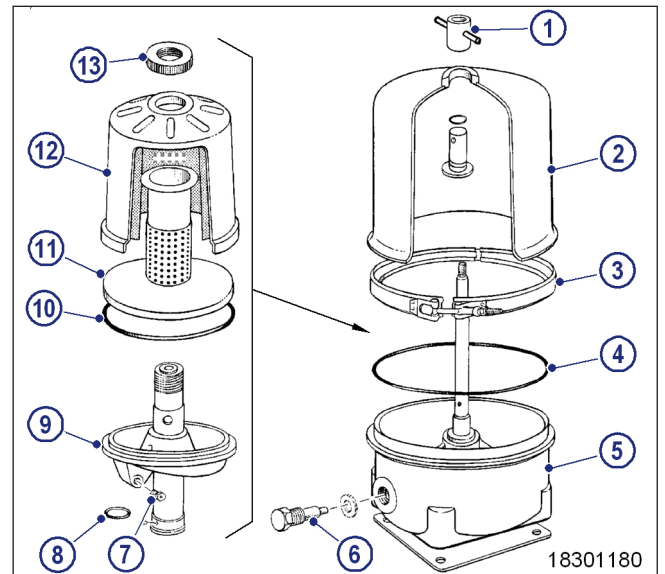
Compressed air gun ejects a jet of pressurized air.

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

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

Cleaning and replacing centrifugal oil filter and filter sleeve

1. Release screw (1) and remove.
2. Remove clamp (3) and take off hood (2).
3. Carefully remove rotor assembly (12) from housing (5).
4. Hold rotor assembly (12) firmly in position with filter wrench and release knurled nut (13).
5. Take off rotor cap (12).
6. Remove filter sleeve, stiffener plate and sealing ring (10).
7. Measure layer thickness of oil residues on filter sleeve.
8. If maximum layer thickness of oil residues exceeds 30 mm, shorten maintenance interval.
9. Take off standpipe (11) from lower rotor section (9).
10. Wash hood (2), rotor cap (12), stiffener plate, standpipe (11), rotor lower section (9) and nozzles (7) with cold cleaner and blow out with compressed air. Do not use sharp-edged objects for cleaning.
11. Check nozzles (7) for obstructions.
12. Push standpipe (11) onto rotor lower section (9).
13. Insert the new filter sleeve with stiffener plate in rotor cap (12) with the smooth surface facing the rotor cap.
14. Check sealing ring (10), fit new one if necessary. Coat sealing ring with grease and insert in groove of rotor cap (12).
15. Place rotor cap (12) onto standpipe (11).
16. Hold rotor assembly (12) firmly in position with filter wrench and tighten knurled nut (13).
17. Lubricate bearings of rotor assembly (12), insert in housing (5) and check for ease of movement.
18. Check sealing ring (4), fit new one if necessary. Fit sealing ring on housing (5).
19. Fit hood (2).
20. Tighten screw (1) by hand.
21. Install clamp (3) and tighten to specified torque using a torque wrench.



Name	Size	Type	Lubricant	Value/Standard
Clamp		Tightening torque		8 Nm to 9 Nm

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

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

8.14.5 Centrifugal oil filter - Cleaning and filter-sleeve replacement

Preconditions

- Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 4-20 Nm	F30044239	1
Torque wrench, 10-60 Nm	F30452769	1
Ratchet adapter	F30027340	1
Cold cleaner(Hakutex 60)	X00056750	1
Filter sleeve	(→ Spare Parts Catalog)	
Sealing ring	(→ Spare Parts Catalog)	

WARNING



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

WARNING



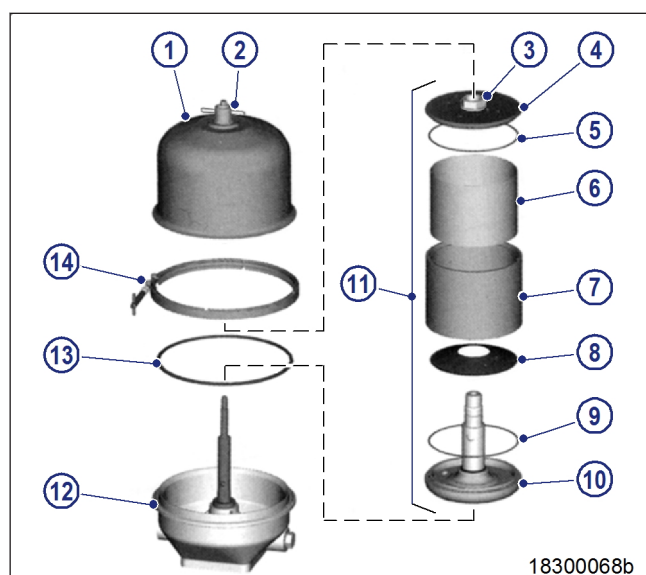
- Compressed air gun ejects a jet of pressurized air.
Risk of injury to eyes and damage to hearing, risk of rupturing internal organs!
- Never direct air jet at people.
 - Always wear safety goggles/face mask and ear defenders.

Centrifugal oil filter – Cleaning and filter-sleeve replacement

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

Result: Shorten maintenance interval if the oil residues exceed the maximum thickness of 45 mm.

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



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

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

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

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

8.15 Coolant Circuit, General, High-Temperature Circuit

8.15.1 Engine coolant – Level check

Preconditions

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

WARNING



Coolant is hot and under pressure.

Risk of injury and scalding!

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

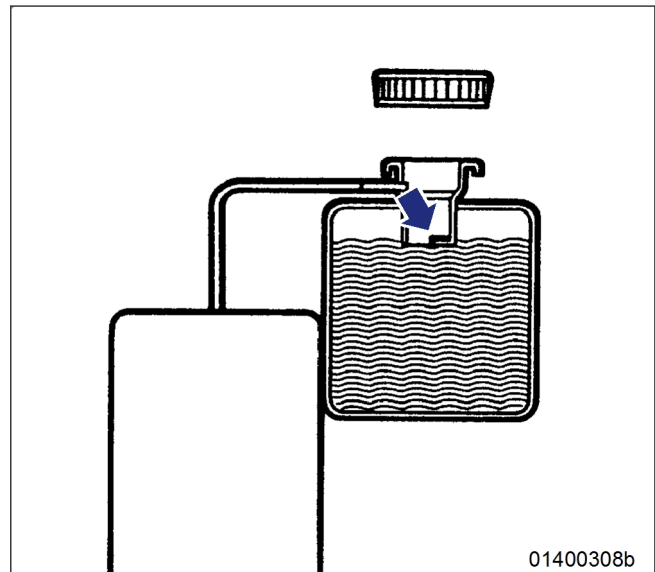
Checking engine coolant level at filler neck:

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

Checking engine coolant level at remote cooler:

Note: Engine coolant must be visible at marker plate.

1. Check engine coolant level.
2. Top up engine coolant as necessary (→ Page 156).
3. Check and clean cap.
4. Place cap on filler neck and close.



Checking engine coolant level via level sensor:

Note: Engine coolant level is automatically monitored by the engine control system.

1. Switch on engine control system and check readings on the display.
2. Top up engine coolant as necessary (→ Page 156).

8.15.2 Engine coolant - Change

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Coolant		

Engine coolant change

1. Drain engine coolant (→ Page 154).
2. Fill with engine coolant (→ Page 156).

8.15.3 Engine coolant - Draining

Preconditions

- Engine is stopped and starting disabled.

WARNING



Coolant is hot and highly pressurized.

Risk of injury! Risk of scalding!

- Allow engine to cool down.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

Preparatory steps

1. Provide a suitable container to collect the coolant.
2. Switch off preheating unit (external).

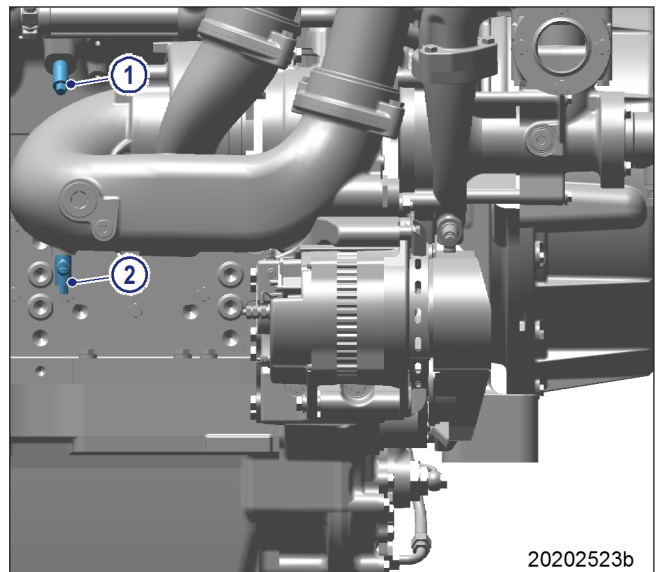
Engine coolant - Draining

1. Provide a suitable container to collect the coolant.
2. Turn cover on coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
3. Continue to turn cover counterclockwise and remove.
4. Extract remaining engine coolant in the coolant expansion tank via the filler neck.

5. Drain engine coolant at preheating unit (external).
6. Open drain valve (2) and drain engine coolant at elbow on engine coolant pump.
7. Open drain valves (1) on A and B side of crankcase and drain engine coolant.

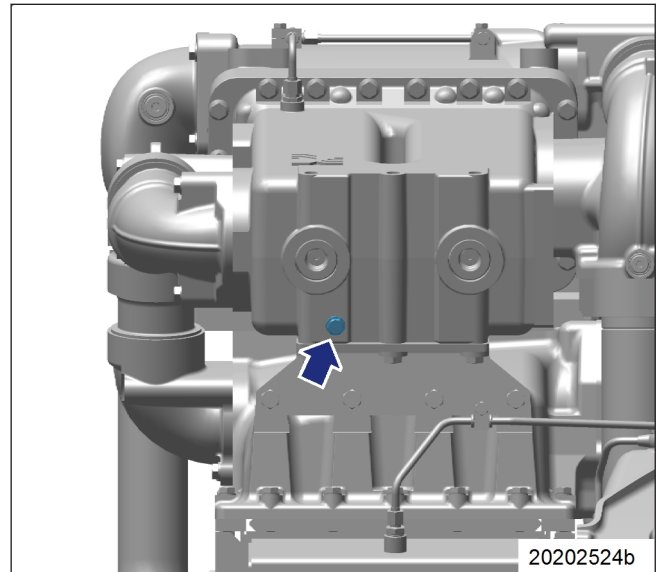
Note: With the air compressor (optional) installed at the drain point (A side), the drain valve is inaccessible.

8. Open supply hose at air compressor.



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9. Drain remaining engine coolant at EGR cooler, A and B side (arrow).



Final steps

1. Close all open drain points.
2. Fit cover on filler neck and close it.

8.15.4 Engine coolant - Filling

Preconditions

- Engine is stopped and starting disabled.
- MTU Fluids and Lubricants Specifications (A001061/..) are available.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine coolant		

WARNING



Coolant is hot and highly pressurized.

Risk of injury! Risk of scalding!

- Allow engine to cool down.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

NOTICE



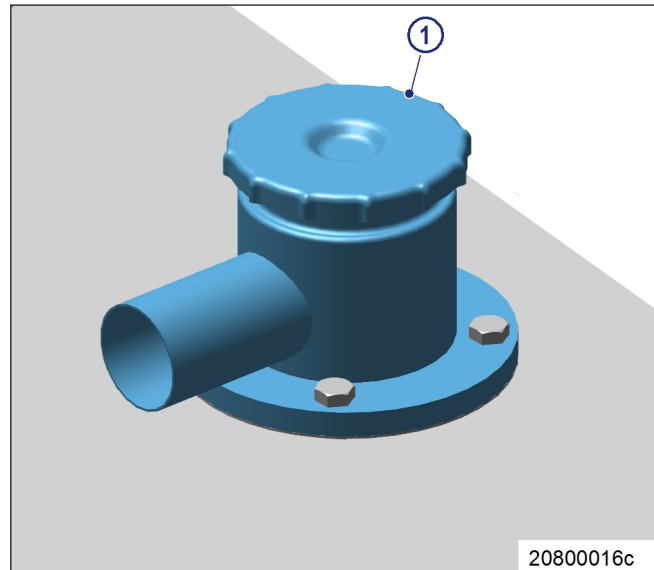
Cold coolant in hot engine can cause thermal stress.

Possible formation of cracks in the engine!

- Fill / top up coolant only into cold engine.

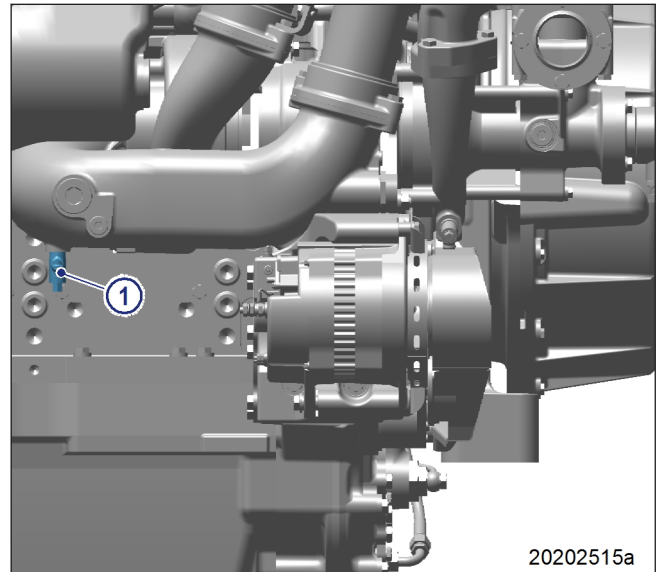
Preparatory steps

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



Filling with engine coolant using pump

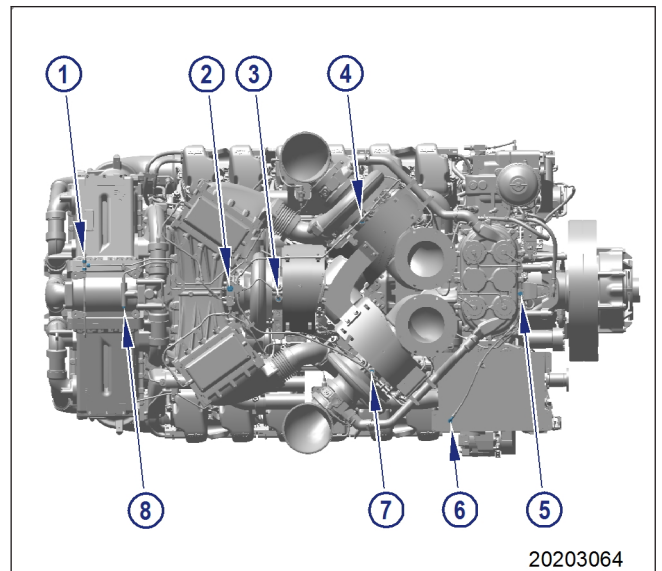
1. Connect appropriate pump with hose to drain valve (1).



2. Open vent points on EGR cooler (1, 8), distributors (2, 5), exhaust turbochargers (3, 4, 7) and oil heat exchanger (6).
3. Open drain valve and pump coolant into engine at 0.5 bar minimum.

Result: When coolant emerges from the vent points, close vent points one by one, proceeding from the lowest point upwards.

4. Fill expansion tank until overflow edge is reached.
5. Close drain valve.
6. Check satisfactory condition of cover and clean sealing faces if required.
7. Fit cap on filler neck and close it.
8. Start engine (→ Page 55) and shut down after 10 second of operation without load (→ Page 55).
9. Continue to turn cover counterclockwise and remove.
10. Check engine coolant level (→ Page 152) and top up coolant as necessary:
 - a) Fill in coolant in expansion tank until the coolant level at top edge of filler neck remains constant.
 - b) Fit cap on filler neck and close it.
 - c) Repeat the steps from "Start engine" (→ Step 8) until no more engine coolant needs to be topped up.
 - d) Disconnect pump and hose.

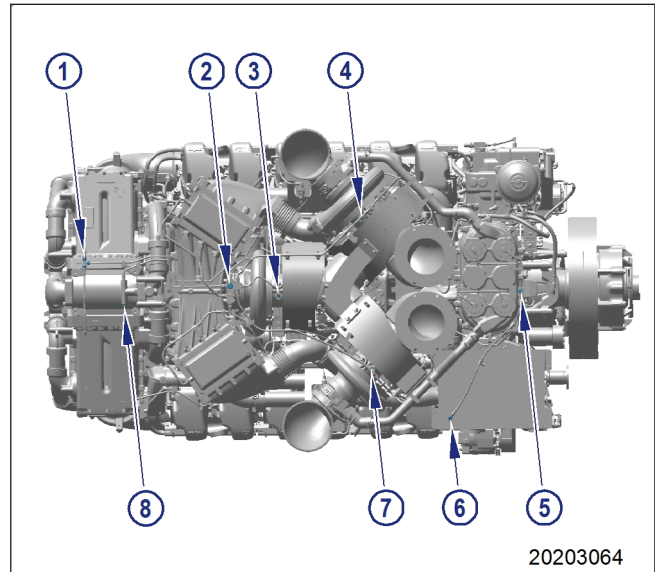


Alternatively: Filling with coolant through filler neck

1. Open vent points on EGR cooler (1, 8), distributors (2, 5), exhaust turbochargers (3, 4, 7) and oil heat exchanger (6).
2. Fill engine coolant in expansion tank via filler neck until coolant level at top edge of filler neck remains constant.

Result: When coolant emerges from the vent points, close vent points one by one, proceeding from the lowest point upwards.

3. Check satisfactory condition of cover and clean sealing faces if required.
4. Place cover onto filler neck and close until first stop is reached.
5. Start engine (→ Page 55) and shut down after 10 second of operation without load (→ Page 56).
6. Turn cover counterclockwise and remove.
7. Check engine coolant level (→ Page 152) and top up coolant as necessary:
 - a) Repeat the steps from “Start engine” (→ Step 5) until no more engine coolant needs to be topped up.
 - b) Check satisfactory condition of cover and clean sealing faces if required.
 - c) Fit cap on filler neck and close it.



Final steps

1. Start the engine and run it without load for some minutes.
2. Check engine coolant level (→ Page 152) and top up coolant as necessary.

8.15.5 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



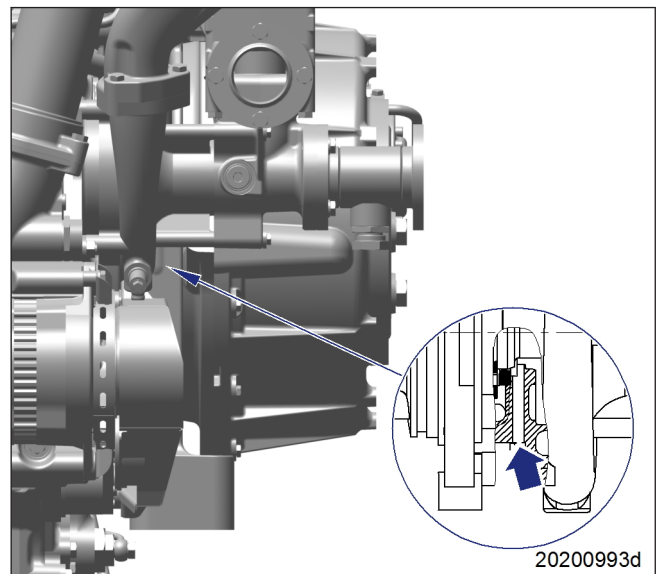
High level of engine noise when the engine is running.

Risk of damage to hearing!

- Wear ear protectors.

Engine coolant pump – Relief bore check

1. Check relief bore (arrowed) for oil and coolant discharge.
2. Stop engine (→ Page 56) and disable engine start, observe general safety instructions “Maintenance and Repair”.
3. Clean relief bore with a wire if it is dirty.
 - Permissible coolant discharge: up to 10 drops per hour
 - Permissible oil discharge: up to 5 drops per hour
4. If the number of drops is higher, contact Service.






8.15.6 Engine coolant – Sample extraction and analysis

Preconditions

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

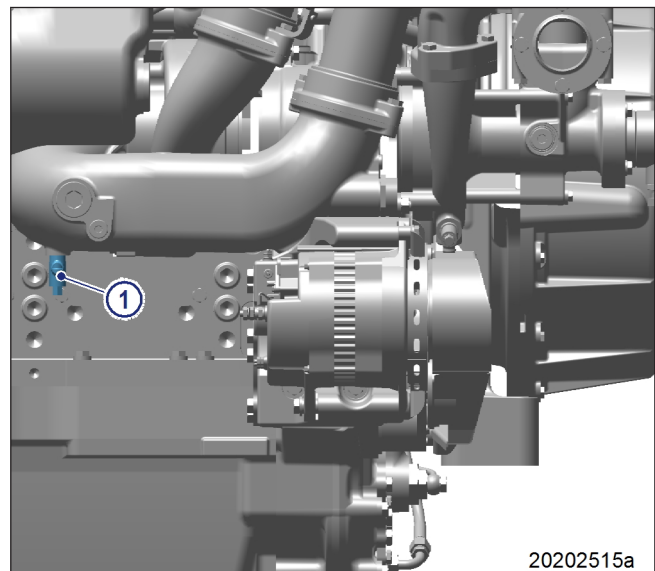
Special tools, Material, Spare parts

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

DANGER 	Rotating and moving engine parts. Risk of crushing, danger of parts of the body being caught or pulled in! <ul style="list-style-type: none">• Only run the engine at low power. Keep away from the engine's danger zone.
WARNING 	Coolant is hot and highly pressurized. Risk of injury! Risk of scalding! <ul style="list-style-type: none">• Allow engine to cool down.• Wear protective clothing, protective gloves, and safety glasses / facial protection.
WARNING 	High level of engine noise when the engine is running. Risk of damage to hearing! <ul style="list-style-type: none">• Wear ear protectors.

Engine coolant – Sample extraction and analysis

1. With the engine running, open drain valve (1).
 2. Drain off approx. 1 liter of engine coolant.
- Result: Drain point is rinsed.
3. Drain approx. 1 liter coolant into a clean container.
 4. Close drain valve (1).
 5. Using the equipment and chemicals of the MTU test kit, check the engine coolant for:
 - Concentration of engine coolant additives
 - pH value
 6. Engine coolant change intervals (→ MTU Fluids and Lubricants Specifications (A001061/..)).



8.15.7 Breather valve – Replacement

Preconditions

- Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Valve breather	(→ Spare Parts Catalog)	1

WARNING



Coolant is hot and under pressure.

Risk of injury and scalding!

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

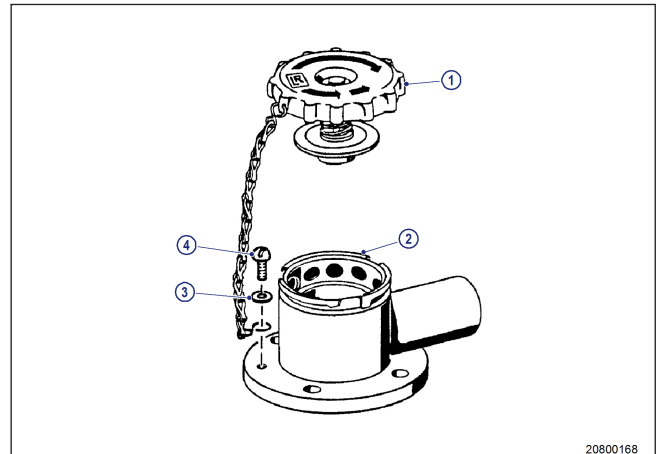
Preparatory steps

- ▶ Switch off preheating unit.

Breather valve – Replacement

Note: Pictorial schematic. Design may deviate.

1. Turn breather valve (1) on coolant expansion tank counterclockwise to the first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Remove chain with screw (4) and washer (3).
4. Draw off separated corrosion inhibitor oil in expansion tank via filler neck (2).
5. Fit new breather valve and close it.
6. Install chain.



8.16 Low-Temperature Circuit

8.16.1 Charge-air coolant - Level check

Preconditions

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

WARNING



Coolant is hot and under pressure.

Risk of injury and scalding!

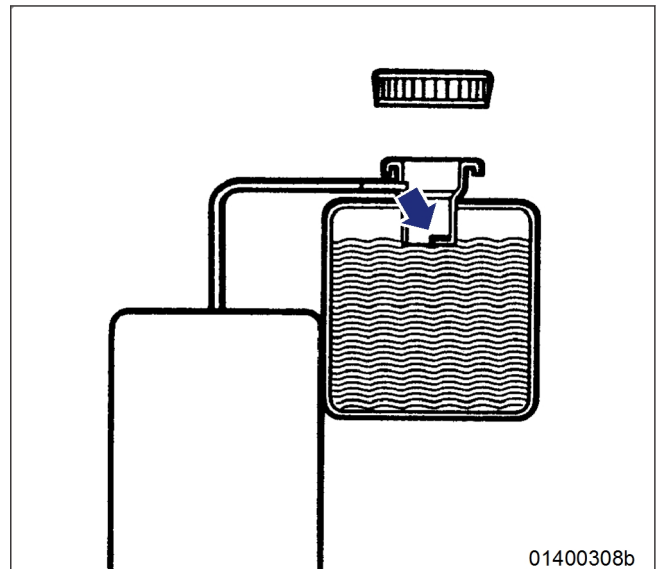
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Checking charge-air coolant level at filler neck:

1. Turn cap on coolant expansion tank counterclockwise to the first stop and allow pressure to escape.
2. Continue to turn cap counterclockwise and remove.

Note: Charge-air coolant must be visible at marker plate.

3. Check charge-air coolant level.
4. Top up charge-air coolant as necessary (→ Page 167).
5. Check that cap is in serviceable condition.
6. Clean sealing surfaces as necessary.
7. Fit cap and close tight.



Checking charge-air coolant level by means of level sensor:

Note: Coolant level is automatically monitored by engine control system.

1. Switch on engine control system and check readings on the display.
2. Top up charge-air coolant as necessary (→ Page 167).

8.16.2 Charge-air coolant - Change

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Coolant		

Charge-air coolant - Change

1. Drain charge-air coolant (→ Page 164).
2. Fill with charge-air coolant (→ Page 167).

8.16.3 Charge-air coolant - Draining

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ Operating voltage is not applied.
- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

Special tools, Material, Spare parts

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

WARNING



Hot components/surfaces.

Risk of burns!

- Allow the engine to cool down to below 50 °C before beginning work.
- Wear suitable protective equipment/thermal gloves.
- Avoid unprotected contact with hot surfaces.

WARNING



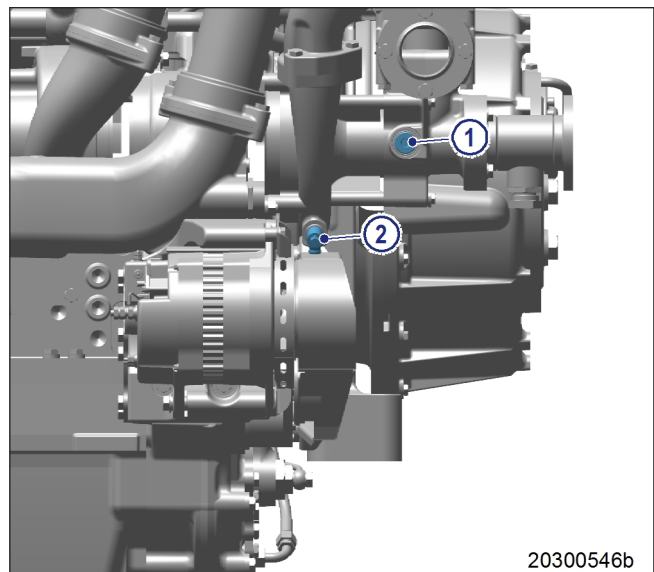
Coolant is hot and highly pressurized.

Risk of injury! Risk of scalding!

- Allow engine to cool down.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

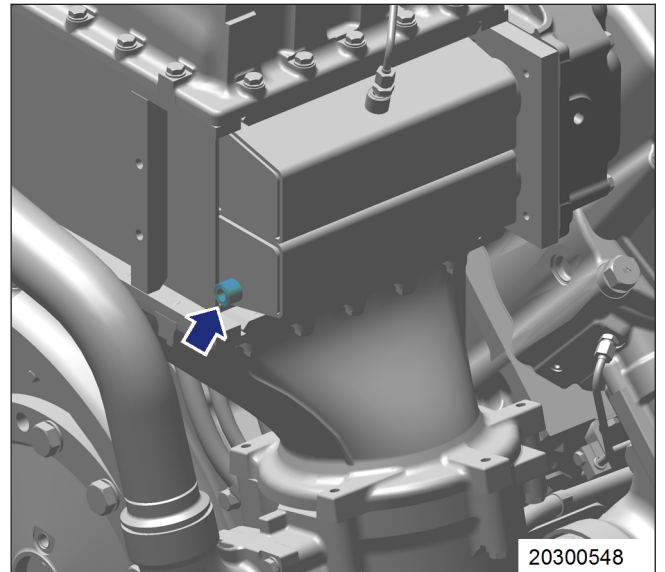
Draining charge-air coolant

1. Provide a suitable container in which to collect the charge-air coolant.
2. Turn cover on coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
3. Continue to turn cover counterclockwise and remove.
4. Extract remaining charge-air coolant in the coolant expansion tank via the filler neck.
5. Open drain valve (2) and drain charge-air coolant at charge-air coolant pump.
6. Unscrew drain screw (1) and drain charge-air coolant at thermostat housing.

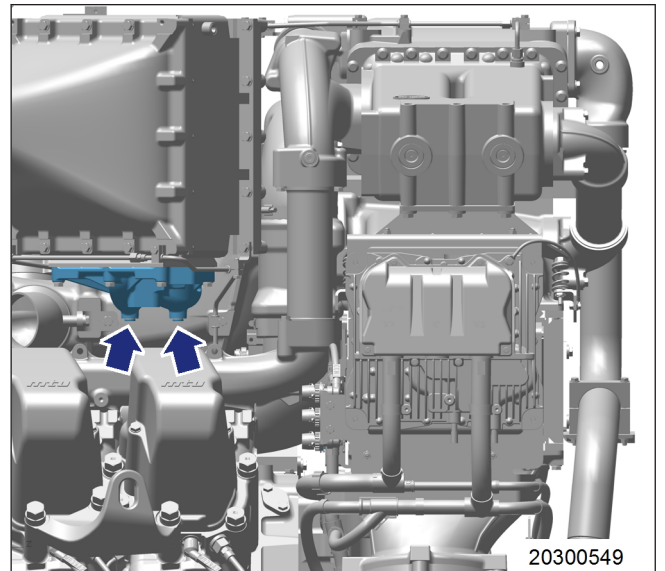


TIM-ID: 0000026956 - 007

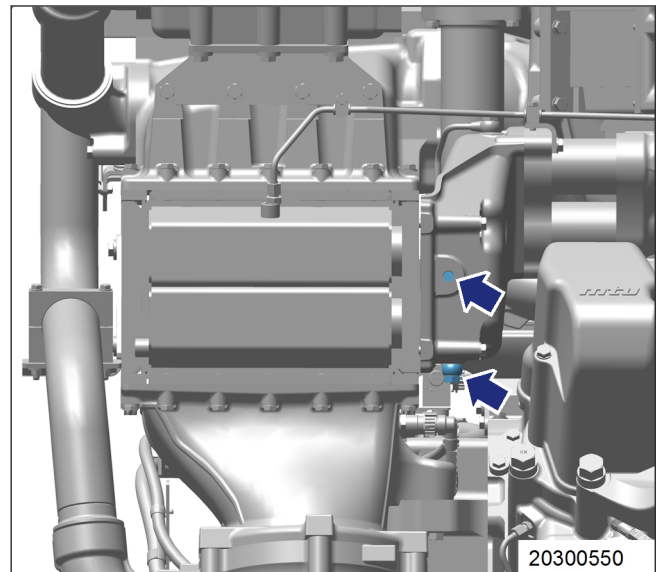
7. Drain remaining charge-air coolant at inter-cooler (high pressure) (arrowed).



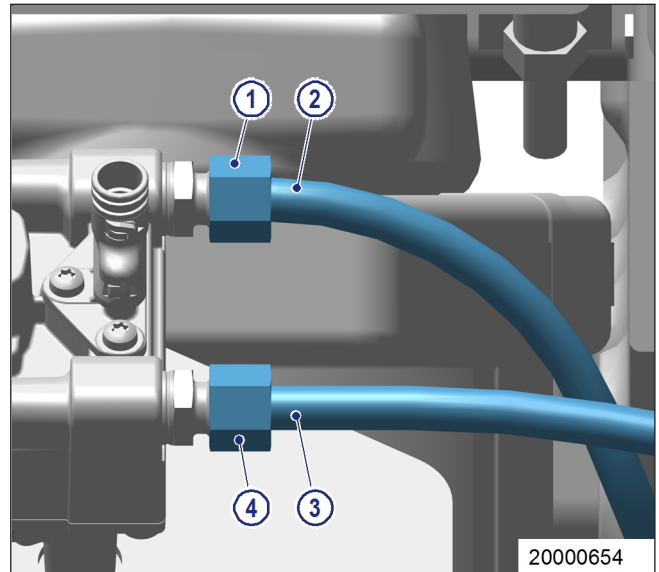
8. Drain remaining charge-air coolant at inter-cooler (low pressure) A side (arrowed).



9. Drain remaining charge-air coolant at inter-cooler (low pressure) B side (arrowed).



- Note:
- The procedure is only described for one exhaust flap, but also applies to the remaining exhaust flaps. Exhaust flap overview (→ Page 125).
 - Collect emerging engine coolant in a suitable container.
10. Loosen the union nut (4) of the lower coolant line (3).
 11. Carefully pull the coolant line (3) out of the union.
 12. Loosen the union nut (1) of the upper coolant line (2).
 13. Pull the coolant line (2) a little out of the union.
- Note: Wait until no more coolant comes out of the lines.
14. Tighten the union nuts (1, 4) of the coolant lines (2, 3) again.



Final steps

1. Close all drain valves and screw in drain plugs with new sealing rings.
2. Fit cap on filler neck and close it.

8.16.4 Charge-air coolant - Filling

Preconditions

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

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Charge-air coolant		

WARNING



Coolant is hot and highly pressurized.

Risk of injury! Risk of scalding!

- Allow engine to cool down.
- Wear protective clothing, protective gloves, and safety glasses / facial protection.

NOTICE



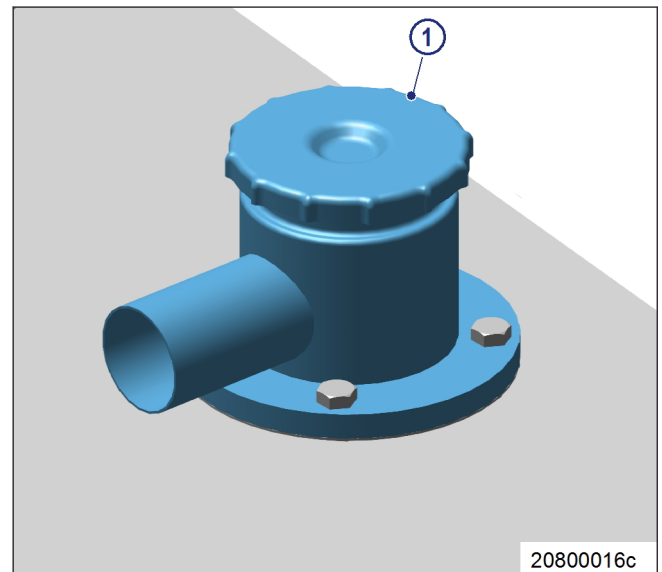
Cold coolant in hot engine can cause thermal stress.

Possible formation of cracks in the engine!

- Fill / top up coolant only into cold engine.

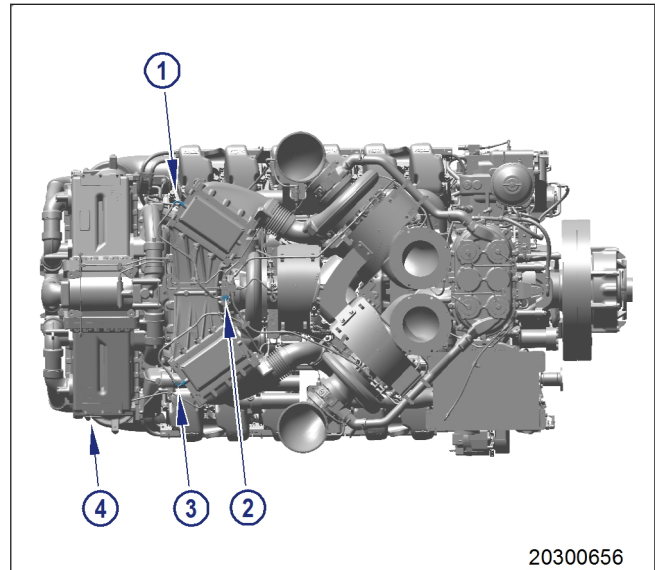
Preparatory steps

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



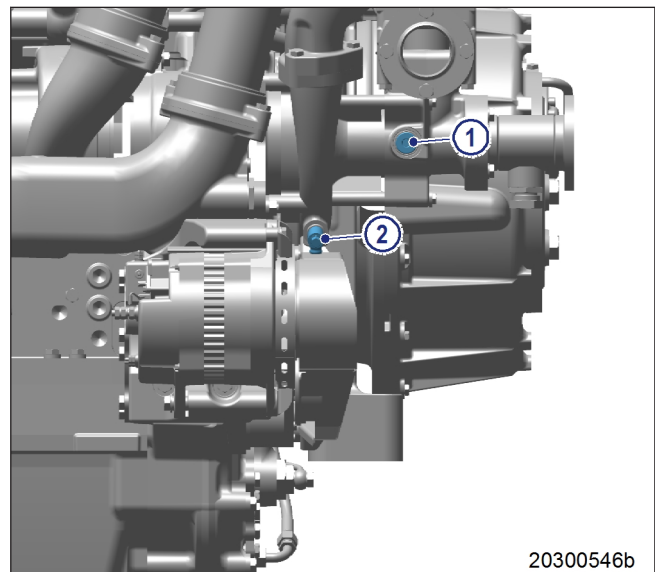
Filling with charge-air coolant through filler neck

1. Open vent points at intercooler (high pressure) (4), intercooler (low pressure) (1, 3) and distributor (2,).
2. Fill in charge-air coolant at expansion tank via filler neck until coolant level at top edge of filler neck remains constant.
3. Check satisfactory condition of cover and clean sealing faces if required.
4. Place cover onto filler neck and close until first stop is reached.
5. Start engine (→ Page 55).
6. After 10 seconds of running the engine without load, shut down the engine (→ Page 56).
7. Turn cover counterclockwise and remove.
8. Check charge-air coolant level (→ Page 162) and top up if required:
 - a) Repeat the steps from “Start engine” (→ Step 5) until charge-air coolant no longer needs to be topped up.
 - b) Check satisfactory condition of cover and clean sealing faces if required.
 - c) Fit cap on filler neck and close it.

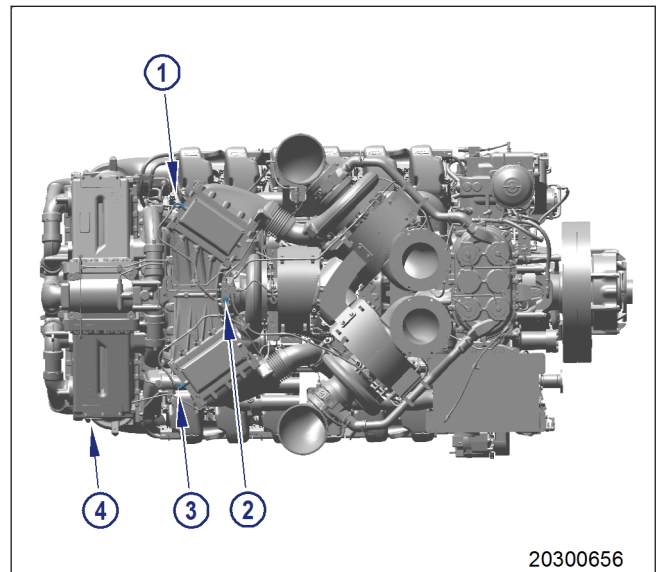


Alternatively: Filling with charge-air coolant using pump

1. Connect suitable pump with a hose to one of the drain valves (1, 2).



2. Open vent points at intercooler (high pressure) (4), intercooler (low pressure) (1, 3) and distributor (2,).
3. Open drain valve and pump charge-air coolant into engine at 0.5 bar minimum.
4. Fill expansion tank until overflow edge is reached.
5. Close drain valve.
6. Check proper condition of cover and clean sealing faces if required.
7. Fit cap on filler neck and close it.
8. Start engine (→ Page 55).
9. After 10 seconds of running the engine without load, shut down the engine (→ Page 56).
10. Turn cover on coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
11. Continue to turn cover counterclockwise and remove.
12. Check charge-air coolant level (→ Page 162) and top up if required:
 - a) Fill charge-air coolant into expansion tank until the coolant level at top edge of filler neck remains constant.
 - b) Fit cap on filler neck and close it.
 - c) Repeat the steps from “Start engine” (→ Step 8) until charge-air coolant no longer needs to be topped up.
 - d) Disconnect pump and hose.



Final steps

1. Start the engine and run it without load for some minutes.
2. Check charge-air coolant level (→ Page 162) and top up if required.

8.16.5 Checking charge-air coolant pump pressure relief port

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.

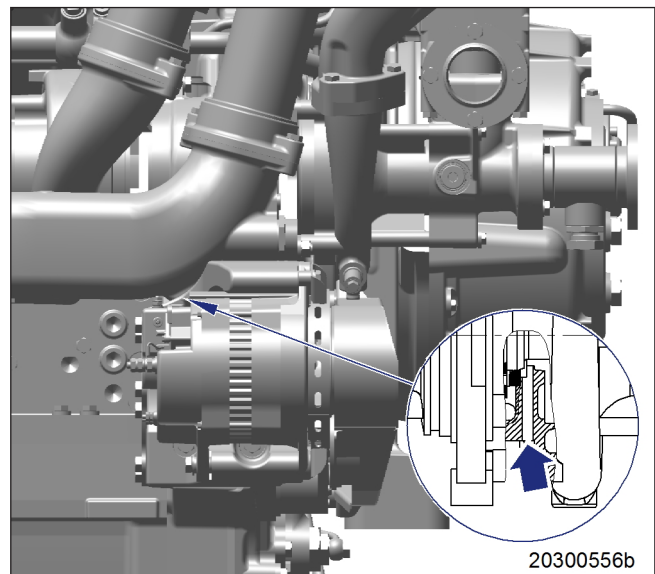
Checking charge-air coolant pump pressure relief port

1. Check pressure relief port (arrow) for oil and coolant discharge.

Note: Observe safety regulations when carrying out maintenance and repair work (→ Page 9).

2. Shut down engine (→ Page 56) and disable engine start.
3. Clean the pressure relief port with a wire if it is dirty.
 - Permissible coolant discharge: up to 10 drops per hour
 - Permissible oil discharge: up to 5 drops per hour

Result: If discharge is greater, contact Service.



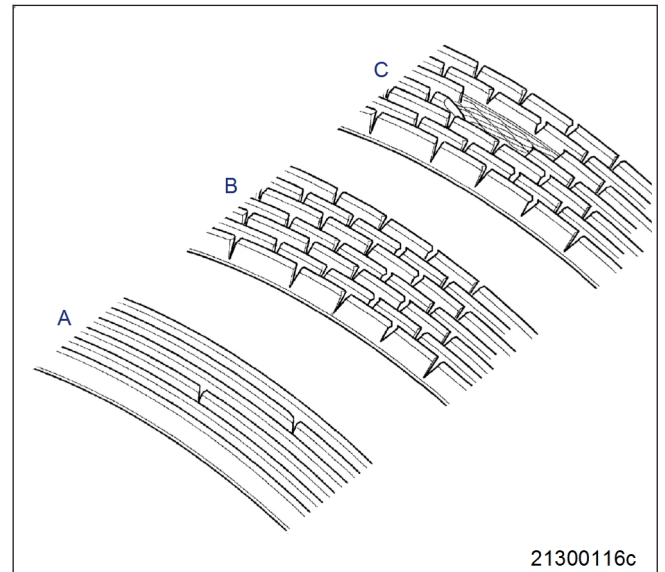
8.17 Belt Drive

8.17.1 Drive belt - Condition check

Preconditions

- Engine is stopped and starting disabled.
- Guard is removed.

Drive belt - Condition check



Item	Findings	Action
Drive belt A	Singular cracks	None
Drive belt B	Cracks on entire circumference	Replace (→ Page 173)
Drive belt C	Chunking	
Drive belt	Belt is oily, shows signs of over-heating	

8.18 Battery-Charging Generator

8.18.1 Battery-charging generator - Check

Preconditions

- ☑ Engine is stopped and starting disabled.

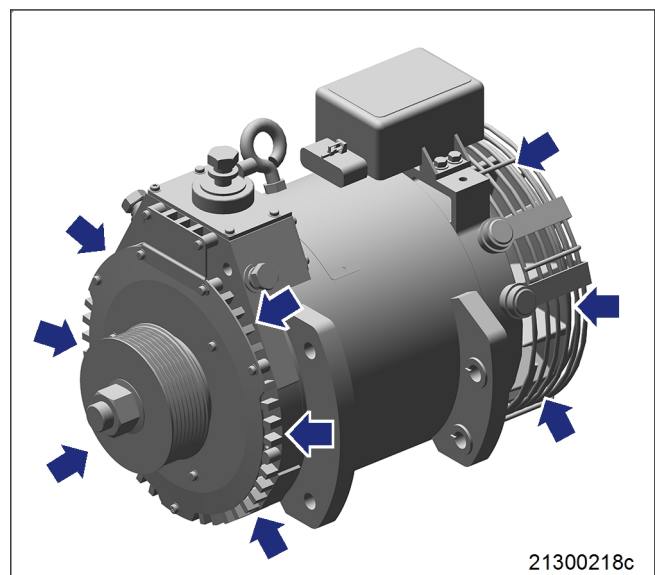
WARNING



Compressed air gun ejects a jet of pressurized air.

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

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



Checking battery-charging generator

Item	Findings	Measure
Ventilation areas (arrows)	Clean	None
Ventilation areas (arrows)	Contaminated	Clean

Cleaning battery-charging generator

Note: Dry-clean battery-charging generator only. Do not insert sharp objects in the ventilation openings.

1. Remove coarse contamination from battery-charging generator.
2. Blow out ventilation areas (arrows) with compressed air until there is no more dust development.

8.18.2 Battery-charging generator drive - Drive belt replacement

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

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

WARNING



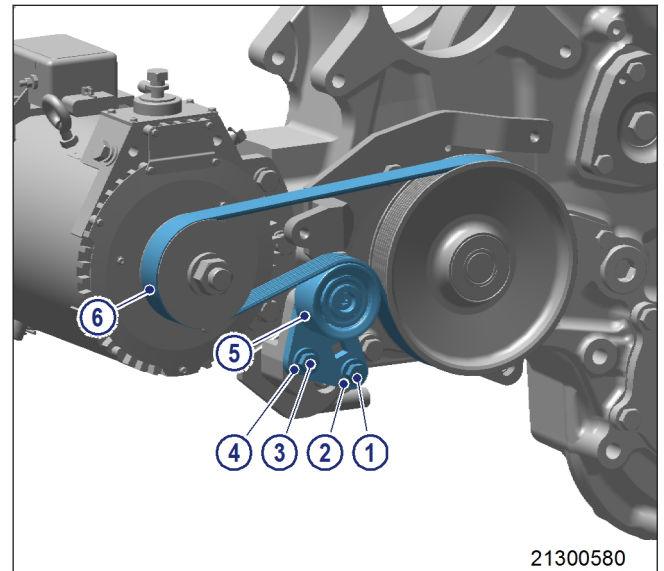
Spring/circlip/tensioning roller preload.

Risk of injury!

- Only use specified tool and equipment.

Battery-charging generator drive - Drive belt replacement

1. Remove protective cover.
 2. Loosen screws (1, 3) by half a turn.
 3. Remove screw (3) with washer (4).
 4. Holding belt tensioner (5), continue to loosen screw (1) and allow belt tensioner (5) to move slowly downwards.
 5. Remove screw (1) with washer (2) and take off belt tensioner (5).
 6. Take off used drive belt (6).
 7. Fit new drive belt (6) and position it on both belt pulleys.
 8. Fit belt tensioner (5) and install screw (1) with washer (2).
 9. Use assembly tool to press belt tensioner (5) against drive belt (6) and hold it in this position.
 10. Install screw (3) with washer (4).
- Note: Make sure not to damage the screw thread.
11. Slowly release belt tensioner (5), until it makes contact with the shank of screw (3).
 12. Tighten screws (1, 3).
 13. Install protective cover.



8.19 Fan Drive

8.19.1 Fan drive - Drive belt tension check / adjustment

Preconditions

- Engine is stopped and starting disabled.

Special tools, Material, Spare parts

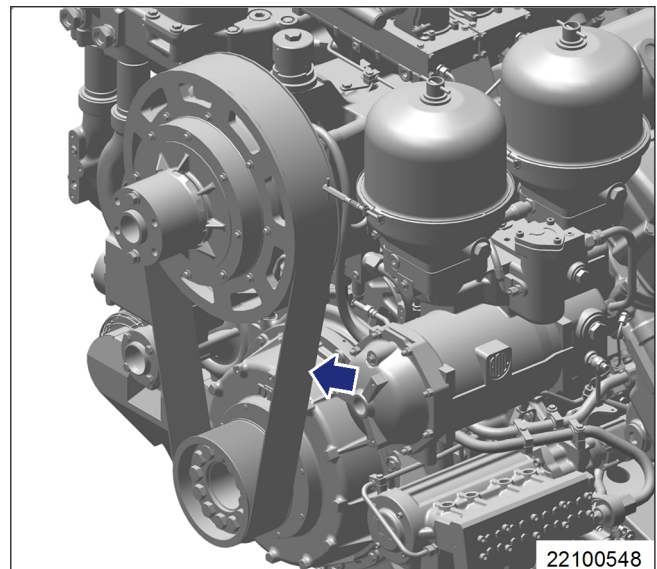
Designation / Use	Part No.	Qty.
Optibell 2 belt tension tester	Y4345711	1

Preparatory steps

1. Remove protective cover.
 2. Check belt condition visually (→ Page 171).
- Result: For drive belt replacement (→ Page 179).

Checking V-belt tension – Rockford S270 fan clutch

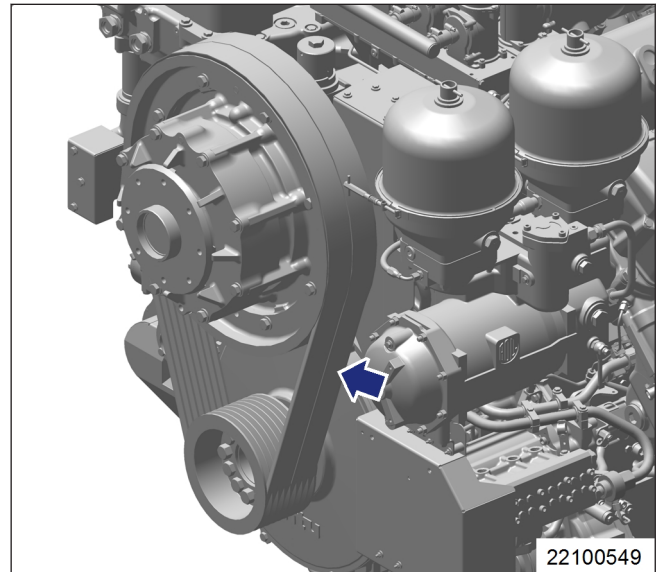
1. Switch on belt tension tester.
2. Hold measuring tip of belt tension tester over belt drive. Tap drive belt (arrow) with a suitable tool.
3. Hold belt tension tester over belt drive until the measured value is indicated.



Initial assembly at MTU	Initial operation with fan	Re-tensioning
None	60 Hz ± 1 Hz	52 Hz ± 1 Hz

Checking V-belt tension – Rockford S370 fan clutch

1. Switch on belt tension tester.
2. Hold measuring tip of belt tension tester over belt drive. Tap drive belt (arrow) with a suitable tool.

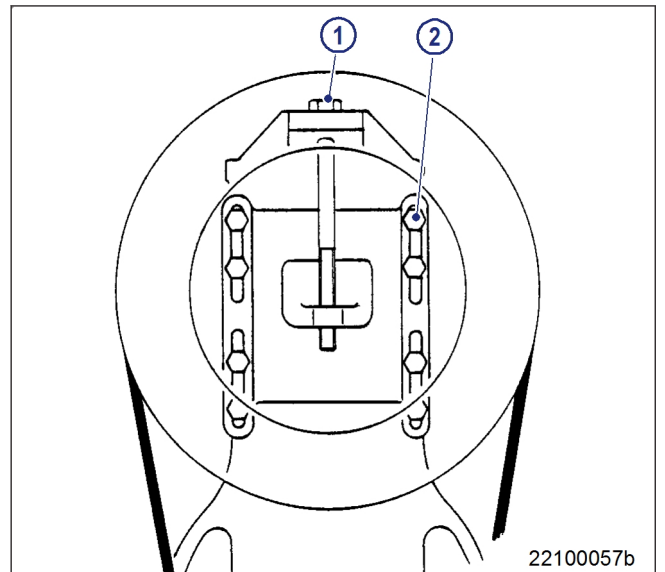


3. Hold belt tension tester over belt drive until the measured value is indicated.

Initial assembly at MTU	Initial operation with fan	Re-tensioning
36 Hz ±5 Hz	49 Hz ±2 Hz	44 Hz ±2 Hz

Adjusting drive belt tension

1. Release screws (2) until fan clutch can be moved.
2. Tighten stud (1) until the required frequency is achieved.



3. For Rockford S270 fan clutch: Tighten screws (2) to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M12x60	Tightening torque		100 Nm +10 Nm

4. For Rockford S370 fan clutch: Tighten screws (2) to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M16x80	Tightening torque		270 Nm +10 Nm

8.19.2 Fan drive - Drive belt replacement

Preconditions

- Engine is stopped and starting disabled.

Special tools, Material, Spare parts

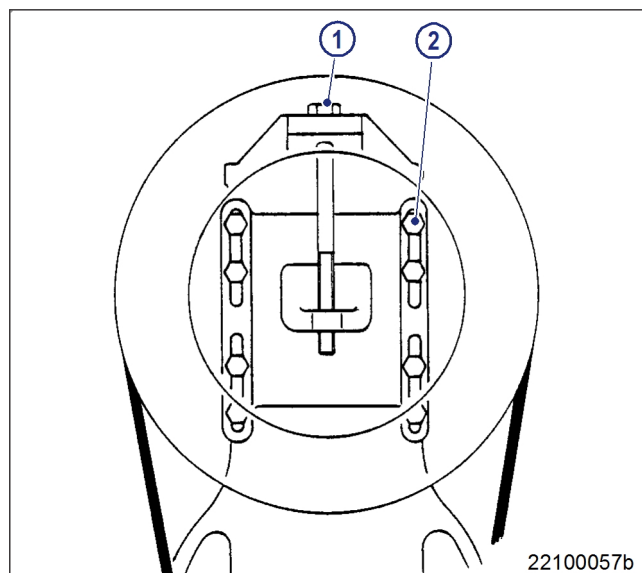
Designation / Use	Part No.	Qty.
Drive belt	(→ Spare Parts Catalog)	

Preparatory steps

1. Remove protective cover.
2. Remove fan.

Replacing drive belt

1. Release screws (2).
2. Slacken off stud (1) until drive belt can be removed.
3. Clean belt pulleys.
4. Fit new drive belt on belt pulleys, ensuring that it is not under tension.
5. Adjust belt tension (→ Page 174).



8.19.3 Fan drive - Drive belt tension check / adjustment

Preconditions

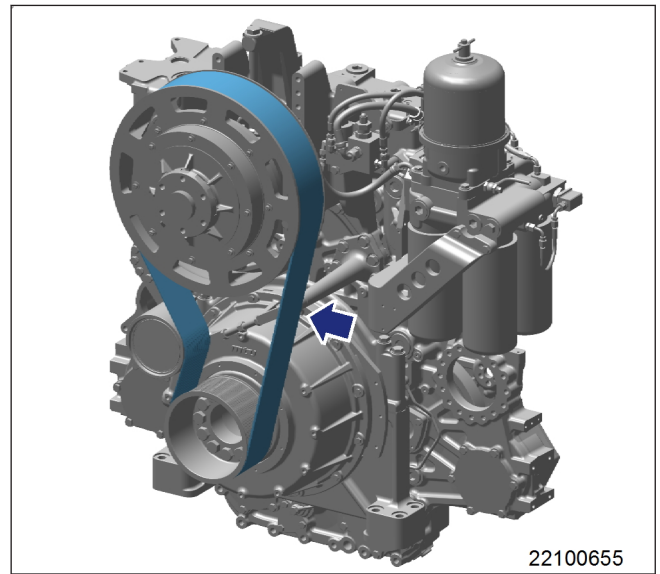
- Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Belt tension tester Optibell 2	Y4345711	1
Torque wrench, 60–320 Nm	F30452768	

Preparatory steps

1. Remove protective cover.
 2. Check belt condition visually (→ Page 171).
- Result: For drive belt replacement, (→ Page 179).



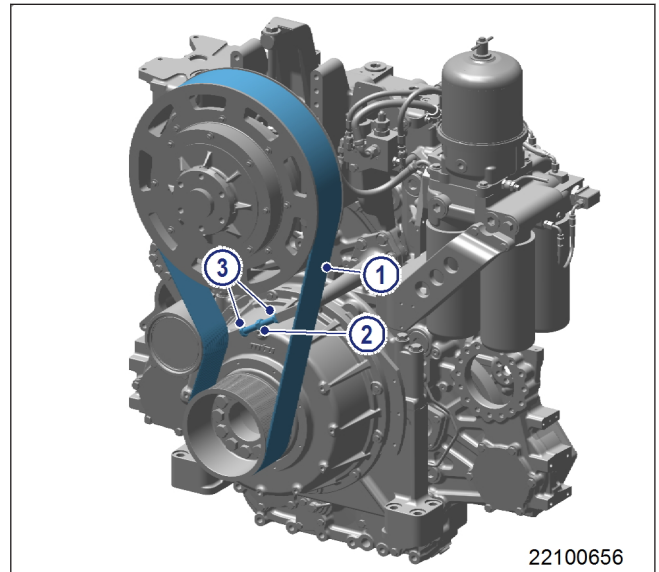
Checking Vee belt tension

1. Switch on belt tension tester.
2. Hold measuring tip of belt tension tester over belt drive. Tap drive belt (arrow) with a suitable tool.
3. Hold belt tension tester over belt drive until the measured value is displayed.

Initial operation with fan	Belt tension adjustment
67 Hz ± 1 Hz	60 Hz ± 1 Hz

Adjusting drive belt tension

1. Loosen hex nuts (3).
2. Tension belt (1) by turning the tie rod (2) until the required frequency (→ Table 2) is attained.
3. Turn crankshaft by minimum two rotations.
4. Tension belt (1) by turning the tie rod (2) until the required frequency (→ Table 2) is attained.



5. Tighten hex nuts (3) with torque wrench to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Hex nut	M16	Tightening torque		70 Nm +7 Nm

8.19.4 Fan drive - Drive belt replacement

Preconditions

- Engine is stopped and starting disabled.

Special tools, Material, Spare parts

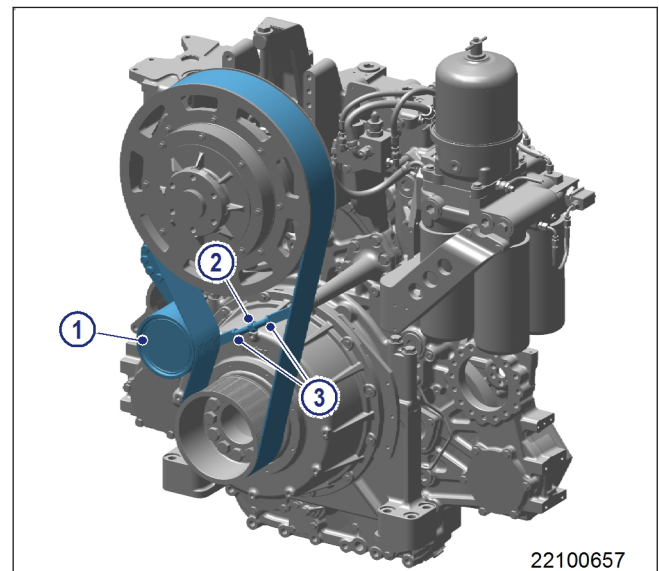
Designation / Use	Part No.	Qty.
Torque wrench, 60–320 Nm	F30452768	
Drive belt	(→ Spare Parts Catalog)	

Preparatory steps

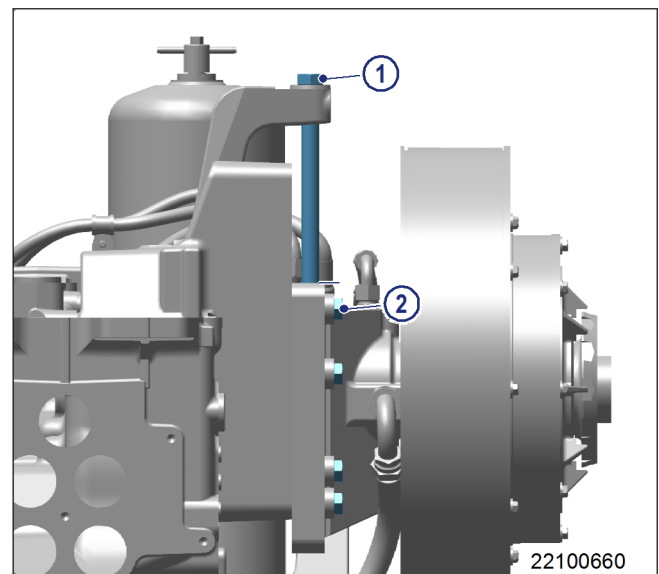
1. Remove protective cover.
2. Remove fan.

Removing drive belt

1. Loosen hex nuts (3).
2. Turn tie rod (2) to extend tie arm length until the arm is freely moveable.
3. Turn tensioning lever (1) outwards.



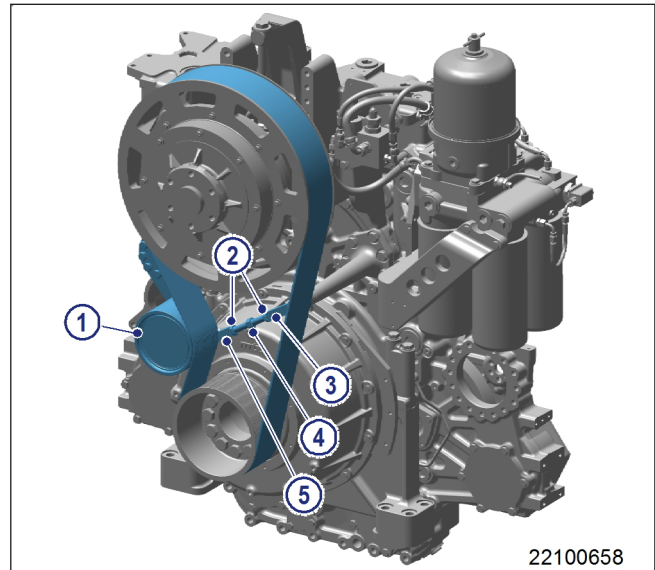
4. If required, loosen screws (2), release tensioning stud (1) and move fan coupling downwards.
5. Take off belt.
6. Clean belt pulleys.



Installing drive belt

1. Fit new drive belt on belt pulleys, ensuring that it is not under tension.

2. Turn tensioning lever (1) inwards.
3. Install tie rod (4) with swivel heads (3, 5) and hex nuts (2).
4. Adjust fan height (→ Page 180).
5. Adjust belt tension (→ Page 177).

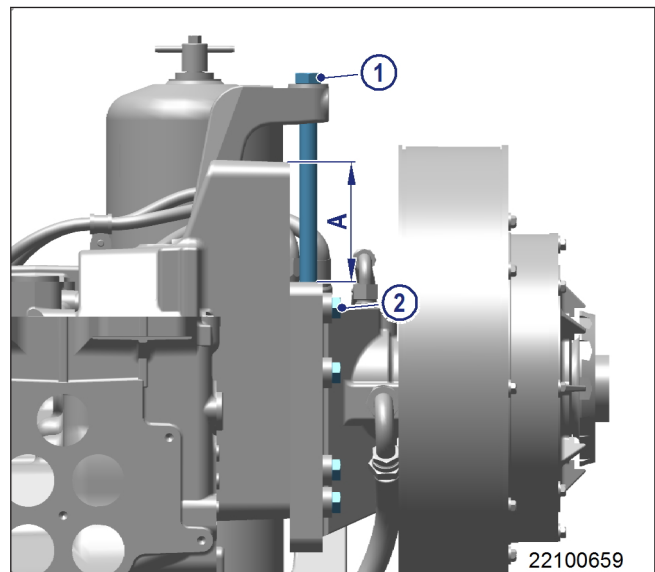


6. Tighten hex nuts (2) with torque wrench to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Hex nut	M16	Tightening torque		70 Nm +7 Nm

Adjusting fan height

1. Loosen screws (2) or leave them snug-fit.
2. Adjust height of fan coupling with tensioning stud (1) until dimension A = 137 mm is attained.



3. Use torque wrench to tighten screws (2) to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Hex bolt	M16x75	Tightening torque		250 Nm +25 Nm

8.20 Engine Mounting / Support

8.20.1 Engine mounting - Check

Preconditions

- Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 300-800 Nm	F30047798	1
Ratchet	F30450902	1
Engine oil		

NOTICE



Contamination of engine mounts made of natural rubber with fuel or oil.

Engine mounts swell. Risk of shorter service life or destruction of the mounts!

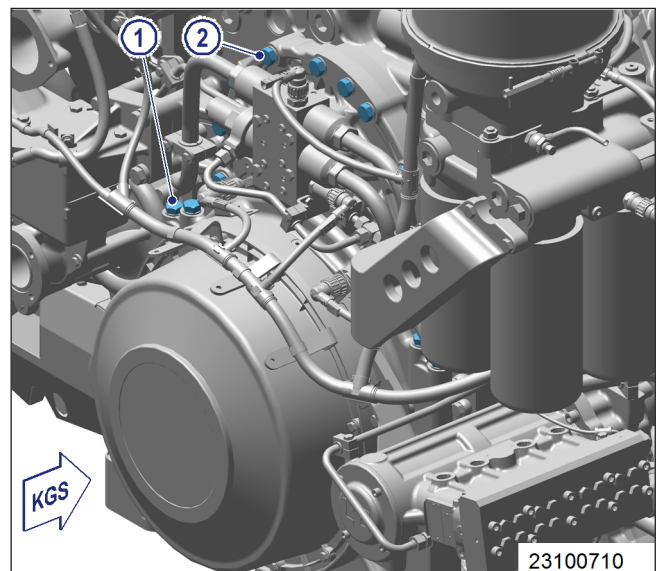
- Cover engine mounts when working with fuel or oil.
- Remove contaminations on the rubber mounts immediately with a dry cloth and degrease them.

Checking general condition

Item	Findings	Action
Visually inspect mounts.	<ul style="list-style-type: none"> • Damage • Brittleness • Deformation • Crack formation • Swelling visible 	Replace (→ Contact Service.)

Check securing screws for firm seating

1. Check securing screws (1, 2) for firm seating.



2. Tighten loose screw connections with torque wrench to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M20	Control torque	(Engine oil)	500 Nm +50 Nm

3. Information on screws to connect engine mounting (6 x Ø21 or 8 x M22) to vehicle frame of vehicle manufacturer, system manufacturer or OEM must be obtained on the basis of the specific requirements. These screws must also be checked for firm seating.

8.20.2 Engine mounting – Resilient mount check

Preconditions

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

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Feeler gage	Y20098771	1
Calipers	Y20001743	1
Box wrench	F30379609	1
Torque wrench 300-800 Nm	F30047798	1
Engine oil		

NOTICE



Contamination of engine mounts made of natural rubber with fuel or oil.

Engine mounts swell. Risk of shorter service life or destruction of the mounts!

- Cover engine mounts when working with fuel or oil.
- Remove contaminations on the rubber mounts immediately with a dry cloth and degrease them.

Engine mounts – Checking the condition of resilient mounts

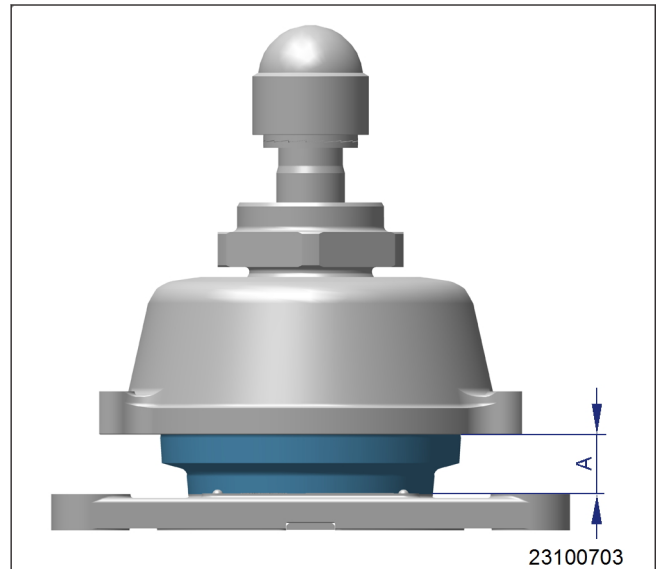
1. Wipe rubber surface with dry cloth, do not use organic detergents.
2. Check resilient mounts for crack formation and deformation by visual inspection.
3. Have cracked mounts replaced, contact Service.

Engine mounts – Measuring adjustment dimension

1. Measure dimension (A) with calipers.

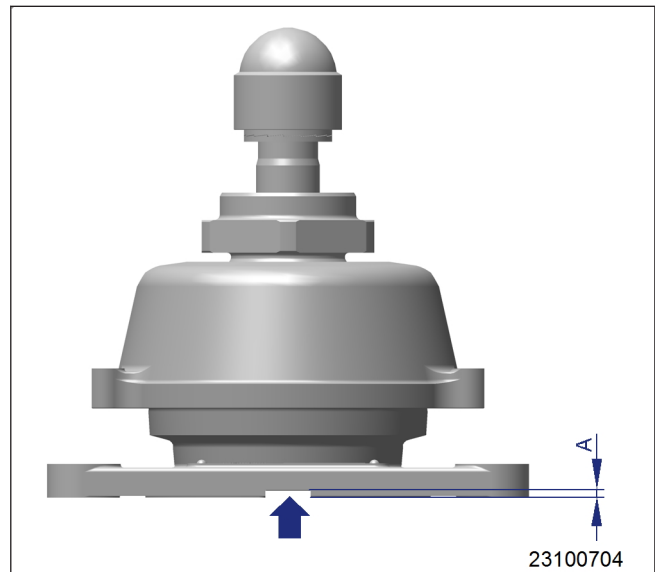
Note: On new blocked mounts, the adjustment dimension is approx. 25 mm.

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



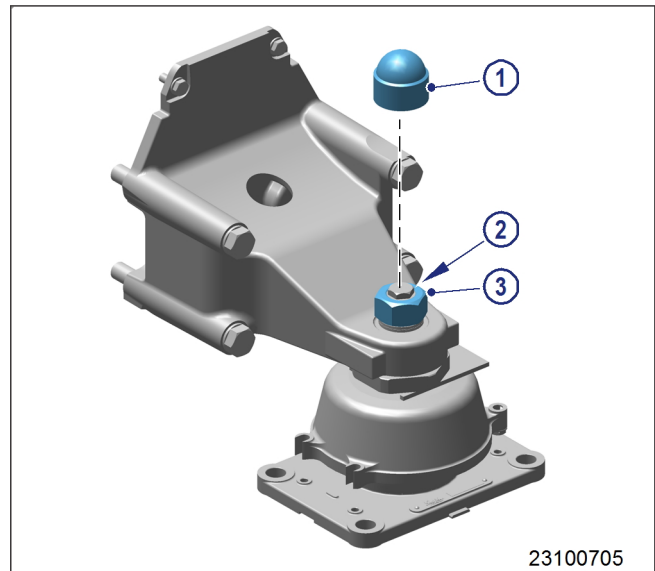
Engine mounts – Checking buffer clearance

1. Check dimension (A) with feeler gage on measuring groove (arrowed).
2. Adjust buffer clearance if dimension (A) is not 4.0 mm +0.5 mm.



Engine mounts – Adjusting buffer clearance

1. Take off protective cap (1).
2. Undo nut (3).
3. Adjust buffer clearance by turning the central buffer (2).
4. Coat mating face of nut (3) and thread of central buffer (2) with a little engine oil. Engine oil must not get in contact with the rubber elements of the resilient mount.



5. Tighten nut (3) to the specified tightening torque securing the central buffer (2) to prevent it turning.

Name	Size	Type	Lubricant	Value/Standard
Nut	M27 x 2	Tightening torque	(Engine oil)	600 Nm +60 Nm

6. Fit protective cap (1).

8.21 Wiring (General) for Engine/Gearbox/Unit

8.21.1 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.

8.22 Accessories for (Electronic) Engine Governor / Control System

8.22.1 Resetting CDC parameter and entering IIG with DiaSys®

Preconditions

- Engine is stopped and starting disabled.

Note: If the parameters for the drift correction (CDC) are not reset, the emission certification becomes invalid.

Resetting parameters for drift correction (CDC) with DiaSys®

1. Use DiaSys® to reset the CDC parameters (→ Dialog system DiaSys® E531920/..).
2. If no DiaSys® is available, contact Service.

Entering the codes for the injectors (IIG) with DiaSys®

1. Use DiaSys® to enter the IIG (→ Dialog system DiaSys® E531920/..).
2. If no DiaSys® is available, contact Service.

8.22.2 Actuators - Visual inspection and test

Preconditions

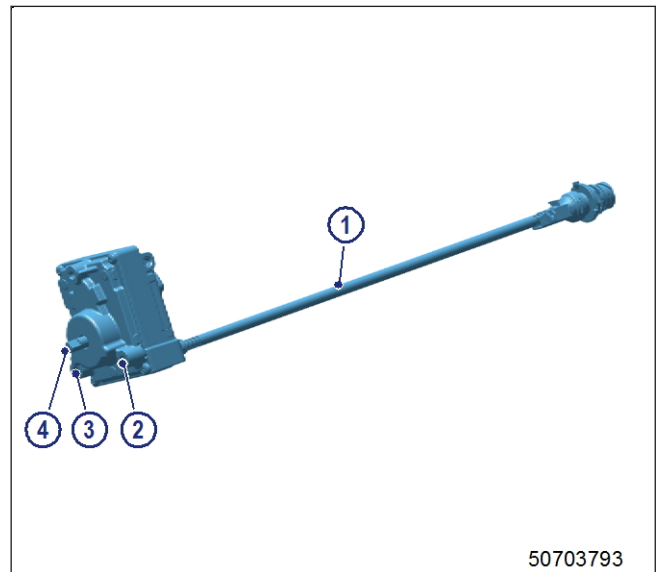
- Engine is stopped and starting disabled.

WARNING	<p>Actuation mechanism in the exhaust and intake area closes automatically.</p> <p>Risk of crushing hands!</p> <ul style="list-style-type: none"> To carry out the teach-in routine, keep clear of the safety zone of the actuation mechanism in the intake and exhaust area. Switch off the operating voltage of the engine governor before starting the mechanical test. Wear protective goggles.
WARNING	<p>Hot components/surfaces.</p> <p>Risk of burns!</p> <ul style="list-style-type: none"> Allow the engine to cool down to below 50 °C before beginning work. Wear suitable protective equipment/thermal gloves. Avoid unprotected contact with hot surfaces.
NOTICE	<p>Carry out the calibration learning run for a functional check of the servomotor. Overwriting of stop values through already existing wear.</p> <p>Exceeding of emission values and engine damage are possible!</p> <ul style="list-style-type: none"> Only carry out the calibration learning run if the servomotor of the flap is connected to the ECU for the first time or a coupling rod was been replaced.

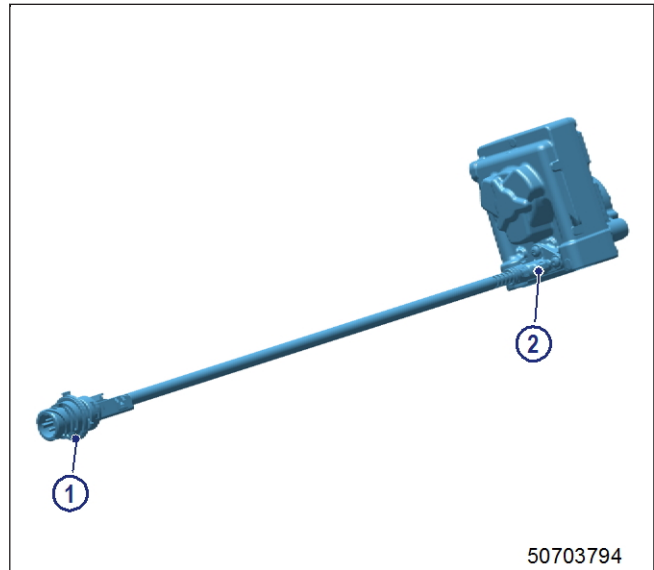
Checking actuators visually

Note

Actuators must not be interchanged or exchanged from other engines - even for test purposes. Always use new actuators.



Item	Findings	Measure
Corrugated pipe (1)	Damaged, holes or cracks.	Replace
Coolant connections (2, 3)	Traces of coolant leaks.	Replace
Output shaft (4)	Damaged	Replace



Item	Findings	Measure
Connector (1)	Damaged	Replace actuator.
Actuator cable connection (2)	Damaged Protective cap not correctly mounted.	Replace actuator. Mount protective cap correctly.
Actuator general condition	Heavily contaminated by black exhaust.	Replace actuator.

Checking actuators with DiaSys®

Note: For installation position of exhaust flaps, refer to overview (→ Page 125).

1. Switch on ECU.

Note: A learning run must not be carried out for a functional test of the servomotor because this would result in malfunction of the wear detection of the flap.

2. For a function test, move the flap via DiaSys® in manual mode into different positions (→ Dialog system E531920/..). If no DiaSys® is available, contact Service.

8.22.3 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.

8.22.4 Engine governor plug connections - Check

Preconditions

- Engine stopped and starting disabled.
- Electronic engine management system is de-energized.

NOTICE



Insertion of unsuitable test probe, e.g. test prod.

The contacts in the plug connection can be bent!

- Carry out check of plug connection only with test connectors.

Checking plug connections at engine governor

1. Check all plug connections for secure seating.
2. Lock loose connectors.
3. Check dust cap on ECU and EXU connectors for damage and correct seating.

8.22.5 NOx sensor – 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
Torque wrench, 10–60 Nm	F30452769	1
Ratchet adapter	F30027340	1
Assembly compound (Molykote P 37)	50564	1
NOx sensor	(→ Spare Parts Catalog)	1

WARNING



Hot components/surfaces.

Risk of burns!

- Allow the engine to cool down to below 50 °C before beginning work.
- Wear suitable protective equipment/thermal gloves.
- Avoid unprotected contact with hot surfaces.

NOTICE



High voltage.

Risk of damage to components!

- Switch off ignition before replacing components.

NOTICE



Ceramic cell breakage due to shock or impact.

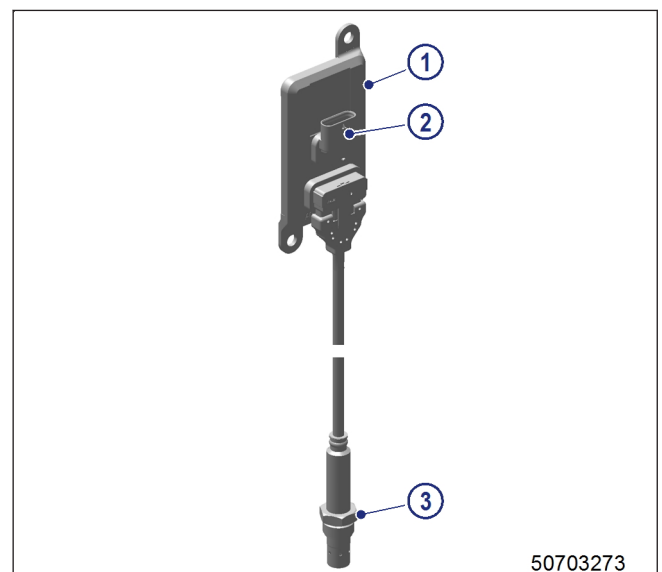
Risk of damage to components!

- Avoid shocks and impacts.
- Exercise extreme care when handling sensors.

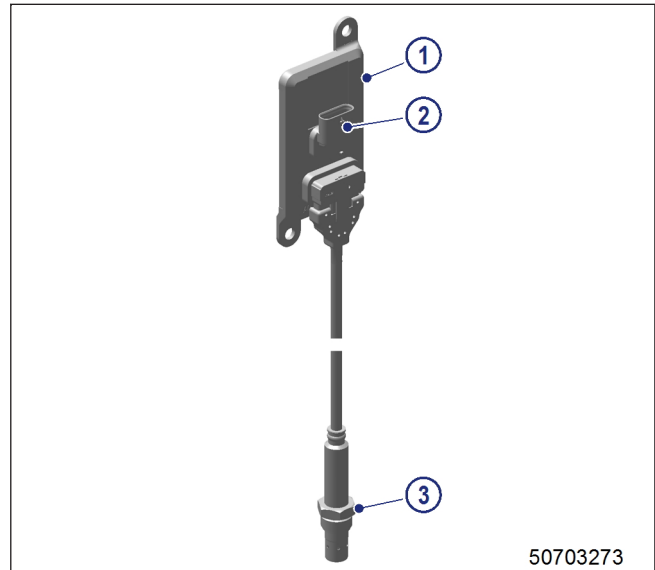
Removing NOx sensor

Note: Observe arrangement and position of sensor (→ Page 25).

1. Disconnect and remove male connector (2) from control unit (1).
2. Unscrew control unit (1) at the eyelets.
3. Remove sensor (3).



Installing NOx sensor



Note: Note the following:

- If the sensor (3) was subjected to shock or impact load, it is considered to be defective and may not be used.
- Always replace NOx sensor (3) together with control unit (1).

1. Install control unit (1) at the eyelets and tighten screws to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M6	Tightening torque		max. 12 Nm

2. Remove protective cap on thread of sensor (3) only just before installation.

Note: Do not wipe off the thread lubricant applied by the manufacturer.

3. Coat sensor (3) thread with specified assembly compound as required.
4. Screw in sensor (3) by hand.
5. Tighten nut (3) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Nut	M20	Tightening torque	(Assembly compound (Molykote P 37))	40 Nm +4 Nm

6. Fit male connector (2) and latch it.

8.22.6 Lambda sensor - Replacement

Preconditions

- Engine is stopped and starting disabled.
- Power supply to electronic engine management system is switched off.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 10–60 Nm	F30452769	1
Ratchet adapter	F30027340	1
Assembly compound (Molykote P 37)	50564	1
Lambda sensor	(→ Spare Parts Catalog)	1

WARNING



Hot components/surfaces.

Risk of burns!

- Allow the engine to cool down to below 50 °C before beginning work.
- Wear suitable protective equipment/thermal gloves.
- Avoid unprotected contact with hot surfaces.

NOTICE



Ceramic cell breakage due to shock or impact.

Risk of damage to components!

- Avoid shocks and impacts.
- Exercise extreme care when handling sensors.

NOTICE



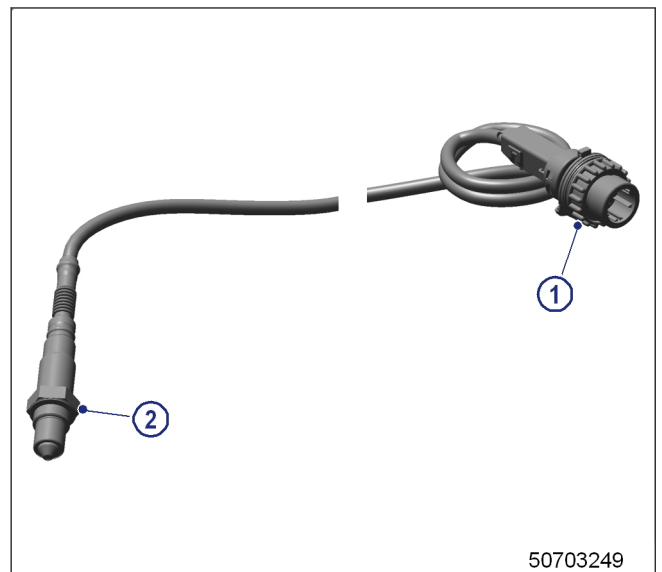
High voltage.

Risk of damage to components!

- Switch off ignition before replacing components.

Removing Lambda sensor

1. Observe the following general information:
 - Layout and position of sensor (→ Page 25).
2. Unplug and remove male connector (1).
3. Remove sensor (2).



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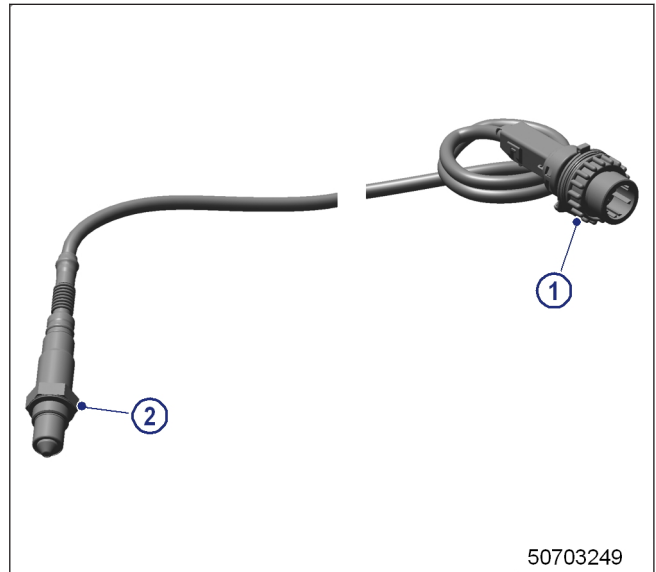
Installing Lambda sensor

Note: When the sensor was subjected to shock or impact load, it is deemed to be defective and may not be used.

1. Remove protective cap on thread only just before installation.

Note: Do not wipe off the thread lubricant applied by the manufacturer.

2. Coat sensor thread with specified assembly compound as required.
3. Screw in sensor by hand.



4. Tighten nut (2) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Nut	M18 x 1.5	Tightening torque	(Assembly compound (Molykote P 37))	40 Nm +4 Nm

5. Fit male connector (1) and latch it.
6. Reset Lambda sensor calibration with DiaSys® (→ Dialog system DiaSys® E531920/..). If no DiaSys® is available, contact Service.

9 Manufacturer's Documentation

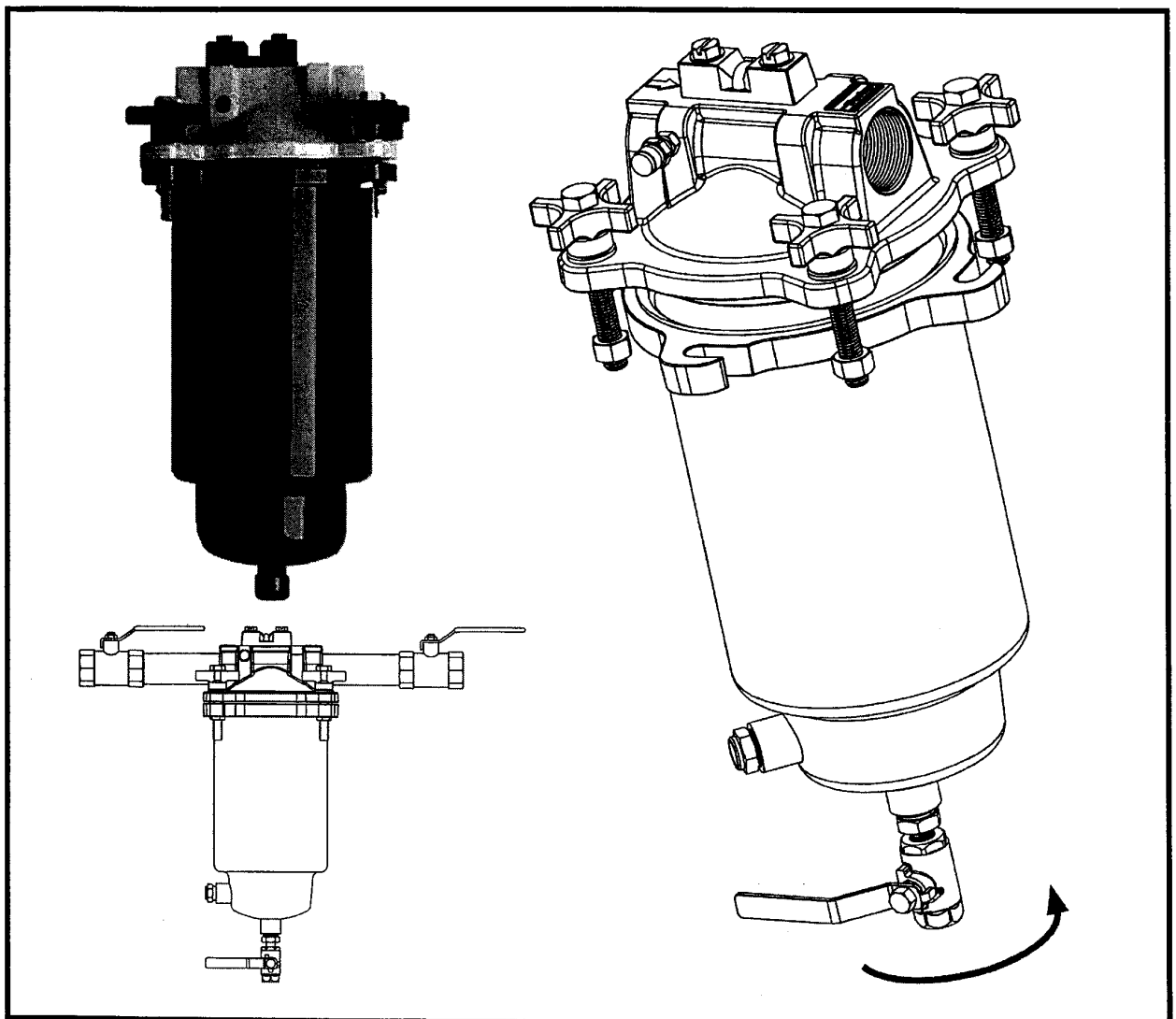
9.1	Prefilter Installation, Operation	197
9.2	Prefilter Installation Instructions	209

9.1 Prefilter Installation, Operation

RACOR®

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- Aviation Fuel Cabinets
- Diesel Fuel Dispensing
- Marine Fuel Docks
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4. Warranty: Seller warrants that the items sold hereunder shall be free from defects in material or workmanship for a period of 12 months from date of shipment from Parker Hannifin Corporation. The warranty period for pumps and motors is specifically limited to 90 days from date of purchase. **THIS WARRANTY COMPRISES THE SOLE AND ENTIRE WARRANTY PERTAINING TO ITEMS PROVIDED HEREUNDER. SELLER MAKES NO OTHER WARRANTY, GUARANTEE, OR REPRESENTATION OF ANY KIND WHATSOEVER. ALL OTHER WARRANTIES, INCLUDING BUT NOT LIMITED TO, MERCHANTABILITY AND FITNESS FOR PURPOSE, WHETHER EXPRESS, IMPLIED, OR ARISING BY OPERATION OF LAW, TRADE USAGE, OR COURSE OF DEALING ARE HEREBY DISCLAIMED.**

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5. Limitation of Remedy: SELLER'S LIABILITY ARISING FROM OR IN ANY WAY CONNECTED WITH THE ITEMS SOLD OR THIS CONTRACT SHALL BE LIMITED EXCLUSIVELY TO REPAIR OR REPLACEMENT OF THE ITEMS SOLD OR REFUND OF THE PURCHASE PRICE PAID BY BUYER, AT SELLER'S SOLE OPTION. IN NO EVENT SHALL SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES OF ANY KIND OR NATURE WHATSOEVER, INCLUDING BUT NOT LIMITED TO LOST PROFITS ARISING FROM OR IN ANY WAY CONNECTED WITH THIS AGREEMENT OR ITEMS SOLD HEREUNDER, WHETHER ALLEGED TO ARISE FROM BREACH OF CONTRACT, EXPRESS OR IMPLIED WARRANTY, OR IN TORT, INCLUDING WITHOUT LIMITATION, NEGLIGENCE, FAILURE TO WARN OR STRICT LIABILITY.

6. Changes, Reschedules and Cancellations: Buyer may request to modify the designs or specifications for the items sold hereunder as well as the quantities and delivery dates thereof, or may request to cancel all or part of this order, however, no such requested modification or cancellation shall become part of the contract between Buyer and Seller unless accepted by Seller in a written amendment to this Agreement. Acceptance of any such requested modification or cancellation shall be at Seller's discretion, and shall be upon such terms and conditions as Seller may require.

7. Special Tooling: A tooling charge may be imposed for any special tooling, including without limitation, dies, fixtures, molds and patterns, acquired to manufacture items sold pursuant to this contract. Such special tooling shall be and remain Seller's property notwithstanding payment of any charges by Buyer. In no event will Buyer acquire any interest in apparatus belonging to Seller which is utilized in the manufacture of the items sold hereunder, even if such apparatus has been specially converted or adapted for such manufacture and notwithstanding any charges paid by Buyer. Unless otherwise agreed, Seller shall have the right to alter, discard or otherwise dispose of any special tooling or other property in its sole discretion at any time.

8. Buyer's Property: Any designs, tools, patterns, materials, drawings, confidential information or equipment furnished by Buyer, or any other items which become Buyer's property, may be considered obsolete and may be destroyed by Seller after two (2) consecutive years have elapsed without Buyer placing an order for the items which are manufactured using such property. Seller shall not be responsible for any loss or damage to such property while it is in Seller's possession or control.

9. Taxes: Unless otherwise indicated on the face hereof, all prices and charges are exclusive of excise, sales, use, property, occupational or like taxes which may be imposed by any taxing authority upon the manufacture, sale or delivery of the items sold hereunder. If any such taxes must be paid by Seller or if Seller is liable for the collection of such tax, the amount thereof shall be in addition to the amounts for the items sold. Buyer agrees to pay all such taxes or to reimburse Seller therefore upon receipt of its invoice. If Buyer claims exemption from any sales, use or other tax imposed by any taxing authority, Buyer shall save Seller harmless from and against any such tax, together with any interest or penalties thereon which may be assessed if the items are held to be taxable.

10. Indemnity For Infringement of Intellectual Property Rights: Seller shall have no liability for infringement of any patents, trademarks, copyrights, trade dress, trade secrets or similar rights except as provided in this Part 10. Seller will defend and indemnify buyer against allegations of infringement of U.S. patents, U.S. trademarks, copyrights, trade dress and trade secrets (hereinafter 'Intellectual Property Rights'). Seller will defend at its expense and will pay the cost of any settlement or damages awarded in an action brought against Buyer based on an allegation that an item sold pursuant to this contract infringes the Intellectual Property Rights of a third party. Seller's obligation to defend and indemnify Buyer is contingent on Buyer notifying Seller within ten (10) days after Buyer becomes aware of such allegations of infringement, and Seller having sole control over the defense of any allegations or actions including all negotiations for settlement or compromise. If an item sold hereunder is subject to a claim that it infringes the Intellectual Property Rights of a third party, Seller may, at its sole expense and option, procure for Buyer the right to continue using said item, replace or modify said item so as to make it noninfringing, or offer to accept return of said item and return the purchase price less a reasonable allowance for depreciation. Notwithstanding the foregoing, Seller shall have no liability for claims of infringement based on information provided by Buyer, or directed to items delivered hereunder for which the designs are specified in whole or part of Buyer, or infringements resulting from the modification, combination or use in a system of any item sold hereunder. The foregoing provisions of this Part 10 shall constitute Seller's sole and exclusive liability and Buyer's sole and exclusive remedy for infringement of Intellectual Property Rights.

If a claim is based on information provided by Buyer or if the design for an item delivered hereunder is specified in whole or in part by Buyer, Buyer shall defend and indemnify Seller for all costs, expenses or judgments resulting from any claim that such item infringes any patent, trademark, copyright, trade dress, trade secret or any similar right.

11. Force Majeure: Seller does not assume the risk of and shall not be liable for delay or failure to perform any of Seller's obligations by reason of circumstances beyond the reasonable control of Seller (hereinafter 'Events of Force Majeure'). Events of Force Majeure shall include without limitation, accidents, acts of God, strikes or labor disputes, acts, laws, rules or regulations of any government or government agency, fires, floods, delays or failures in delivery of carries or suppliers, shortages of materials and any other cause beyond Seller's control.

12. Entire Agreement/Governing Law: The terms and conditions set forth herein, together with any amendments, modifications and any different terms or conditions expressly accepted by Seller in writing, shall constitute the entire Agreement concerning the items sold, and there are no oral or other representations or agreements which pertain thereto. This Agreement shall be governed in all respects by the law of the State of Ohio. No actions arising out of the sale of the items sold hereunder or this Agreement may be brought by either party more than two (2) years after the cause of action accrues.

Hydrocarbon Filtration FBO-10 and FBO-14 Series Housing and Cartridges

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4	Illustration of Typical Isolation Valve Layout
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6	Illustration and Spare Parts List

MAXIMUM FLOW RATES

	Maximum Flow Rates			Clean Dry	Change
	Flow Range	Diesel	Jet Fuel	Gasoline	Delta P
FBO-10					
Prefilter	5-40 GPM	20	40	50	**
Filter Separator	5-35 GPM	18	35	45	**
Absorber	5-25 GPM	18	35	45	**
FBO-14					
Prefilter	10-60 GPM	30	60	75	**
Filter Separator	10-50 GPM	25	50	65	**
Absorber	10-37 GPM	26	55	70	**

** Varies With Fluid and Flow Rate

ELEMENT APPLICATIONS

	Micron Rating	FBO-10	FBO-14
		6 X 10 Element	6 X 14 Element
Filter Separator	1	FBO-60327	FBO-60336
	5	FBO-60328	FBO-60337
	10	FBO-60353	FBO-60356
	25	FBO-60329	FBO-60338
Prefilter	1	FBO-60330	FBO-60339
	5	FBO-60331	FBO-60340
	10	FBO-60356	FBO-60357
	25	FBO-60332	FBO-60341
Absorptive Filter	1	FBO-60333	FBO-60342
	5	FBO-60334	FBO-60343
	10	FBO-60355	FBO-60358
	25	FBO-60335	FBO-60344

Product Description, Installation, Operation and Service Instructions For Parker Hannifin Racor Division, Hydrocarbon Filtration FBO-10 & FBO-14 Series Housings and Cartridges

FBO SERIES PRODUCT DESCRIPTION

Racor Hydrocarbon Filtration's new FBO-10 and FBO-14 filter assemblies are designed to meet the toughest hydrocarbon refueling conditions and give maintenance personnel ease of filter changeouts.

The FBO assembly can flow 25 gpm/95 lpm or up to 60 gpm/230 lpm depending on the unit, cartridges installed and the fuels being filtered.

FBO SERIES APPLICATIONS

The FBO assembly can be used on mobile refuelers or installed in refueling cabinets.

The unit can also be used for diesel fuel dispensing pumps or as an engine primary fuel filter/water separator.

FBO FEATURES

The assembly features a "locking ring collar," that attaches the filter housing to the aluminum die-cast filter head with four bolts.

The slotted "locking ring collar" allows maintenance personnel to hand loosen the four collar bolts, rotate and lower the bowl assembly for cartridge changeouts.

With a new cartridge installed, simply raise the bowl and rotate into position on the locking ring and hand tighten evenly.

CLOSURE HARDWARE

The closure hardware consists of stainless steel nuts, bolts and washers with metal hand knobs for ease of maintenance.

**No V-Band Clamps are used.
This allows one person to
easily change the filter
cartridge.**

APPLICATIONS

Jet Fuel
Aviation Gas
Diesel Fuel
Gasoline
Kerosene
JP4, JP5, JP8

INSTALLATIONS

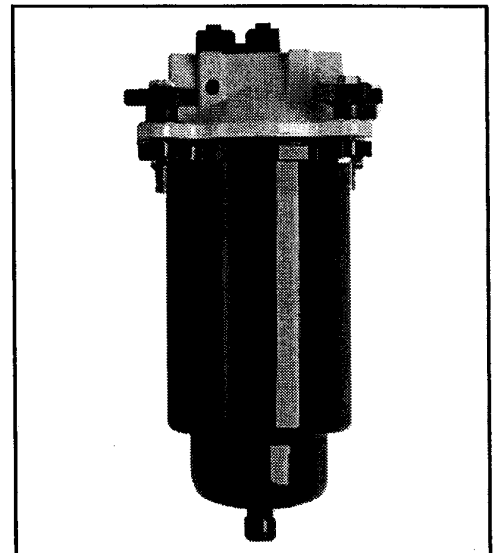
Aviation Fuel Trucks
Aviation Fueling Cabinets
Diesel Fuel Dispensing System
Marine Fuel Docks
Fuel Systems on Large Diesel Engines

STANDARD DESIGN FEATURES

Die-cast Aluminum Head
Steel Filter Bowl Assembly
Powder Coated Components
"Locking Ring Collar," No Clamps
1 1/2" NPT Inlet and Outlet
150 psi @ 240° F Maximum Design Pressure
Manual Drain Valve
Manual Vent Valve

OPTIONAL ACCESSORIES

Water Sight Glass or Electronic Water Probe
Delta P Indicator.



Cartridge Options

(1, 5, 10, 25 micron)
FP Prefilters
OCP Coalescers
FW Water Absorbing

Installation, Operation and Service Instructions

INSTALLATION

1. Remove the housing protectors from the inlet and outlet connections.
2. Make certain that connections are free of any debris.

CAUTION:
Be sure to correctly identify the inlet and outlet connections to avoid piping the unit backwards. *The unit will not perform properly if connections are reversed.*

3. Provide shut-off valves in the inlet and outlet piping as close to the unit as possible. *This is necessary for isolating the unit from the system when cartridge replacement is necessary. (See Illustration on page 4).*
4. Connect the housing into the piping system with a minimum number of turns and fittings, especially on the inlet side.
5. For installations on fuel dispensing pump, connect the fuel delivery hose directly to the outlet connection.
6. Provide room for the housing to clear the cartridge during change-out. *(A 2 inch base clearance is required).*
7. We recommend installation of a differential pressure gauge so the differential pressure across the housing can be monitored. This allows accurate determination of when the cartridge should be changed.

Part numbers 72694 or 72783 are differential pressure gauges specifically designed to be used on FBO-10 and FBO-14.

8. For **Absorptive Cartridges** used in aviation fuel or diesel fuel service, **ALWAYS** install a differential pressure gauge or other means of determining the differential pressure.

See Maximum Flow Rates Chart for applicable flow rates on page ii, before page 1.

CAUTION:

On systems where pressures can exceed 75 psi, a pressure bypass around the pump **must be installed** to protect the cartridge and system from a high pressure shock or sudden cartridge seal-off due to a slug of water in the product.

OPERATION AND SERVICE

Open Vent & Drain Valves Each Day

It is recommended that the vent and drain valves be opened once each day to permit the escape of entrapped air and accumulated water.

Limited Maintenance Required

Since there are no moving parts, maintenance is limited to an occasional cartridge replacement, requiring only a 2 inch (51mm) base clearance.

Maintenance Guidelines For: Inspection of Head Gasket and Cartridge and Seal Gasket Change-Out

1. The *head gasket* should be carefully inspected for signs of damage or deterioration each time the housing is opened.
2. Each Parker Element Replacement Kit contains a *housing seal gasket*. It is recommended that the seal gasket *be replaced at every cartridge changeout*.
3. Replace the seal gasket if it shows any signs of wear.
4. We recommend the seal gasket be lubricated with petroleum jelly or oil prior to installation.

CAUTION:

Use only non-sparking tools when performing any maintenance or service work on this equipment.

Cartridge Replacement Procedures

Frequency of Cartridge Element Replacement

The frequency of cartridge element replacement is dependent upon the following conditions:

For Aviation Fuel Service

Replace the cartridge when the differential pressure across the housing exceeds 15 psi; red indication on the DP gauge; after one year of service; or when there is a significant reduction in flow through the housing, whichever occurs first.

For All Other Applications

Replace the cartridge when the differential pressure exceeds 25 psi; red indication of DP gauge; after one year of service; when the flow is significantly reduced; or if the pressure has been steadily climbing then begins to decrease, whichever occurs first.

Cartridge Replacement Procedures

When any of the above noted conditions indicate that cartridge replacement is necessary, observe the following procedures.

1. Close the inlet and outlet isolation valves to isolate the filter from the system.
2. Open the drain valve on the housing bottom and allow all fluid to drain from the unit.
3. Open the vent valve on the cover of the housing and allow the unit to thoroughly vent before opening the cover.
4. Loosen the four (4) knobs attaching the head to the housing flange.
5. Remove the head gasket and discard.
6. Remove and discard the expended cartridge in a FIRE-SAFE place, in accordance with local and national regulations.
7. Flush the interior of the housing with clean, processed, filtered product or a suitable solvent. A nonmetallic bristle brush will help to remove caked-on debris. Rinse the housing and unit cover with a clean solvent and dry with soft, lint-free wiping cloths.

CAUTION:

Due to the toxic effects of some additives used in filtered fluids, care should be exercised in handling the expended cartridges and/or all internal parts that have been in contact with the filtered product.

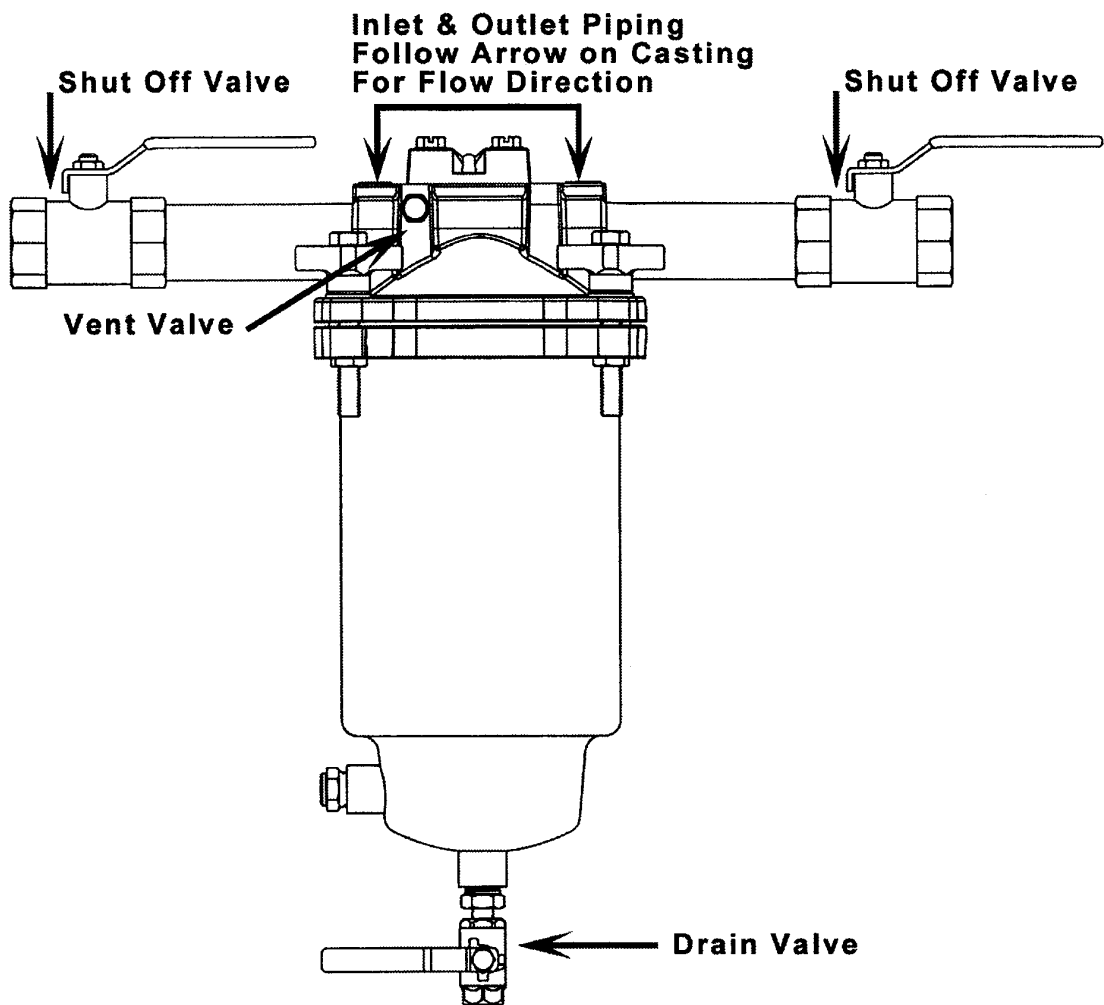
8. Lightly lubricate new head gasket with Vaseline or Petroleum Jelly and position it on the head. If Vaseline is not available, lubricate the gasket with the fuel or oil that it will be used in.
9. Insert a new cartridge into the housing. Position housing (with cartridge) underneath filter head. Push/twist cartridge onto head spigot. The head "conical spring" will seat/seal the cartridge in the housing. (See *head/spring/cartridge installation instruction on page 5.*)
10. "Rotate" housing onto the collar bolts. Hand tighten knobs until head is "snug" to housing. See *Illustration on Page 5.*

NOTE:

A TORQUE WRENCH IS RECOMMENDED. TIGHTEN ALL COLLAR BOLTS TO 50 IN LBS.

11. Close the drain plug or valve on the bottom of the housing.
12. SLOWLY open the inlet and outlet valves; allow the unit to fill completely.
13. Leave the vent valve on top of the unit open; to allow entrapped air to escape while filling.
14. When a small amount of fluid flows from the vent valve, close it tightly.
15. During the initial filling and after the above maintenance, and while unit is in operation, examine housing and all connections for leaks, including head/flange junction
16. Assure any and all leaks are identified and repaired before allowing fuel to flow through housing.

**Illustration:
Typical Isolation Valve Layout**

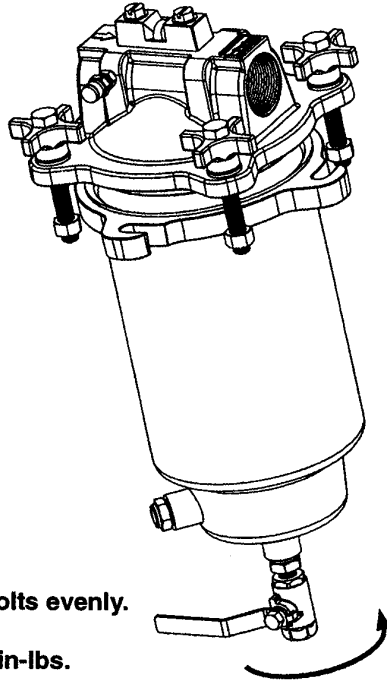


NOTE:

Valves should be installed on each side of the filter assembly, so the fuel flow can be shut off during element changeouts or filter assembly maintenance.

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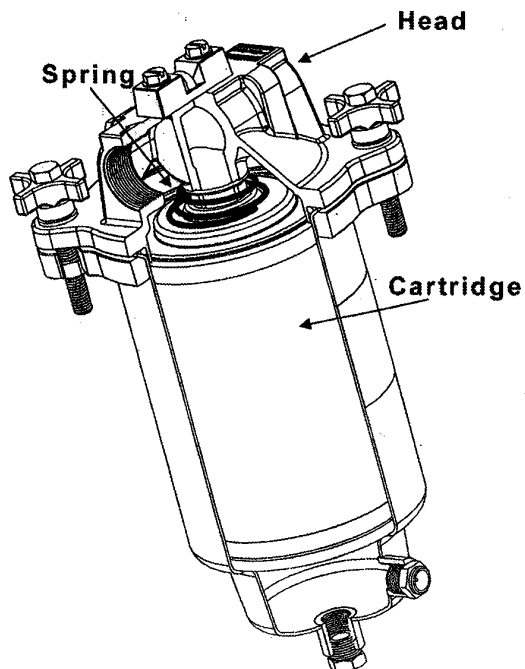
**Illustration:
Housing to Head Assembly**



NOTE:

1. Hand tighten all four collar bolts evenly.
2. If a torque wrench is used; torque each collar bolt to 50 in-lbs.

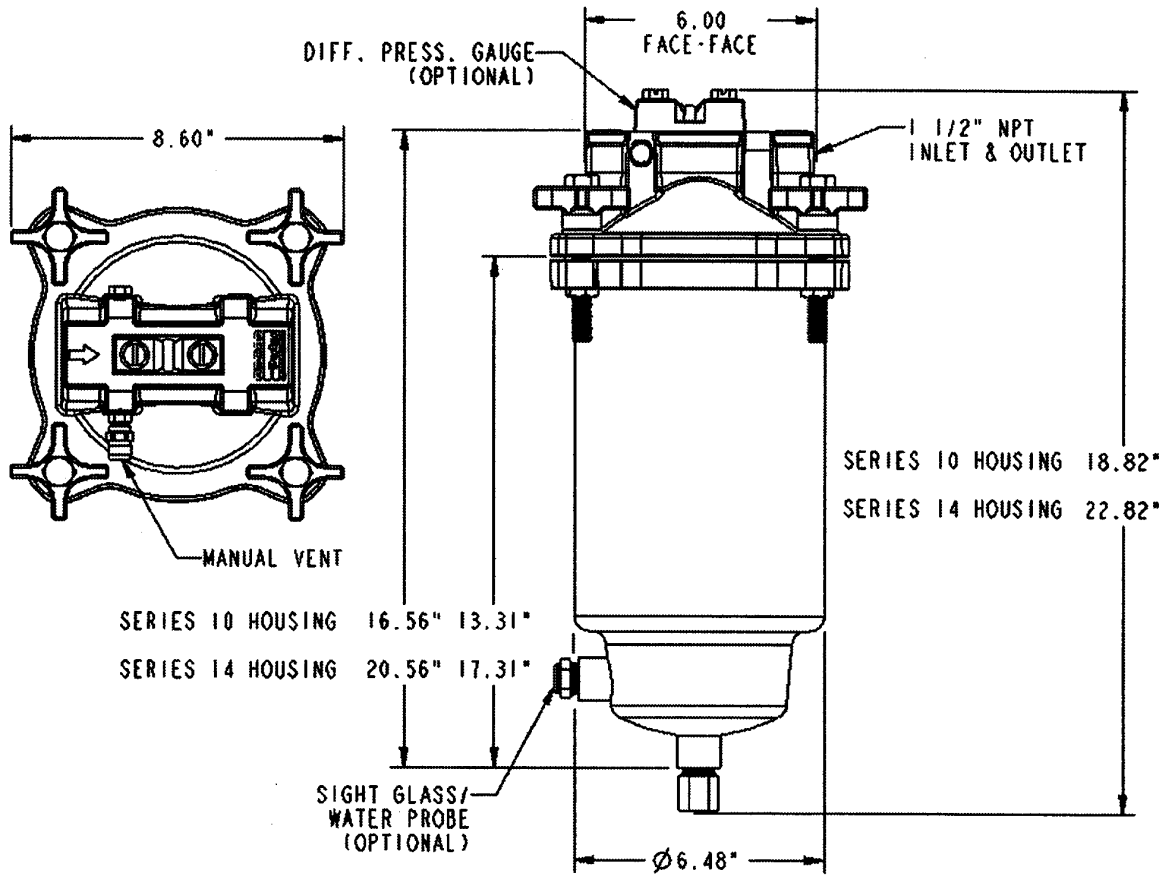
**Illustration:
Head/Spring/Cartridge Installation**



NOTE:

1. Location of Spring

Illustration and Spare Parts List



Spare Parts List

Description	Part Number	Quantity
½" Washer	71328	4
½" Hex Nut	71329	4
Spring	72368	1
Purge Valve	72695	1
O-Ring	72699	1
1/8" Pipe Plug	72700	1
½" Pipe Plug	72701	1
¼" Pet Cock	72702	1
½" - ¼" Bushing	72709	1
Handle Assembly (knob)	72712	4
Sight Glass	72710	1
DP Gauge 15 psid	72694	1
DP Gauge 30 psid	72783	1
Water Probe	RK 30880	1
Housing Assembly FBO-10	72805	1
Housing Assembly FBO-14	72806	1
Head, with DP Gauge Ports	72531	1
Head, without DP Gauge Ports	72718	1
¼" NPT Close Nipple	72812	1
¼" NPT Ball Valve	71943-25	1

Also Available From Racor

Filter Vessels

Racor manufactures filter vessels with flow rates up to 5,000 gallons per minute. Those vessels include prefilters, vertical filter separators, horizontal filter separators, clay treaters and fuel monitors.

API/IP Qualified Elements

Racor currently produces coalescers and fuel monitors to API/IP qualifications. Qualification reports of each test are available by contacting Racor. These include applications for both vertical and horizontal filter separators and fuel monitor elements.

RVFS Filter Vessels

Racor RVFS filter vessels offer economical systems for flow rates up to 150 gallons per minute for aviation fuels and up to 75 gallons per minute for diesel fuels. RVFS units can be supplied in single units or as duplex systems, with optional electronic monitoring systems. These units are being used with high flow diesel engines as prefilters or as fuel dispensing systems for aviation fuels or diesel fuel.

Filter Elements

Racor manufactures a full range of API/IP coalescers, IP fuel monitors, prefilters, coalescers, separators, synthetic pleated media elements, clay bags and canisters, activated carbon cartridges, fuel monitors, water absorbing elements and spin-on filters, oily water separator elements, and natural gas coalescers.

For more information on Racor Hydrocarbon Filters ask for brochure #7537 or call (800) 451-7299.

Racor also offers a full line of mobile and marine fuel, oil, air and coolant filters for all gasoline, diesel fuel and natural gas powered engines.

For more information on mobile and marine products, call (800) 344-3286.

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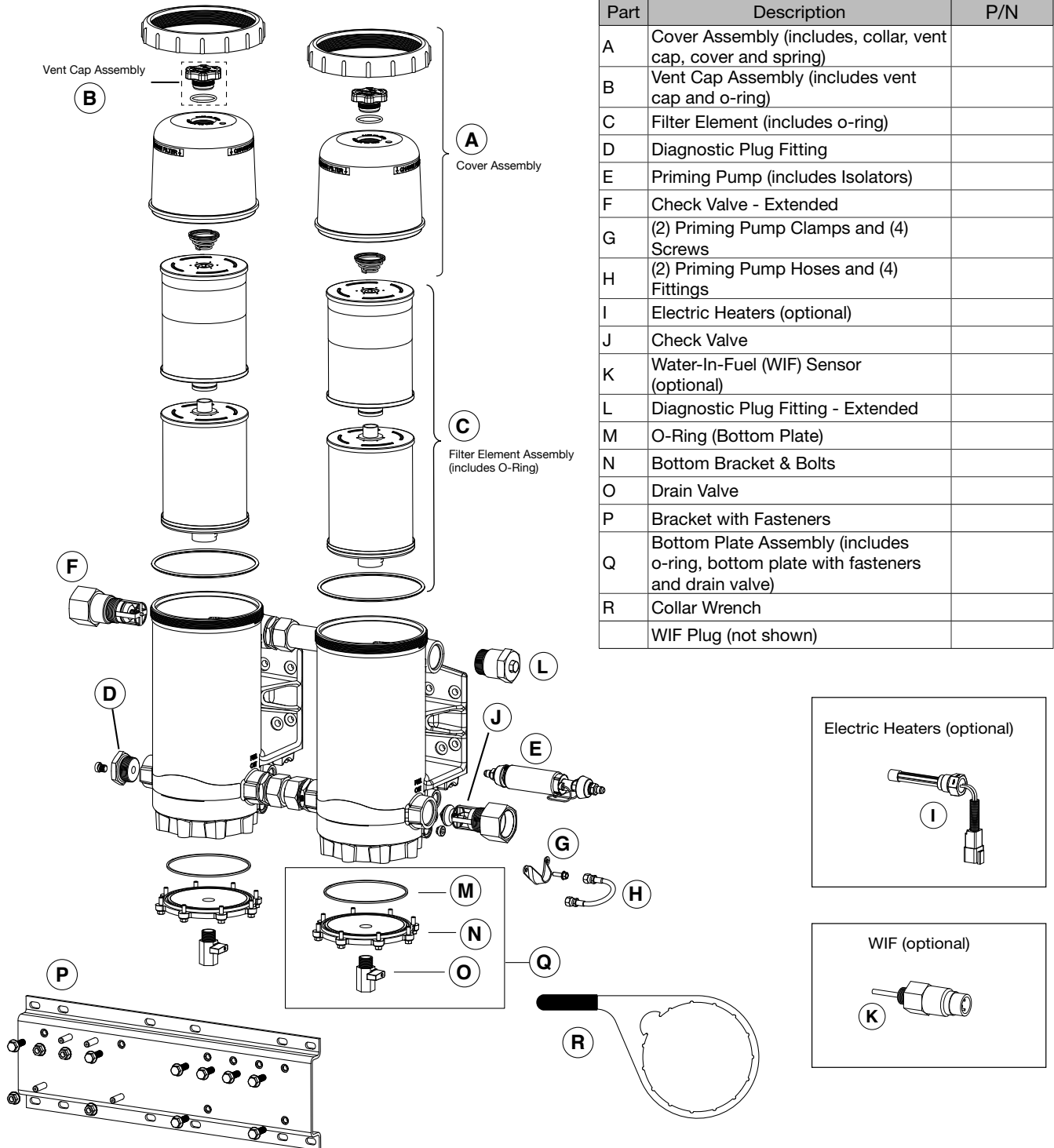
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Brochure No. 7581
100 2-21-03

9.2 Prefilter Installation Instructions



Industrial Pro Installation Instructions

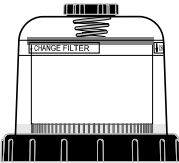
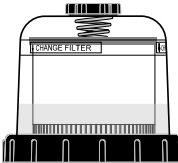
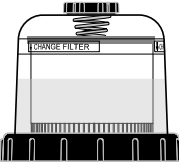
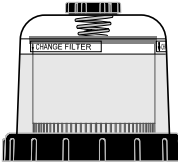


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“SEEING IS BELIEVING”®

- See when *NOT* to change the fuel filter.
- See the condition of the fuel. Seeing what collects on the filter media or what’s happening inside the clear cover can help diagnose many fuel and mechanical conditions.
- “Filter on Top” configuration. Water and debris removed from the fuel falls to the lower chamber and stays away from the filter media resulting in longer filter life.
- Built in protection when priming the fuel filter. Unfiltered fuel is kept on the “dirty” side of the filter media during priming ensuring only clean fuel reaches the engine.

	
<p>When new, the fuel level in the filter will be very low with minimal restriction. As the filter is used, contaminants collect on the filter from the bottom up. Fuel rises on the filter indicating remaining filter life.</p>	<p>Fuel level increases in clear cover. As contaminants collect on the filter, the fuel rises to a non-contaminated section of the filter, providing optimal filtration while maintaining lowest restriction.</p>
	
<p>Fuel level at filter wrap level. Even though the fuel level is now more than half of the filter element, the fuel is still flowing through clean media at minimal restriction levels. The filter still has significant life remaining.</p>	<p>The filter element is now completely covered by fuel. At this point, all of the media’s surface area is utilized. Restriction is increasing and the filter element should be changed at the next scheduled maintenance interval.</p>



Fuel Processor Installation

This system must be installed between the fuel tank and the transfer fuel pump on the suction side of the fuel system.

⚠ **WARNING:** Fuels are combustible.

- **RISK OF FIRE OR EXPLOSION:**

- Avoid open flames, electrical sparks or ignition sources
- Do not smoke.

⚠ **WARNING:** When diesel fuel is circulated through an operating engine, it can become very hot. To prevent personal injury,

⚠ Scalding hazard: Do not allow fuel to come in contact with eyes or unprotected skin. Allow the engine and fuel to cool to ambient temperature before replacing the fuel filter or performing service operations which could result in spillage of fuel from the fuel system. If this is not possible, protective equipment (face shield, insulated hat, gloves, and apron) must be worn.

⚠ Always perform engine or vehicle fuel system maintenance in a well ventilated area that is kept free of bystanders.

⚠ **CAUTION:** To ensure priming pump hoses are not kinked by mishandling, do not lift or handle the fuel processor by the hoses. Do not allow the weight of the processor to rest on the hoses.

Installation Steps

1. With the engine shut down and at ambient temperature, close the fuel shutoff valve (if equipped) and place a suitable container under the fuel filters.
 2. Remove the primary fuel filter element assembly, sedimenter, and/or water separator. Drain the used element and dispose of it in an environmentally responsible manner, according to state and/or federal (EPA) recommendations. The fuel can be returned to the tank.
 3. **Installation of the Industrial Pro should be on the suction side of the fuel system. Do not exceed 22 lb/in² (15 kPa) inlet pressure to the fuel processor.**
 4. Mount the Industrial Pro in the desired location keeping the following points in mind:
 - Mounting the Industrial Pro directly on the engine is **NOT RECOMMENDED**.
 - Mount vertically with the cover and element pointing up.
 - Make sure there is enough top and side clearance for the cover to be conveniently removed for filter replacement. Filter service clearance: Dual Tall: 6.0" (152 mm) minimum
- ⚠ **CAUTION:** The Industrial Pro functions BEST when installed so that the Filter Element is above the "FULL" level of the fuel tank. The housing can be installed up to 6' (1.8 m) below the "FULL" level of the fuel tank. Installing below the "FULL" level causes the starting level to be higher than normal. If mounted below full tank level, a shut off valve will be required at the inlet to allow filter changes without overflow of fuel. Mounting below 6' (1.8 m) eliminates the "SEEING IS BELIEVING" functionality.



Industrial Pro Installation Instructions

- Securely mount the Industrial Pro using twelve bolts (3/8"-24UNF or M10). (See Figure 1)

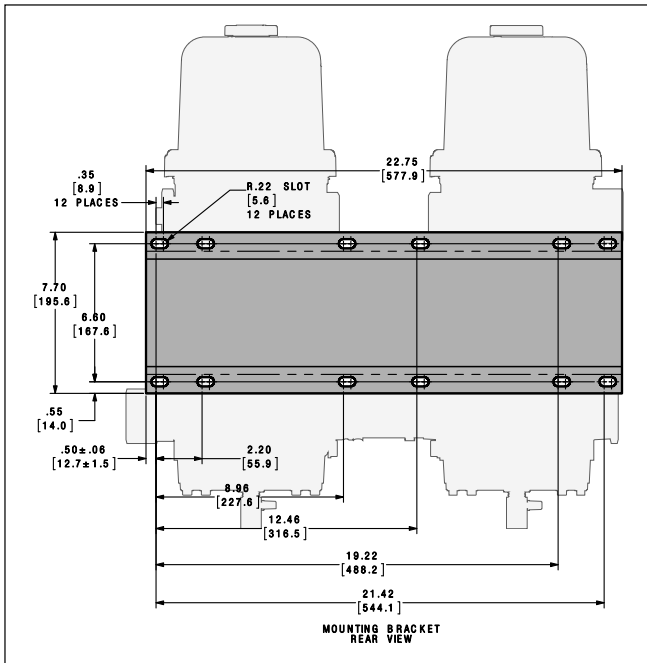


Figure 1 - Mounting Dimensions

- Route the fuel supply line from the fuel tank to Industrial Pro inlet (see Figure 2). Route a fuel line from the Industrial Pro outlet to the fuel pump inlet.

- ⚠ CAUTION: To avoid fuel line water traps that can freeze in cold conditions and restrict, or block, the flow of fuel to the engine, be certain that there are no low spots in the hoses when routing them in the engine compartment.

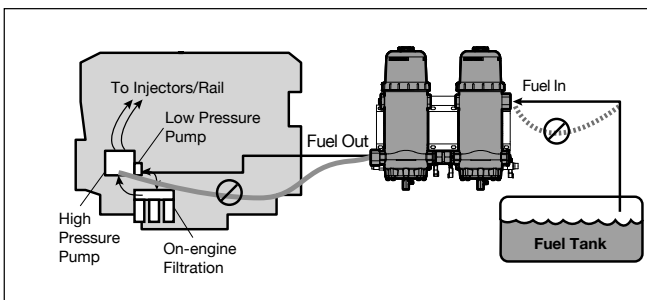


Figure 2 - Industrial Pro Connections

Note: When the engine is shut off, fuel levels may drop until the engine is restarted.

To minimize restrictions, observe the following guidelines when plumbing the system.

- Keep the fuel line routing as smooth as possible with no low hanging loops which can trap water.
- Use 90° elbows only when necessary.

- If the fuel hoses are made up to length on the job, be sure that the inner liner of the fuel hose is not cut by the fitting, creating potential check valve effects. Also make sure hoses are clean and free of debris before installing.

- ⚠ CAUTION: To avoid damaging the aluminum fuel housing, do not over-tighten fuel lines or line fittings. Do not exceed 65 ft-lbs (88 N·m). See the table of torque values on page 10.

- Apply liquid thread sealant to the inlet and outlet hose threads and connect the hoses to the unit.

Installing a WIF (Water In Fuel) Sensor With Optional Indicator (LED)

⚠ **WARNING:** Fuels are combustible.

• **RISK OF FIRE OR EXPLOSION:**

- Avoid open flames, electrical sparks or ignition sources
- Do not smoke.

⚠ **Before Installation:**

- Check that the engine is stopped and starting is disabled.
- Switch off the operating voltage to the engine ECU.

1. Screw the WIF sensor (See Figure 3) (3) with the sealing ring A18x22 (4) in the Industrial Pro WIF sensor port by hand.
2. Tighten the sensor (3) with torque wrench to max. 30 Nm (22 ft-lbs) tightening torque.
3. Connect the F70 plug (1) of the WIF sensor harness (5) to the WIF sensor (3) and tighten the bayonet lock (2) (Figure 3).

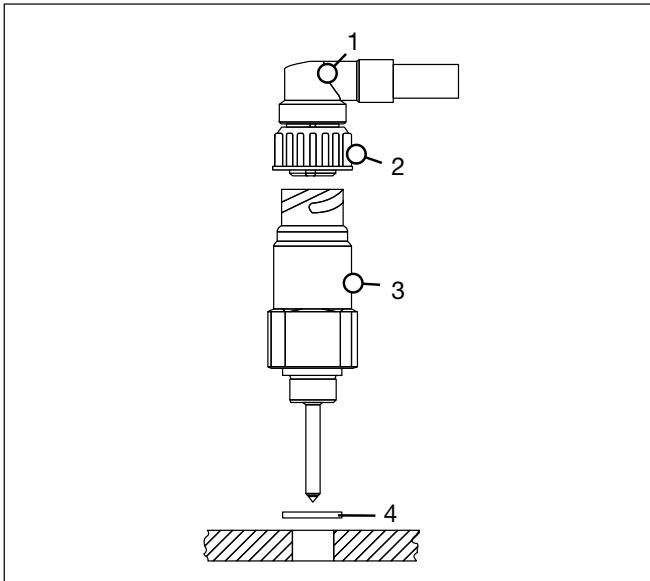


Figure 3 - WIF Sensor Installation

4. Route the WIF sensor harness (5) from the Industrial Pro to the XF70 connector on the engine. Securely route and support the the WIF sensor harness in the equipment.

5. Connect the XF70 plug of the WIF sensor harness (Figure 4) (5) to the XF70 connector on the engine and tighten the bayonet lock (2) (Figure 3).

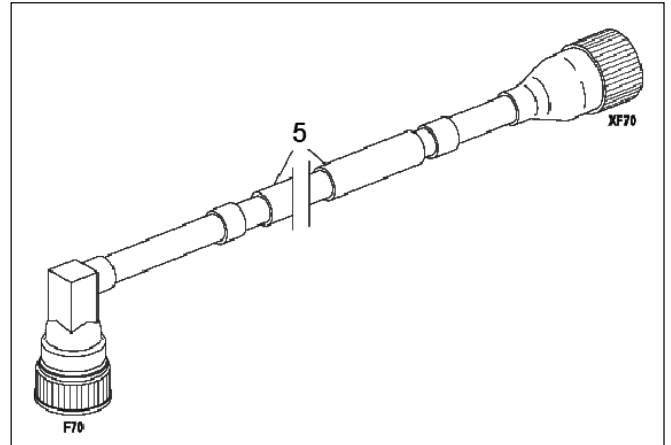


Figure 4 - WIF Sensor Harness

Note: The WIF sensor must be activated in the engine ECU for proper monitoring.



Priming Pump Electrical Specifications

Supply Voltage: 24V

Maximum Current 6A@24V

Recommended Fuse: 10 Amp

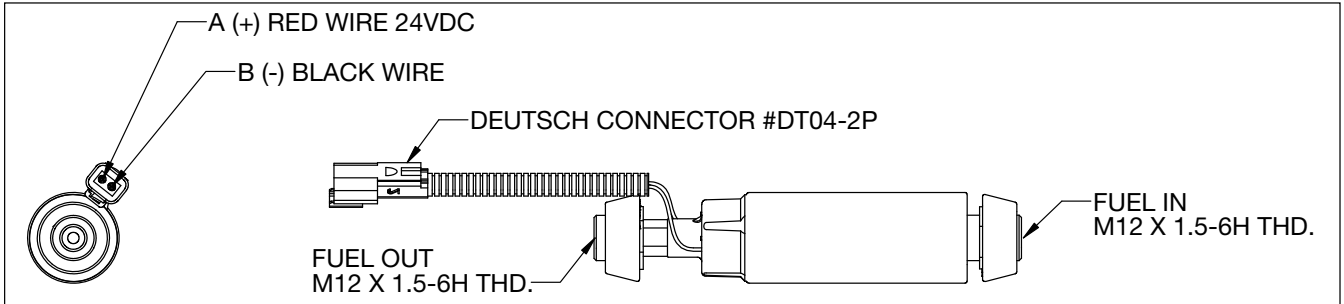


Figure 5 - Priming Pump Electrical Connections



Primer Pump Service

⚠ **WARNING:** Fuels are combustible.

- **RISK OF FIRE OR EXPLOSION:**

- Avoid open flames, electrical sparks or ignition sources
- Do not smoke.

Disassembly

1. Open the vent cap and then open the drain valve - drain the Industrial Pro below the primer pump connections points.
2. Close the drain valve. Dispose of the fuel in an environmentally safe manner.
3. Disconnect the primer pump electrical connection.
4. Disconnect the fuel hoses at the fittings on the primer pump.
5. Remove the fittings (use backup wrench as needed) and set aside for later use. If the unit has 90° fittings, note the fitting orientation.
6. Remove the fitting on the end of the pump using two wrenches to hold the end stationary as the fitting is loosened. See Figure 6.
7. The washer on the fittings **MUST** be in place when reassembled.

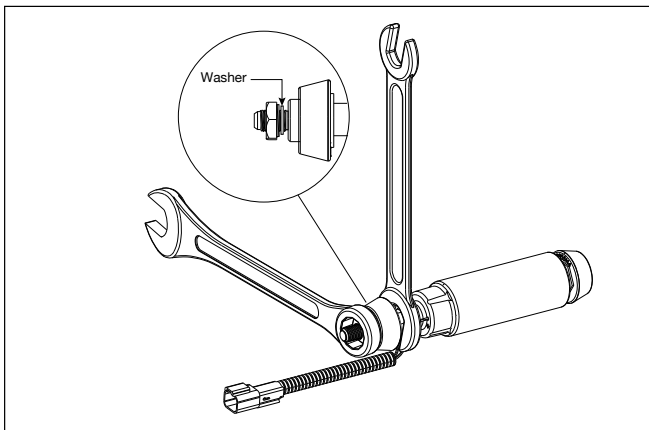


Figure 6 - Removing the Primer Pump Fitting

8. Remove the primer pump mounting strap bolts and straps.
9. Remove primer pump.

Assembly

1. Install the new primer pump with fuel flow arrow aimed towards fuel outlet. (See Figure 7)

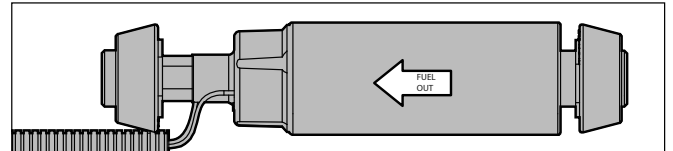


Figure 7 - Primer Pump

2. Install the primer pumps straps and bolts and torque to 8-10 ft-lbs.
3. Install the primer pump fittings aimed as originally installed (noted during disassembly).

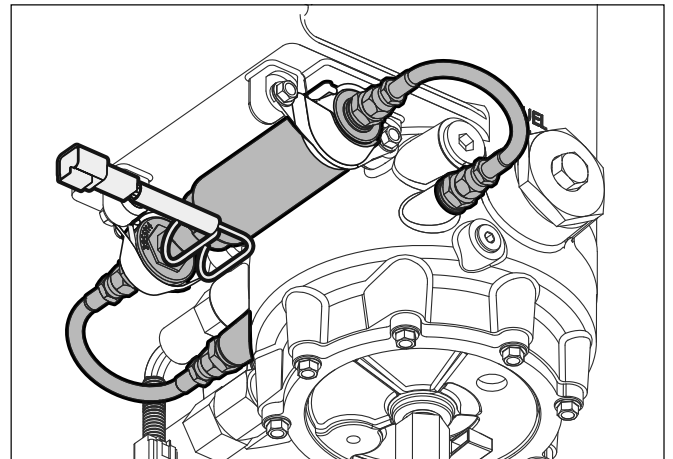


Figure 8 - Primer Pump Location

4. Torque the primer pump fitting jam nuts to 10-15 ft-lbs (use backup wrench as needed).
5. Connect the fuel hoses to the primer pump and torque to 10-15 ft-lbs (use backup wrench as needed).
6. Connect the primer pump electrical connection.

Priming

Use primer pump to prime the Industrial Pro or follow manual process listed below.

1. Prime the unit by filling the clear cover with clean diesel fuel until it reaches the top of the filter.
2. Install the vent cap.
3. Start the engine and run for one minute.
4. Slowly open the vent cap and allow the fuel to drop to about one inch above the collar.
5. Close the vent cap.

Note: It is normal for the fuel level to vary after the initial start-up and during.



Installing an Optional Electric Heater

⚠ WARNING: Fuels are combustible.

- RISK OF FIRE OR EXPLOSION:**
 - Avoid open flames, electrical sparks or ignition sources

Do not smoke. All units come with pre-drilled ports to allow for pre-heaters (dual units require two pre-heaters):

Dual Tall: Four ports (two per body). (See Figure 9)

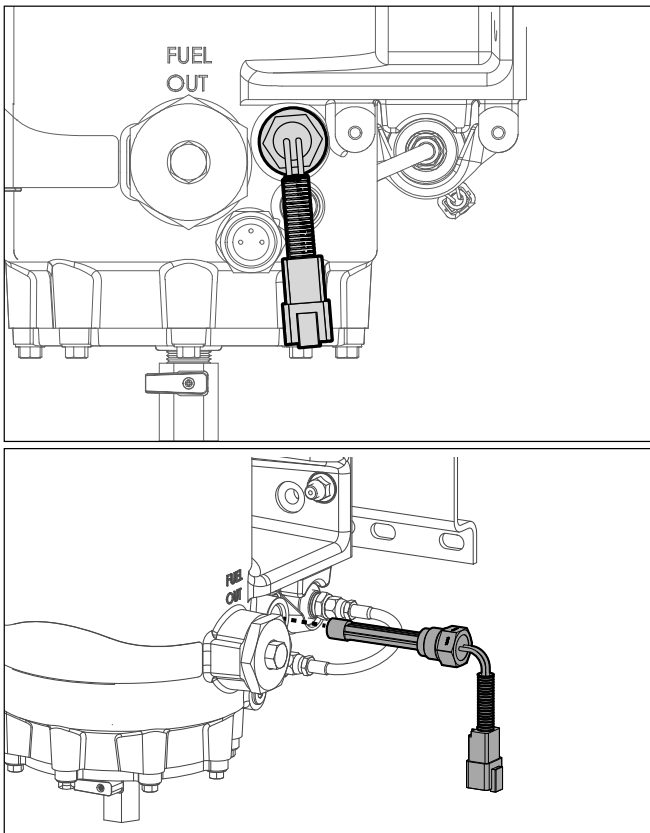


Figure 9 - Pre-heater Installation

To install, thread heater into housing and torque to 15-30 ft-lbs (20.3-40.7 N-m). Follow the wiring diagram in Figures 10 and 11.

Refer to equipment owner's manual for more specific information related to wiring diagrams of the equipment to which the unit will be applied.

Note: When wiring the electric preheater, use a fuse NOT a circuit breaker.

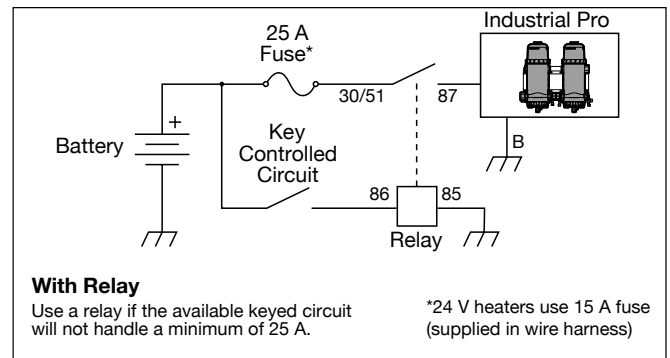


Figure 10 - Wiring with Relay

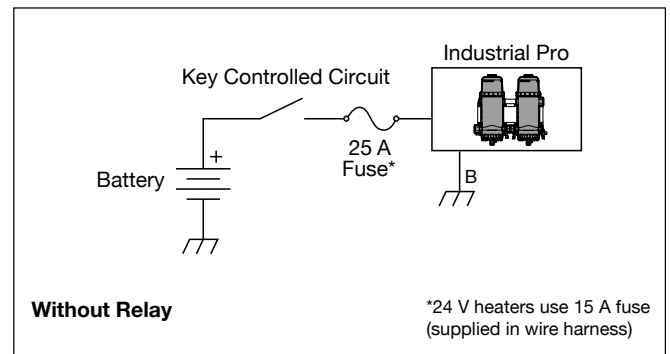


Figure 11 - Wiring without Relay

Note: For systems with multiple Industrial Pro® units, the pre-heater power supply wiring must be split in the junction box. See Figure 12 for wiring a Dual system.

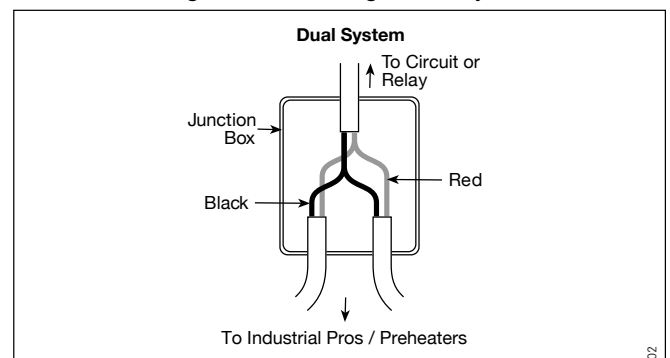


Figure 12 - Wiring Dual Filter Systems

TIM-ID: 0000083486 - 402



Filter Change Procedure

⚠ **WARNING:** Fuels are combustible.

- **RISK OF FIRE OR EXPLOSION:**

- Avoid open flames, electrical sparks or ignition sources

Note: Do not smoke. Change the filter only when the fuel level reaches and remains at the top of the black band on the filter. The filter may become dark, however, there is additional filter capacity and restriction will remain low until the fuel reaches the black band.

1. Turn off the engine. Remove the vent cap and dispose of the O-ring. Clean the threads of the vent cap and on the top of the cover. Set the vent cap aside.
2. Open the drain valve and drain the fuel completely from the unit, then close the drain valve. The unit must be completely drained to prevent contamination of the clean side of the filtration system.
3. Using the collar wrench loosen the collar. (See Figure 13) Remove the clear cover and collar from the Industrial Pro. Discard the cover O-ring and install a new O-ring (supplied with the filter) on the cover. Clean the threads on the collar and body of the Industrial Pro.

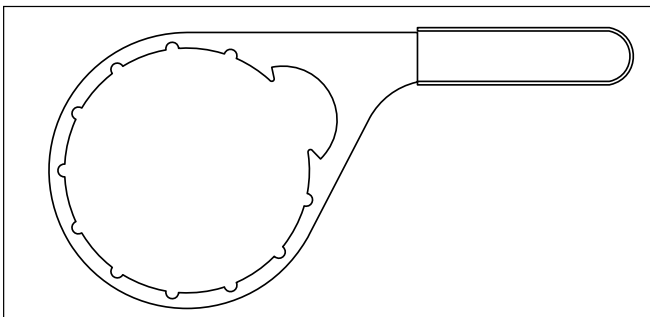


Figure 13 – Collar Wrench

4. Install the new O-ring on the vent cap (supplied with the filter).
5. Remove the filter element(s) from the Industrial Pro by pulling upward.
6. Install the new filter element. Figure 14 shows a key of the filter which fits into a keyway on the center boss. Position the filter element so the filter element key is lined up with the keyway on the center boss of the housing and press the filter element into the housing. Ensure the filter element is fully seated by firmly pushing on the end plate.

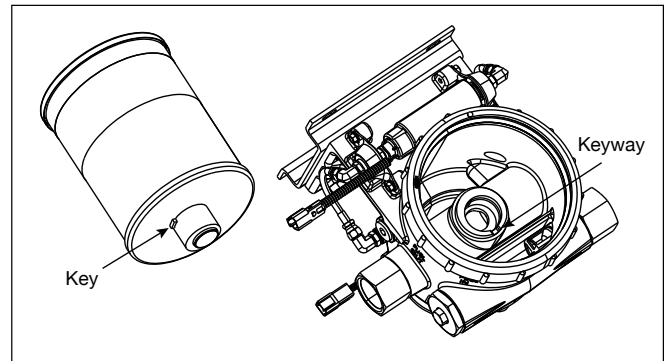


Figure 14 – Keyway

7. After checking to make sure the new o-ring seal is seated correctly on the base of the cover, install the cover and collar. Simultaneously apply modest pressure to the top of the cover and turn the collar until it no longer spins freely. Using the collar wrench, tighten the collar the distance of two additional ribs.
8. Prime the fuel system according to the steps in the "Priming the Fuel System" section in this manual. (The vent cap will be returned to the Industrial Pro during the priming process).

Priming the Fuel System

1. Check to make sure the drain valve at the base of the Industrial Pro is closed. Close the fuel shutoff valve (if equipped).
2. Remove the vent cap from the top of the clear cover. Fill the Industrial Pro full of clean fuel. Tighten the vent cap (**tighten by hand only**) until it "clicks".
3. Open the fuel shutoff valve (if equipped). Start the engine. When the lubrication system reaches its normal operating pressure, increase engine speed to high idle for one to two minutes. Loosen the vent cap until the fuel level drops to just above the collar. Tighten the vent cap (tighten by hand only) until it "clicks".

Note: The clear filter cover will not fill completely during engine operation. It will gradually fill over time and the fuel level will rise as the filter becomes clogged.



Draining Contaminants

1. Turn off the engine and open the vent cap.
2. Place a suitable container under the drain valve at the base of the Industrial Pro and open the drain valve.
3. Water will flow into the container. When fuel begins to flow out of the drain, close the drain valve.
4. Tighten the vent cap by hand until it “clicks.”
5. Start the engine. Raise the RPM for one minute to purge the air from the system.

Suggested Preventive Maintenance

Weekly – Drain water.

Every Filter Change – Change o-rings.

Every 12 Months – Check all electrical connections for corrosion. Check all fuel fittings for leaks.

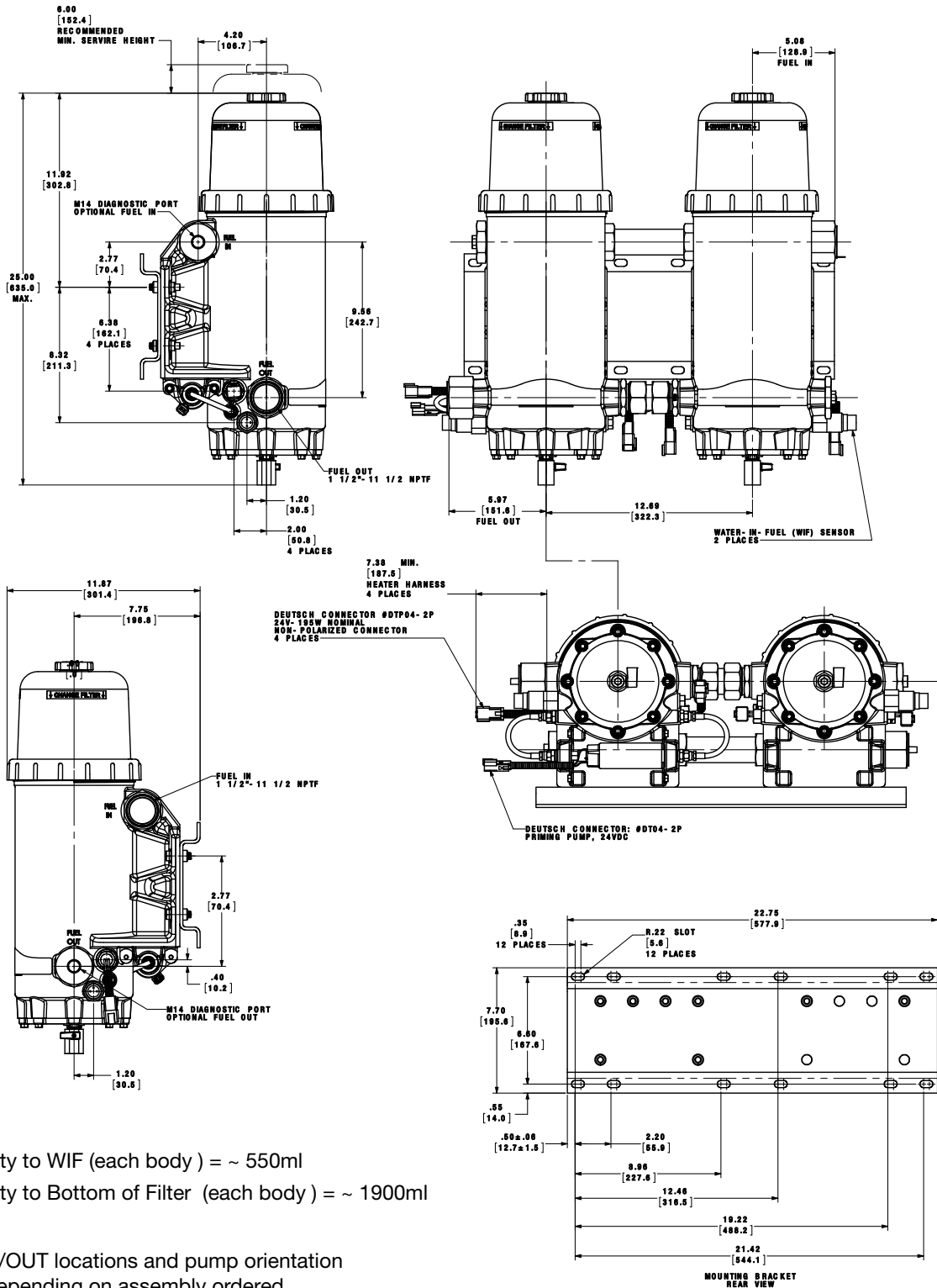
Extreme winter or salt corrosion environments may require lubrication of the top collar threads with antiseize lubricant every 180 days.

Torque Values

Application	Torque	
	ft-lb	N-m
WIF Probe to Housing	22	30
Fuel Connection Fittings to Housing Body	55-65	74.6-88.1
Heater to Housing	15-30	20.3-40.7
Drain Valve to Bottom Plate	10-15	13.6-20.3
Primer Pump Strap to Body	8-10	10.8-13.6
Primer Pump Fittings to Housing Body	13-15	17.6-20.3
Pump Inlet/Outlet Hose to Fittings	10-15	13.6-20.3
Assembly to Mounting Bracket	35-50	47.5-67.8
Bottom Plate	8-10	10.8-13.6



Dimensions



Water Capacity to WIF (each body) = ~ 550ml
 Water Capacity to Bottom of Filter (each body) = ~ 1900ml

Note: Fuel IN/OUT locations and pump orientation will change depending on assembly ordered.

10 Appendix A

10.1 Abbreviations

Abbreviation	Meaning	Explanation
A/D	Analog/Digital converter	Converter: converts sensor voltages into digital values
ADEC	Advanced Diesel Engine Controller	Engine management system
AFRS	Air Filter Restriction Sensor	
AGR	Abgasrückführung	Exhaust Gas Recirculation
AL	Alarm	
ANSI	American National Standards Institute	Association of American standardization organizations
ATL	Abgasturbolader/Abgasturboaufladung	Exhaust turbocharger/exhaust turbocharging
ATS	Air Temperature Sensor	
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	Drift correction setting with DiaSys in engine governor
CEL	Check Engine Lamp	1st function: Warning lamp (rectify fault as soon as possible) 2nd function: Read out fault codes
CKT	Circuit	
CLS	Coolant Level Sensor	Monitors coolant level
CM	Current Measurement	Current measured value
CPS	Coolant Pressure Sensor	Monitors coolant pressure
CR	Common Rail	
CTS	Coolant Temperature Sensor	Monitors coolant temperature
DDEC	Detroit Diesel Electronic Controls	Engine control system made by Detroit Diesel
DDL	Diagnostic Data Link	Diagnostic lines
DDR	Diagnostic Data Reader	Diagnostic unit
Dia-Sys®	Electronic dialog system	
DIN	Deutsches Institut für Normung e. V.	German national standards institute. At the same time identifier of German standards (DIN = "Deutsche Industrie-Norm")
DL	Default Lost	Alarm: Default CAN bus failure
DMC	Data Matrix Code	
DOC	Diesel Oxidation Catalyst	Oxidation catalyst upstream of the diesel particulate filter
DPF	Diesel Particulate Filter	
DT	Diagnostic Tool	Diagnostic unit
ECM	Electronic Control Module	Electronic control unit of the DDEC system

Abbreviation	Meaning	Explanation
ECU	Engine Control Unit	Engine governor
EDM	Engine Data Module	Memory module for engine data
EE-PROM	Electrically Erasable Programmable Read Only Memory	Electrically Erasable Programmable Read Only Memory
EFPA	Electronic Foot Pedal Assembly	Electronic accelerator pedal
EGR	Exhaust Gas Recirculation	
EIL	Engine Ident Label	
EIM-ID	Emission Identification Number	
EMU	Engine Monitoring Unit	
ESCM	Extreme Site Condition Management	Power reduction for operation in extreme conditions
ESD	Single accumulator pressure	
ETK	Ersatzteilkatalog	Spare Parts Catalog
EUI	Electronic Unit Injector	Electronic injection nozzle unit
FO	Frequency Output	
FPS	Fuel Pressure Sensor	Monitors fuel pressure
FRS	Fuel - Differential Pressure Sensor	
FTS	Fuel Temperature Sensor	Monitors fuel temperature
FWCP	Fire Water Control Panel	Control cabinet
GND	Ground	
HP	High Pressure	
HI	High	Alarm: Measured value exceeds 1st maximum limit
HIHI	High High	Alarm: Measured value exceeds 2nd maximum limit
HT	High Temperature	
IDM	Interface Data Module	Memory module for interface data
IIG	Initial injector equalization	Initial input of injector code in Engine Control Unit with DiaSys in
INJ	Injector	
ISO	International Organization for Standardization	International umbrella organization for all national standardization institutes
KGS	Kupplungsgegenseite	Engine free end in accordance with DIN ISO 1204
KS	Kupplungsseite	Engine driving end in accordance with DIN ISO 1204
L1	Limit 1	Limit value, limit 1
L2	Limit 2	Limit value, limit 2
LED	Light Emitting Diode	
LLK	Ladeluftkühlung	Charge-air cooling
LO	Low	Alarm: Measured value lower than 1st minimum limit value
LOLO	Low Low	Alarm: Measured value lower than 2nd minimum limit value
LSG	Limit Speed Governor	Maximum-speed governor
LSU	Lambda Sonde Universal	Universal Lambda probe
LT	Low Temperature	
MCR	Maximum Continuous Rating	Torque limitation curve

Abbreviation	Meaning	Explanation
N/A	Not Applicable	
LP	Low Pressure	
NN	Normal Null	Reference surface for heights above sea level
NT	Niedertemperatur	Low temperature
OEM	Original Equipment Manufacturer	
OI	Optimized Idle	
OLS	Oil Level Sensor	Monitors oil level
OPS	Oil Pressure Sensor	Monitors oil pressure
OTS	Oil Temperature Sensor	Monitors oil temperature
OT	Oberer Totpunkt	Top Dead Center
PAN	Panel	Control panel
PIM	Peripheral Interface Module	
PWM	Pulse Width Modulation	Modulated signal
P-xyz	Pressure-xyz	Pressure measuring point xyz
RL	Redundancy Lost	Alarm: Redundant CAN bus failure
SAE	Society of Automotive Engineers	U.S. standardization organization
SD	Sensor Defect	Alarm: Sensor failure
SEL	Stop Engine Lamp	1st function: Warning lamp (stop engine and rectify fault) 2nd function: Read out fault codes
SID	System Identifier	
SRS	Synchronous Reference Sensor	TDC cylinder 1
SS	Safety System / Security Shutdown	Safety system alarm
TBS	Turbocharger Boost Sensor	Monitors charge-air pressure
TCI	Turbo Compressor Inlet	
TCO	Turbo Compressor Outlet	
TD	Transmitter Deviation	Alarm: Sensor comparison fault
TPS	Throttle Position Sensor	
TRS	Timing Reference Sensor	
T-xyz	Temperature-xyz	Temperature measuring point xyz
U_PDU	Voltage Power Driver Unit	Distribution voltage for solenoid valve output stages
UDV	Pressure relief valve	
UT	Unterer Totpunkt	Bottom Dead Center
VNT	Variable Nozzle Turbine	
VSG	Variable-Speed Governor	
VSS	Vehicle Speed Sensor	
WZK	Werkzeugkatalog	Tool Catalog
ZKP	Zuordnung - Kategorie - Parameter	Assignment - Category - Parameter. A number allocated to a parameter describing its function and assignment

10.2 MTU Contact/Service Partners

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Your contact person in our Customer Assistance Center:

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Fax.: +49 7541 9077778

Asia/Pacific: +65 6100 2688

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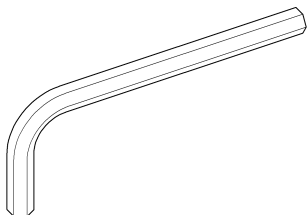
Tel.: +49 7541 9077777

Fax.: +49 7541 9077778

11 Appendix B

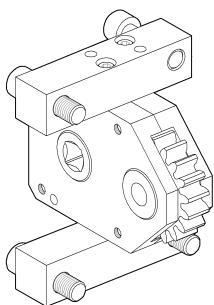
11.1 Special Tools

Allen key



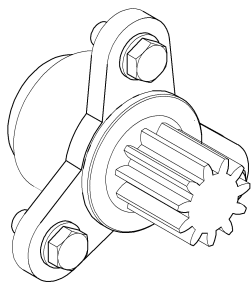
Part No.:	F30002815
Qty.:	1
Used in:	8.5.3 Valve clearance – Check and adjustment (→ Page 106)

Barring device



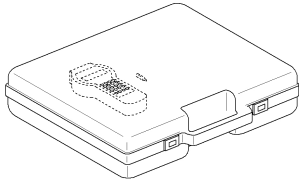
Part No.:	F6555766
Qty.:	1
Used in:	8.3.1 Cylinder liner – Endoscopic examination (→ Page 97)

Barring tool



Part No.:	F6787910
Qty.:	1
Used in:	8.1.1 Engine – Barring manually (→ Page 92)

Belt tension tester Optibell 2

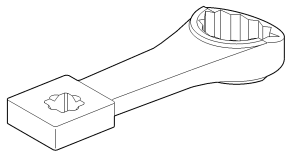


Part No.: Y4345711

Qty.: 1

Used in: 8.19.3 Fan drive – Drive belt tension check / adjustment
(→ Page 177)

Box wrench

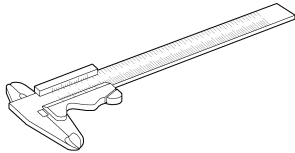


Part No.: F30379609

Qty.: 1

Used in: 8.20.2 Engine mounting – Resilient mount check
(→ Page 183)

Calipers

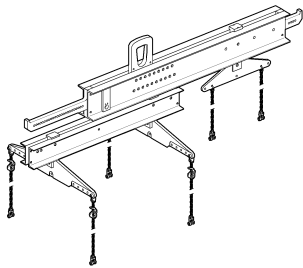


Part No.: Y20001743

Qty.: 1

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(→ Page 183)

Crossbeam

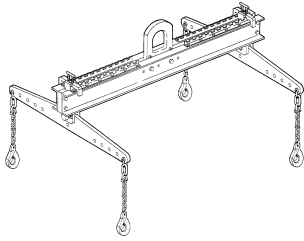


Part No.: T80091826

Qty.: 1

Used in: 2.1 Transportation (→ Page 15)

Crossbeam

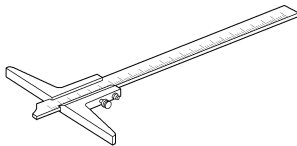


Part No.: T80092210

Qty.: 1

Used in: 2.1 Transportation (→ Page 15)

Depth gauge, 200 mm

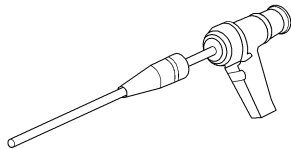


Part No.: Y20000918

Qty.: 1

Used in: 8.5.2 Valve protrusion – Measurement (→ Page 104)

Endoscope

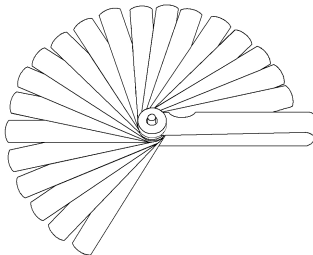


Part No.: Y20097353

Qty.: 1

Used in: 8.3.1 Cylinder liner – Endoscopic examination (→ Page 97)

Feeler gage

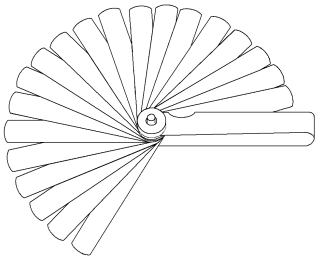


Part No.: Y20098771

Qty.: 1

Used in: 8.20.2 Engine mounting – Resilient mount check (→ Page 183)

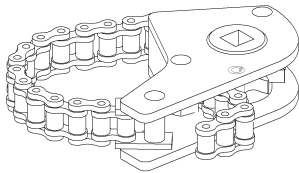
Feeler gauge



Part No.: Y20098771

Qty.: 1
Used in: 8.5.3 Valve clearance - Check and adjustment
(→ Page 106)

Filter wrench



Part No.: F30379104

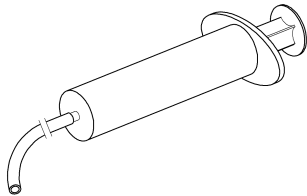
Qty.: 1
Used in: 8.9.1 Fuel filter - Replacement (→ Page 122)

Qty.: 1
Used in: 8.9.2 Additional fuel filter - Replacement (→ Page 123)

Qty.: 1
Used in: 8.14.1 Engine oil filter - Replacement (→ Page 140)

Qty.: 1
Used in: 8.14.4 Centrifugal oil filter and filter sleeve - Cleaning and replacement (→ Page 148)

Fuel suction device



Part No.: F30378207

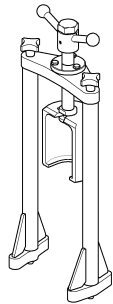
Qty.: 1
Used in: 8.6.1 HP fuel pump - Filling with engine oil (→ Page 112)

High-pressure cleaning unit

Part No.: -

Qty.: 1
Used in: 5.8 Plant - Cleaning (→ Page 58)

Installation/removal jig

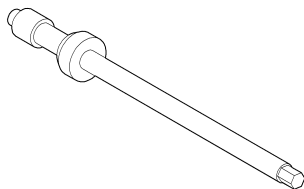


Part No.: F6796646

Qty.: 1

Used in: 8.7.2 Injector – Removal and installation (→ Page 115)

Milling cutter

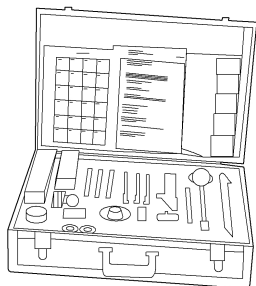


Part No.: F30452739

Qty.: 1

Used in: 8.7.2 Injector – Removal and installation (→ Page 115)

MTU test kit



Part No.: 5605892099/00

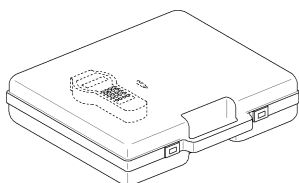
Qty.: 1

Used in: 8.13.4 Engine oil – Sample extraction and analysis (→ Page 138)

Qty.: 1

Used in: 8.15.6 Engine coolant – Sample extraction and analysis (→ Page 160)

Optibell 2 belt tension tester

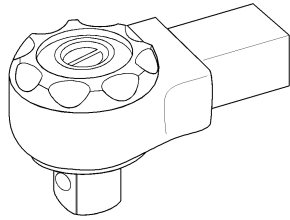


Part No.: Y4345711

Qty.: 1

Used in: 8.19.1 Fan drive – Drive belt tension check / adjustment (→ Page 174)

Ratchet

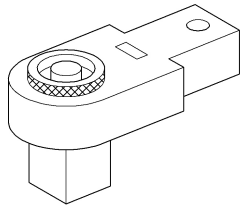


Part No.: F30450902

Qty.: 1

Used in: 8.20.1 Engine mounting – Check (→ Page 181)

Ratchet adapter



Part No.: F30027340

Qty.: 1

Used in: 2.3 Crankshaft – Transport locking device (→ Page 17)

Qty.: 1

Used in: 8.11.3 Exhaust flaps – Coupling rod replacement (→ Page 130)

Qty.: 1

Used in: 8.14.5 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 150)

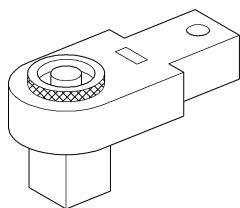
Qty.: 1

Used in: 8.22.5 NOx sensor – Replacement (→ Page 191)

Qty.: 1

Used in: 8.22.6 Lambda sensor – Replacement (→ Page 193)

Ratchet adapter

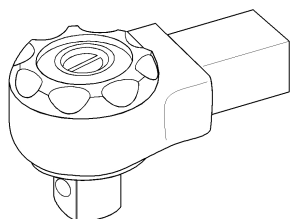


Part No.: F30027341

Qty.: 1

Used in: 8.13.3 Engine oil – Change (→ Page 136)

Ratchet adapter

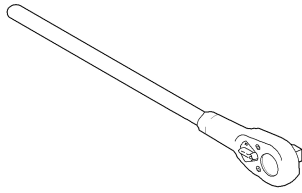


Part No.: F30450902

Qty.: 1

Used in: 8.13.3 Engine oil – Change (→ Page 136)

Ratchet with extension



Part No.: F30006212

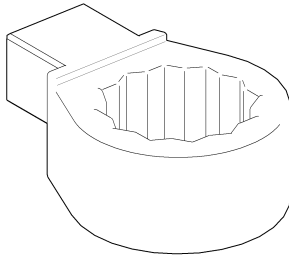
Qty.: 1

Used in: 8.1.1 Engine - Barring manually (→ Page 92)

Qty.: 1

Used in: 8.3.1 Cylinder liner - Endoscopic examination (→ Page 97)

Socket wrench, 24 mm

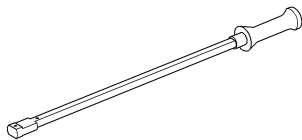


Part No.: F30039526

Qty.: 1

Used in: 8.5.3 Valve clearance - Check and adjustment (→ Page 106)

Torque wrench 300-800 Nm



Part No.: F30047798

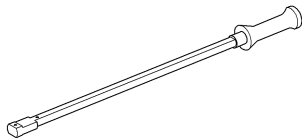
Qty.: 1

Used in: 8.13.3 Engine oil - Change (→ Page 136)

Qty.: 1

Used in: 8.20.2 Engine mounting - Resilient mount check (→ Page 183)

Torque wrench, 10-60 Nm

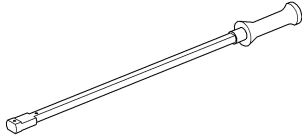


Part No.: F30452769

Qty.: 1

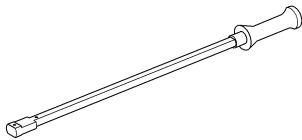
Used in: 8.13.3 Engine oil - Change (→ Page 136)

Torque wrench, 10–60 Nm



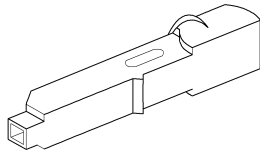
Part No.:	F30452769
Qty.:	1
Used in:	2.3 Crankshaft – Transport locking device (→ Page 17)
Qty.:	1
Used in:	8.6.1 HP fuel pump – Filling with engine oil (→ Page 112)
Qty.:	1
Used in:	8.7.2 Injector – Removal and installation (→ Page 115)
Qty.:	1
Used in:	8.14.2 Automatic oil filter – Oil filter candle replacement W1035 (→ Page 142)
Qty.:	1
Used in:	8.14.5 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 150)
Qty.:	1
Used in:	8.22.5 NOx sensor – Replacement (→ Page 191)
Qty.:	1
Used in:	8.22.6 Lambda sensor – Replacement (→ Page 193)

Torque wrench, 300–800 Nm



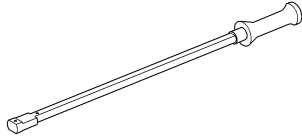
Part No.:	F30047798
Qty.:	1
Used in:	8.20.1 Engine mounting – Check (→ Page 181)

Torque wrench, 4–20 Nm



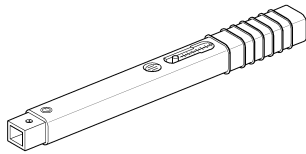
Part No.:	F30044239
Qty.:	1
Used in:	8.4.1 Oil mist fine separator – Replacement (→ Page 101)
Qty.:	1
Used in:	8.5.4 Cylinder head cover – Removal and installation (→ Page 110)
Qty.:	1
Used in:	8.7.2 Injector – Removal and installation (→ Page 115)
Qty.:	1
Used in:	8.14.4 Centrifugal oil filter and filter sleeve – Cleaning and replacement (→ Page 148)
Qty.:	1
Used in:	8.14.5 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 150)
Qty.:	1
Used in:	8.22.5 NOx sensor – Replacement (→ Page 191)

Torque wrench, 60–320 Nm



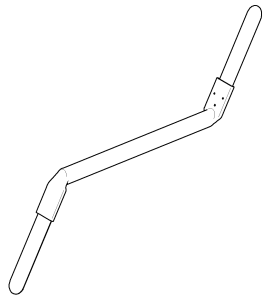
Part No.:	F30452768
Qty.:	1
Used in:	2.3 Crankshaft – Transport locking device (→ Page 17)
Qty.:	1
Used in:	8.5.3 Valve clearance – Check and adjustment (→ Page 106)
Qty.:	1
Used in:	8.7.2 Injector – Removal and installation (→ Page 115)
Qty.:	1
Used in:	8.13.3 Engine oil – Change (→ Page 136)
Qty.:	1
Used in:	8.14.2 Automatic oil filter – Oil filter candle replacement W1035 (→ Page 142)
Qty.:	
Used in:	8.19.3 Fan drive – Drive belt tension check / adjustment (→ Page 177)
Qty.:	
Used in:	8.19.4 Fan drive – Drive belt replacement (→ Page 179)

Torque wrench, 6–50 Nm



Part No.:	F30027336
Qty.:	1
Used in:	8.11.3 Exhaust flaps – Coupling rod replacement (→ Page 130)

Valve adjusting gauge



Part No.:	Y4349603
Qty.:	1
Used in:	8.5.3 Valve clearance – Check and adjustment (→ Page 106)

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