Technical Documentation

Diesel Engine
20 V 4000 G22-G82

Operating Instructions
M015565/02E

Wichtig – Important – Importante

Bitte die Karte „Inbetriebnahmemeldung“ abtrennen und ausgefüllt an MTU Friedrichshafen GmbH zurücksenden.

Die Informationen der Inbetriebnahmemeldung sind Grundlage für den vertraglich vereinbarten Logistik-Support (Gewährleistung, Ersatzteile etc.).

Please complete and return the “Commissioning Note” card below to MTU Friedrichshafen GmbH.

The Commissioning Note information serves as a basis for the contractually agreed logistic support (warranty, spare parts, etc.).

Veuillez séparer la carte “Signalisation de mise en service“ et la renvoyer à la MTU Friedrichshafen GmbH.

Les informations contenues dans la signalisation de mise en service constituent la base pour l'assistance en exploitation contractuelle (garantie, rechanges, etc.).

Rogamos separen la tarjeta “Aviso de puesta en servicio“ y la devuelvan rellenada a MTU Friedrichshafen GmbH.

Las informaciones respecto al aviso de puesta en servicio constituyen la base para el soporte logístico contractual (garantía, piezas de repuesto, etc.).

Ritagliare “Avviso di messa in servizio“ e rispedirlo debitamente compilato alla MTU Friedrichshafen GmbH.

Le informazioni ivi registrate sono la base per il supporto logistico contrattuale (garanzia, ricambi, ecc.).

É gentileza cortar o cartão "Participação da colocação em serviço", preenché-lo e devolvé-lo a MTU Friedrichshafen.

Os dados referentes à colocação em serviço representam a base para o suporte logístico (garantia, peças sobressalentes, etc.) estabelecido contratualmente.

Postcard

MTU Friedrichshafen GmbH
Department SCSD
88040 Friedrichshafen
GERMANY

Bitte in Blockschrift ausfüllen!
Please use block capitals!
Prière de remplir en lettres capitales!
¡A rellenar en letras de imprenta!
Scrivere in stampatello!
Favor preencher com letras de forma!

Motornr.: Engine No.: N° du moteur: N° de motor: Motore N.: No. do motor:	Auftragsnr.: MTU works order No.: N° de commande: N° de pedido: N. commessa: No. do pedido:
Motortyp: Engine model: Type du moteur: Tipo de motor: Motore tipo: Tipo do motor:	Inbetriebnahmedatum: Date put into operation: Mise en service le: Fecha de puesta en servicio: Messa in servizio il: Data da colocação em serviço:
Eingebaut in: Installation site: Lieu de montage: Lugar de montaje: Installato: Incorporado em:	Schiffstyp / Schiffshersteller: Vessel/type/class / Shipyard: Type du bateau / Constructeur: Tipo de buque / Constructor: Tipo di barca / Costruttore Tipo de embarcação/estaleiro naval:
Endabnehmer/Anschrift: End user`s address: Adresse du client final: Dirección del cliente final: Indirizzo del cliente finale: Usuário final/endereço:	
Bemerkung: Remarks: Remarques: Observaciones: Commento: Observações:	

Inbetriebnahme-meldung

Commissioning Note

Notice de mise en service

Aviso de puesta en servicio

Avviso di messa in servizio

Participação da colocação em serviço

1 Safety

1.1 General conditions

General

In addition to the instructions in this publication, the applicable country-specific legislation and other compulsory regulations regarding accident prevention must be observed. This engine is a state-of-the art product and conforms with all applicable specifications and regulations. Nevertheless, persons and property may be at risk in the event of:

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

Correct use

The engine is intended exclusively for the application specified in the contract or defined at the time of delivery. Any other use is considered improper use. The manufacturer will accept no liability for any resultant damage. The responsibility is borne by the user alone.

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

Modifications or Conversions

Modifications made by the customer to the engine may affect safety.

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

Spare parts

Only genuine MTU spare parts must be used to replace components or assemblies. In the event of any damage caused by the use of other spare parts, no liability nor warranty claims vis-à-vis the engine manufacturer will be accepted.

1.2 Personnel and organizational requirements

Personnel

Work on the engine must only be carried out by properly qualified and instructed personnel.

The specified legal minimum age must be observed.

Responsibilities of the operating, maintenance and repair personnel must be specified.

Organization

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

It must be kept at hand near the engine and accessible at any time to all personnel involved in operation, maintenance, repair or transportation.

The personnel must be instructed on engine operation and repair by means of this publication, and in particular the safety instructions must be explained.

This is especially important for personnel who work on the engine only on an occasional basis. Such personnel must be given instructions repeatedly.

Working clothes and protective equipment

Wear proper work clothing for all work.

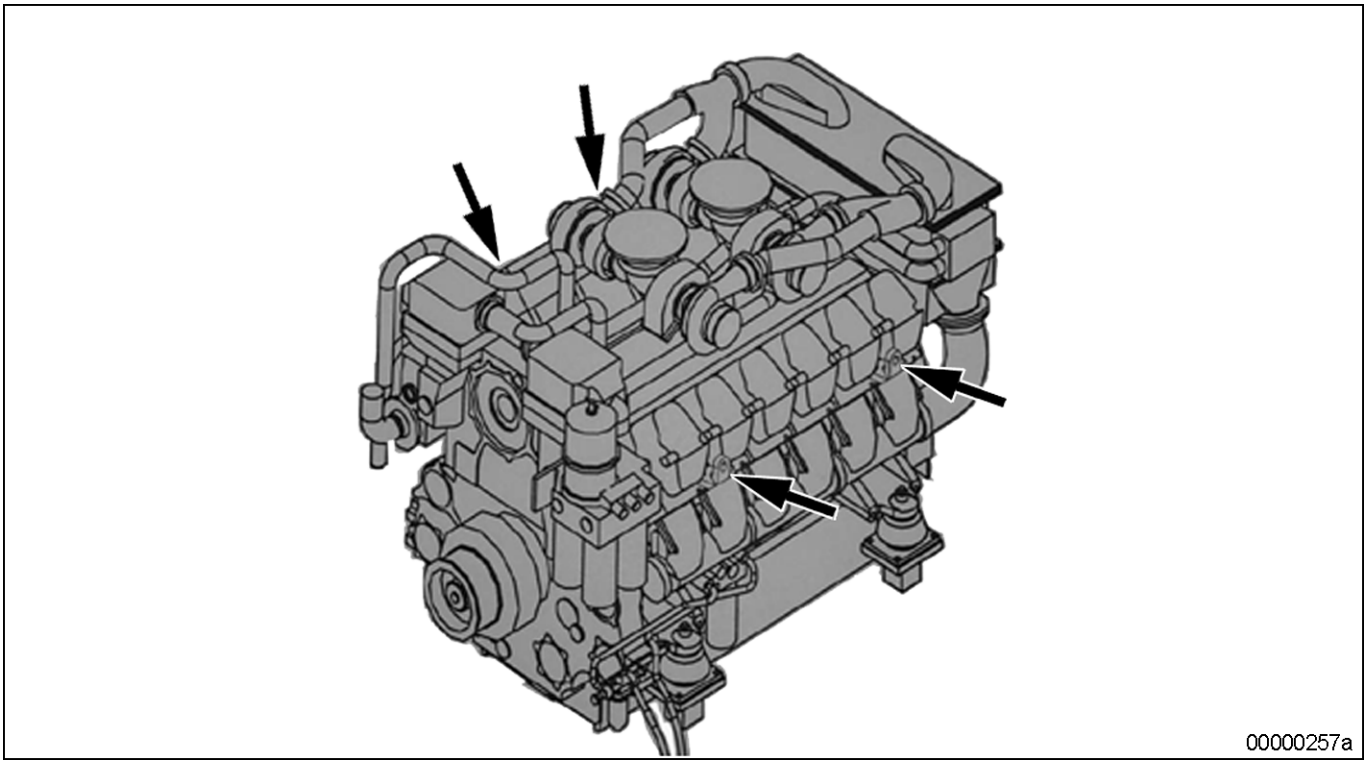
Depending on the kind of work, use additional protective equipment, e.g. protective goggles, gloves, helmet, apron.

Work clothing must be tight fitting so that it does not catch on rotating or projecting components.

Do not wear jewelry (e.g. rings, chains etc.).

1.3 Transport

Engine transport



Lift the engine only with the lifting eyes provided.

Use only the transport and lifting equipment approved by MTU.

Take note of the engine center of gravity.

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

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

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

Setting the engine down after transport

Place the engine only on an even, firm surface.

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

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

1.4 Safety precautions when working on the engine

Safety precautions when putting the equipment into operation

Prior to initial operation, the product must have been installed correctly and approved according to MTU specifications.

Before putting the device or the system into operation, always ensure

- that all maintenance and repair work is completed
- that all loose components have been removed from rotating parts
- that nobody is standing in the danger zone of moving engine components.

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

Safety requirements for operators

Procedures for cases of emergency must be practised regularly.

The operator must be familiar with the controls and displays.

The operator must know the consequences of each operation to be carried out.

The operator must carry out the individual operations according to the documentation.

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

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

- notify the supervisory personnel in charge
- analyze the message
- if required, carry out emergency operations e.g. emergency engine stop.

Engine operation

When the engine is running, always wear ear protectors.

Ensure that the engine room is well ventilated.

Mop up any leaked or spilt fluids and lubricants immediately or soak up with a suitable bonding agent.

Exhaust gases from combustion engines are poisonous. Inhalation of poisonous exhaust gases is a health hazard. The exhaust pipework must be free of leaks and discharge the gases to atmosphere.

During engine operation, do not touch battery terminals, generator terminals or cables.

Inadequate protection of electrical components can lead to electric shocks and serious injuries.

When the engine is running, never release coolant, oil, fuel, compressed-air or hydraulic lines.

Maintenance and repair

Strict adherence to the maintenance and repair schedule is an essential safety factor.

Never carry out maintenance and repair work with the engine running unless expressly instructed to do so. Lock-out/tag-out the engine to preclude undesired starting. Disconnect the battery when electrical starters are fitted. Close the main valve on the compressed-air system and vent the compressed air line when air starters are fitted. Post the "Do Not Start" sign in the operating room or affix it to the controlling device! Persons not involved must keep clear.

Never attempt to rectify faults or carry out repairs if you do not have the necessary experience or special tools required. Have maintenance and repair work carried out by qualified and authorized personnel only.

Use only proper, calibrated tools.

Do not work on engines or components which are only held by lifting equipment or crane. Always support by suitable means which conform with the applicable regulations before commencing maintenance or repair work.

Before barring the engine, make sure that nobody is standing in the danger zone. After completing work on the engine, check that all protective devices/safety guards have been installed and that all tools and loose parts have been removed from the engine.

Fluids emerging under high pressure can penetrate clothing and skin and may cause serious injury. Before starting work, relieve pressure in systems and H.P. lines which are to be opened.

Never bend a fuel line and do not install bent lines. Keep fuel injection lines and connections clean. Always seal connections with caps or covers if a line is removed or opened.

Take care not to damage fuel lines during maintenance and repair work. To tighten the connections when installing the lines, use the correct tightening torque and ensure that all retainers and dampers are installed correctly.

Ensure that all fuel injection lines and pressurized oil lines have sufficient distance to other components to avoid contact with them. Do not place fuel or oil lines near hot components, except when necessary for design reasons during installation.

Elastomers (e.g. "Viton" sealing rings) are stable under normal operating conditions. The material decomposes when exposed to fire or temperatures exceeding 300 °C. Hydrogen fluoride vapors are released in this case. The resulting acid leads to serious burning if it contacts the skin. Do not touch elastomeric seals if they have carbonized or resinous appearance. Wear protective gloves!

Take care with hot fluids in lines, pipes and chambers ⇒ Risk of injury!

Note cooling period for components which are heated for installation or removal ⇒ Risk of injury!

Never touch hot parts of the compressor and exhaust system ⇒ Risk of burning!

Take special care when removing ventilation or plugs from engine. In order to avoid discharge of highly pressurized liquids, hold a cloth over the screw or plug. It is even more dangerous if the engine has recently been shut down, as the liquids can still be hot.

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

When draining, collect fluids in a suitable container, mop up any spilt fluids or wipe or soak them with a suitable bonding agent.

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

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

In order to prevent back injuries when lifting heavy components adults, depending on age and sex, should only lift weights between max. 10 kg and 30 kg, therefore:

- Use lifting gear or seek assistance.
- Ensure that all chains, hooks, slings, etc. are tested and authorized, are sufficiently strong and that hooks are correctly positioned. Lifting eyes must not be unevenly loaded.

Welding work

Never carry out welding work on the engine or engine-mounted units.

Never use the engine as a ground connection. This prevents the welding current passing through the engine resulting in burnt/scorched bearings, sliding surfaces and tooth flanks which may lead to bearing seizure and/or other material damage.

Never route the welding lead over or near the wiring harnesses of MTU systems. The welding current may otherwise induce an interference voltage in the wiring harnesses which could conceivably damage the electrical system.

The welding unit ground connection must not be more than 60 cm from the weld point.

If components (e.g. exhaust manifold) are to be welded, they must be removed from the engine.

It is not necessary to remove the connector and the connections when carrying out welding operation on MTU electronics if the master switch for power supply is switched from "ON" to "OFF" and the wire is disconnected from the negative and positive poles on the battery.

Hydraulic installation and removal

Only the hydraulic installation and removal equipment specified in the work schedule and in the assembly instructions must be used.

The max. permissible push-on pressure specified for the equipment must not be exceeded.

The H.P. lines for hydraulic installation and removal are tested with 3800 bar.

Do not attempt to bend or apply force to lines.

Before starting work, pay attention to the following:

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

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

During hydraulic installation and removal, ensure that nobody is standing in the immediate vicinity of the component to be installed/removed. As long as the system is under pressure, there is the risk that the component to be installed/removed may be suddenly released from the pressure connection.

Before use, the tools must be checked at regular intervals (crack test).

Working on electrical/electronic assemblies

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

De-energize the appropriate areas prior to working on assemblies. Any measures requiring a power supply are expressly defined as such at the appropriate place in the manual.

Gases released from the battery are explosive. Avoid sparks and naked flames. Do not allow battery acids to come in contact with skin or clothing. Wear protective goggles. Do not place tools on the battery. Before connecting the cable to the battery, check battery polarity. Battery pole reversal may lead to injury through the sudden discharge of acid or bursting of the battery body.

Do not damage wiring during removal work and when reinstalling wiring and ensure that during operation it is not damaged by contact with sharp objects, by rubbing against other component or by a hot surface.

Do not secure wiring to fluid-carrying lines.

On completion of the maintenance and repair work, any cables which have become loose must be correctly connected and secured.

On completion of all repair work, the component and system must be subjected to a function check. Separate testing of the repaired component without system integration is insufficient.

If wires are installed beside mechanical components and there is a risk of chafing, use cable clamps to properly support the wires.

For this purpose, no cable binders must be used as, during maintenance and / or repair work, the binders can be removed but not installed a second time.

Spare parts shall be properly stored prior to replacement, i.e. particularly protected against moisture. Defective electronic components and assemblies must be suitably packed when dispatched for repair, i.e. particularly protected against moisture and impact and wrapped in antistatic foil if necessary.

Working with laser equipment

When working with laser equipment, always wear special laser-protection goggles.

Laser equipment can generate extremely intensive, concentrated radiation by the effect of stimulated emission in the range of visible light or in the infrared or ultraviolet spectral range. The photochemical, thermal and optomechanical effects of the laser can cause damage. The main danger is irreparable damage to the eyes.

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

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

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

Operation of electrical equipment

When operating electrical equipment, certain components of this equipment are live.

Noncompliance with the warning instructions given for this equipment may result in serious injury or damage to property.

1.5 Auxiliary materials, fire prevention and environmental protection

Fire prevention

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

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

When starting the engine with a foreign 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 foreign power source to the ground lead of the engine or to the ground terminal of the starter.

Always keep suitable fire-fighting equipment (fire extinguishers) at hand and familiarize yourself with their use.

Noise

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

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

Environmental protection

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

Manipulation of the injection control system can influence the engine performance and exhaust emissions. As a result, compliance with environmental regulations may no longer be guaranteed.

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

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

Auxiliary materials

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

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

Lead

- When working with lead or lead-containing pastes, avoid direct contact to the skin and do not inhale lead vapors.
- Adopt suitable measures to avoid the formation of lead dust!
- Switch on fume extraction system.
- After coming into contact with lead or lead-containing materials, wash hands!

Acids and alkaline solutions

- When working with acids and alkalis, wear protective goggles or face mask, gloves and protective clothing.
- Immediately remove clothing wetted by acids and alkalis!
- Rinse injuries with plenty of water!
- Rinse eyes immediately with eyedrops or clean tap water.

Paints

- When painting anywhere other than in spray booths equipped with extractors, ensure good ventilation. Make sure that adjacent work areas are not affected.
- No naked flames!
- No smoking.
- Observe fire prevention regulations!
- Wear masks providing protection against paint and solvent fumes.

Liquid nitrogen

- Store liquid nitrogen only in small quantities and always in regulation containers without fixed covers.
- Do not bring liquid nitrogen in contact with the body (eyes, hands), as this causes frostbite and loss of tissue.
- Wear protective clothing, including gloves, closed shoes and protective goggles!

- Ensure that the room is well ventilated. Nitrogen concentration exceeding 88% of breathing air leads to suffocation.
- Avoid all knocks and jars to the containers, fixtures or workpieces.

Compressed air

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

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

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

- Pay special attention to the pressure level in the compressed air network and pressure vessel!
- Devices and equipment connected must either be designed for this pressure or, if the permitted pressure for the connected elements is lower than the pressure required, a pressure reducing valve and safety valve (set to permitted pressure) must form an intermediate connection. Hose coupling and connections must be securely attached!
- Always wear protective goggles when blowing off tools or chips!
- The snout of the air nozzle should be provided with a protective disc (e.g. rubber disc), which prevents air-borne particles being deflected and thereby prevents injury to eyes.
- First shut off compressed air lines before compressed air equipment is disconnected from the supply line or before equipment or tools are exchanged!
- Unauthorized use of compressed air, e.g. forcing flammable liquids (hazard class AI, AII and B) out of containers, carries the risk of explosion!
- Forcing compressed air into thin-walled containers (e.g. containers made of tin, plastic and glass) for drying purposes or to check for leaks, results in a risk of shattering!
- Do not use compressed air to clean contaminated clothing whilst it is being worn.

Used oil

Used oil may contain health-threatening combustion residues.

Rub barrier cream into hands!

Wash hands after contact with used oil.

1.6 Standards for warning notices in the publication

 **DANGER**	In the event of immediate danger. **Consequences: Death or serious injury.** • Preventive measures
 **WARNING**	In the event of possibly dangerous situations. **Consequences: Death or serious injury.** • Preventive measures
 **CAUTION**	In the event of dangerous situations. **Consequences: Slight injury or material damage.** • Preventive measures

Note: This Publication contains especially emphasized safety instructions in accordance with the American standard ANSI Z535, which begin with one of the above signal words according to the degree of danger:

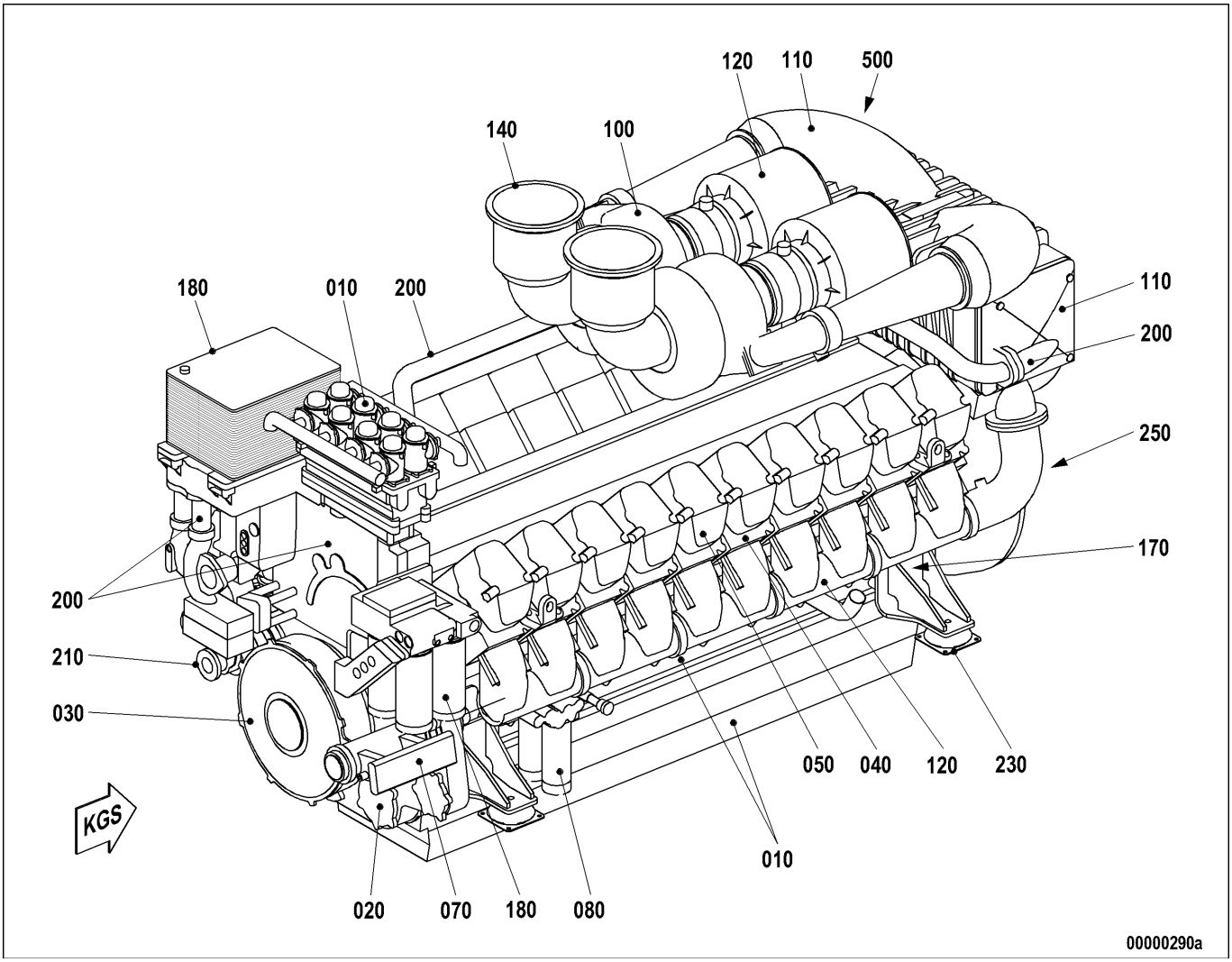
Warning notices

1. Read and become acquainted with all cautions and symbols before operating or repairing this product.
2. Pass on all safety instructions to your operating, maintenance, repair and transport personnel!

2 Product Summary

2.1 Engine Layout

2.1.1 Engine layout



010 Crankcase and attachments
020 Gear train
030 Running gear
040 Cylinder head
050 Valve gear
070 HP fuel system
080 LP fuel system
100 Exhaust turbocharger
110 Intercooler
120 Air intake / air supply
140 Exhaust system
170 Starting equipment
180 Lube oil system
200 Cooling system
210 Electric power supply, engine-related
230 Mounting system
250 Drive systems, drive end and free end (couplings)
500 Monitoring and control system, general electric devices

Engine model designation

Key to the engine model designations 20V 4000 Gxy/Pxy

20	Number of cylinders
V	Cylinder configuration: V-engine
4000	Series
G/P	Application
x	Application segment (2, 4, 6, 8)
y	Design index (2,...)

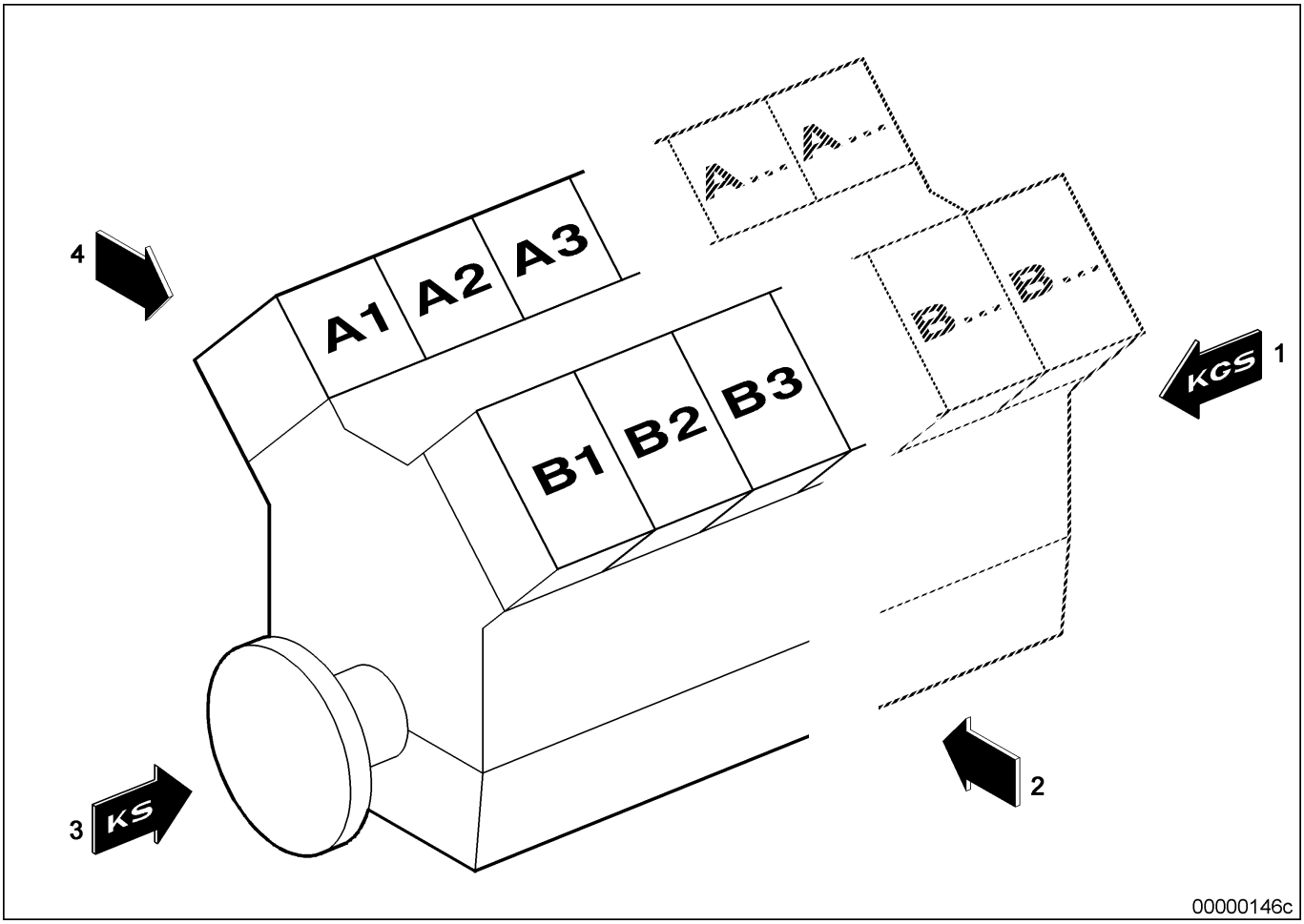
2.2 Engine Side and Cylinder Designations

2.2.1 Engine side and cylinder designations

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

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

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

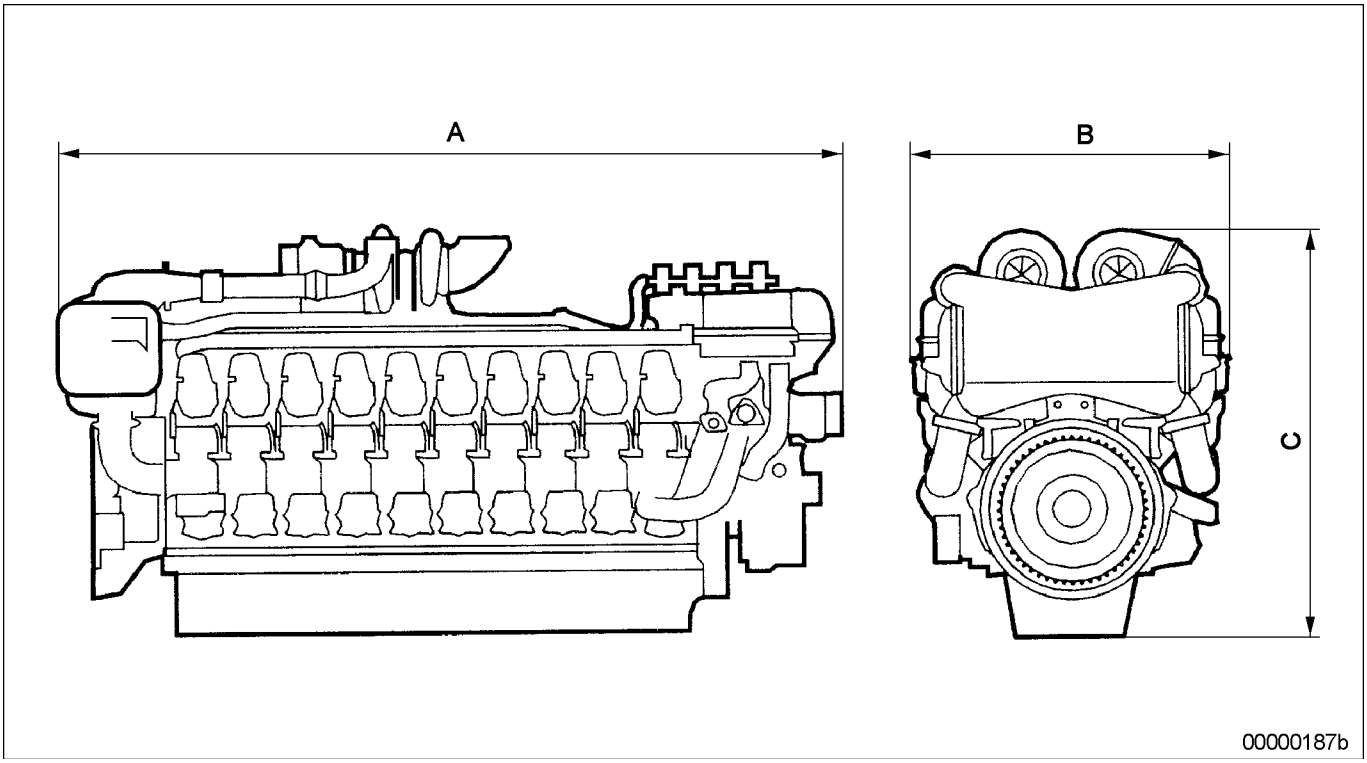


1 KGS = Free end
2 Right side
3 KS = Driving end
4 Left side

2.3 Main Engine Dimensions

2.3.1 Main engine dimensions

Main engine dimensions



Length (A)	approx. 3520 mm
Width (B)	approx. 1460 mm
Height (C)	approx. 2040 mm

2.4 Firing Order

2.4.1 Firing order

Firing order

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

2.5 Final Compression Pressure

2.5.1 Final compression pressure

Final compression pressure

Final compression pressure at 120 rpm	24 bar to 28 bar

2.6 Technical Data

2.6.1 20V 4000 engine data: Continuous operation, unlimited 3A, optimized fuel consumption G62, optimized exhaust emission (EPA) G82

Explanation:
- DL Ref. value: Continuous power (CP)
- BL Ref. value: Fuel stop power (FSP)
- A Design value
- G Guaranteed value
- R Guideline value
- L Limit value, up to which the engine can be operated, without change (e.g. of power setting)
- N Not yet defined value
- - Not applicable
- X Applicable

REFERENCE CONDITIONS

Engine model			**20V 4000G62**	**20V 4000 G82**
Application group			3A	3A
Intake air temperature		°C	25	25
Charge-air coolant temperature		°C	55	55
Raw water inlet temperature		°C	-	-
Barometric pressure		mbar	1000	1000
Site altitude above sea level		m	100	100

POWER-RELATED DATA (power ratings are net brake power to ISO 3046)

Number of cylinders			**20**	**20**
Engine rated speed	A	rpm	1500	1800
Continuous power ISO 3046 (10% overload capability, design power DIN 6280, ISO 8528)	A	kW	2000	2060

GENERAL CONDITIONS (for maximum power)

Number of cylinders			**20**	**20**
Intake air depression (new filter) (design)	A	mbar	25	25
Intake air depression (limit value)	L	mbar	50	50
Exhaust backpressure (design)	A	mbar	30	30
Exhaust backpressure (limit value)	L	mbar	50	50

MODEL-RELATED DATA (basic design)

Number of cylinders			**20**	**20**
Engine with exhaust turbocharging (ETC) and charge air cooling (CAC)			X	X
Exhaust piping, non-cooled			X	X
Working method: four-cycle, diesel, single-acting			X	X
Combustion method: Direct fuel injection			X	X
Cooling system: conditioned water			X	X
Direction of rotation: c.c.w. (facing driving end)			X	X
Number of cylinders			20	20
Cylinder configuration: V angle		degrees	90	90
Bore		mm	165	165
Stroke		mm	210	210
Cylinder displacement		liter	4.49	4.49
Total displacement		liter	89.81	89.81
Compression ratio			15.5	15.5
Cylinder heads: single-cylinder			X	X
Cylinder liners: Wet, replaceable			X	X
Number of inlet valves, per cylinder			2	2
Number of exhaust valves, per cylinder			2	2
Standard flywheel housing flange (engine main PTO)		SAE	00	00
Flywheel interface		DISC	21"	21"

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			**20**	**20**
Charge air pressure before cylinder (abs.), CP	R	bar ABS	2.5	2.5

COOLING SYSTEM (HT circuit)

Number of cylinders			**20**	**20**
Coolant temperature (at engine outlet to cooling equipment)	A	°C	95	95
Coolant temperature after engine, alarm	R	°C	97	97
Coolant temperature after engine, shutdown	L	°C	99	99
Coolant antifreeze content, max. permissible	L	%	50	50
Pressure loss in the external cooling system, max. permissible	L	bar	0.7	0.7

COOLING SYSTEM (LT circuit)

Number of cylinders			**20**	**20**
Coolant temperature before intercooler (at engine inlet from cooling equipment)	A	°C	55	55
Coolant antifreeze content, max. permissible	L	%	50	50
Pressure loss in the external cooling system, max. permissible	L	bar	0.7	0.7

LUBE OIL SYSTEM

Number of cylinders			**20**	**20**
Lube oil operating temperature before engine, from	R	°C	85	86
Lube oil operating temperature before engine, to	R	°C	95	95
Lube oil temperature before engine, alarm	R	°C	95	95
Lube oil temperature before engine, shutdown	L	°C	--	--
Lube oil operating pressure before engine, from	R	bar	4.8	4.8
Lube oil operating pressure before engine, to	R	bar	6.0	6.0
Lube oil pressure before engine, alarm	R	bar	4.5	4.5
Lube oil pressure before engine, shutdown	L	bar	4.0	4.0

FUEL SYSTEM

Number of cylinders			**20**	**20**
Fuel pressure at supply connection to engine (when engine is starting), min. admissible	L	bar	-0.1	-0.1
Fuel pressure at supply connection to engine (when engine is starting), max. admissible	L	bar	1.5	1.5

GENERAL OPERATING DATA

Number of cylinders			**20**	**20**
Cold start capability: air temperature (w/o start aid, w/o preheating) (case A)	R	°C	5	5
Preheating temperature (min.)	R	°C	32	32
Firing speed, from	R	rpm	80	80
Firing speed, to	R	rpm	120	120

CAPACITIES

Number of cylinders			**20**	**20**
Engine coolant capacity (without cooling equipment)	R	liter	205	205
Intercooler coolant capacity	R	liter	55	55
Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	R	liter	390	390
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	liter	340	340
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	245	245
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	340	340

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			**20**	**20**
Engine weight, dry (basic engine configuration acc. to scope of supply specification)	R	kg	9450	9450

ACOUSTICS

Number of cylinders			**20**	**20**
Exhaust noise, unsilenced, CP, (sound power level LW, ISO 6798)	R	db(A)	approx. 127	approx. 127
Engine surface noise with attenuated intake noise filter), CP, (sound power level LW, ISO 6798)	R	db(A)	approx. 125	approx. 125

2.6.2 20V 4000 engine data: Continuous operation, variable 3B, optimized fuel consumption G22/G62, optimized exhaust emission (TA-Luft) G22/G62, optimized exhaust emission (EPA) G42/G82

Explanation:
- DL Ref. value: Continuous power (CP)
- BL Ref. value: Fuel stop power (FSP)
- A Design value
- G Guaranteed value
- R Guideline value
- L Limit value, up to which the engine can be operated, without change (e.g. of power setting)
- N Not yet defined value
- - Not applicable
- X Applicable

REFERENCE CONDITIONS

Engine model			**20V 4000G22**	**20V 4000G62**	**20V 4000G22**	**20V 4000G62**	**20V 4000G42**	**20V 4000 G82**
Application group			3B	3B	3B	3B	3B	3B
Intake air temperature		°C	25	25	25	25	25	25
Charge-air coolant temperature		°C	55	55	55	55	55	55
Raw water inlet temperature		°C	-	-	-	-	-	-
Barometric pressure		mbar	1000	1000	1000	1000	1000	1000
Site altitude above sea level		m	100	100	100	100	100	100

POWER-RELATED DATA (power ratings are net brake power to ISO 3046)

Number of cylinders			**20**	**20**	**20**	**20**	**20**	**20**
Engine rated speed	A	rpm	1500	1500	1500	1500	1800	1800
Continuous power ISO 3046 (10% overload capability, CP, design power DIN 6280, ISO 8528)	A	kW	2200	2420	2200	2420	2490	2740

GENERAL CONDITIONS (for maximum power)

Number of cylinders			**20**	**20**	**20**	**20**	**20**	**20**
Intake air depression (new filter) (design)	A	mbar	25	25	25	25	25	25
Intake air depression (limit value)	L	mbar	50	50	50	50	50	50
Exhaust backpressure (design)	A	mbar	30	30	30	30	30	30
Exhaust backpressure (limit value)	L	mbar	50	50	50	50	50	50

MODEL-RELATED DATA (basic design)

Number of cylinders			**20**	**20**	**20**	**20**	**20**	**20**
Engine with exhaust turbocharging (ETC) and charge air cooling (CAC)			X	X	X	X	X	X
Exhaust piping, non-cooled			X	X	X	X	X	X
Working method: four-cycle, diesel, single-acting			X	X	X	X	X	X
Combustion method: Direct fuel injection			X	X	X	X	X	X
Cooling system: conditioned water			X	X	X	X	X	X
Direction of rotation: c.c.w. (facing driving end)			X	X	X	X	X	X
Number of cylinders			20	20	20	20	20	20
Cylinder configuration: V angle		degrees	90	90	90	90	90	90
Bore		mm	165	165	165	165	165	165
Stroke		mm	210	210	210	210	210	210

Number of cylinders			**20**	**20**	**20**	**20**	**20**	**20**
Cylinder displacement		liter	4.49	4.49	4.49	4.49	4.49	4.49
Total displacement		liter	89.81	89.81	89.81	89.81	89.81	89.81
Compression ratio			15.5	15.5	15.5	15.5	15.5	15.5
Cylinder heads: single-cylinder			X	X	X	X	X	X
Cylinder liners: Wet, replaceable			X	X	X	X	X	X
Number of inlet valves, per cylinder			2	2	2	2	2	2
Number of exhaust valves, per cylinder			2	2	2	2	2	2
Standard flywheel housing flange (engine main PTO)		SAE	00	00	00	00	00	00
Flywheel interface		DISC	21"	21"	21"	21"	21"	21"

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			**20**	**20**	**20**	**20**	**20**	**20**
Charge air pressure before cylinder (abs.), CP	R	bar ABS	2.7	3.0	3.4	3.7	2.9	3.2

COOLING SYSTEM (HT circuit)

Number of cylinders			**20**	**20**	**20**	**20**	**20**	**20**
Coolant temperature (at engine outlet to cooling equipment)	A	°C	95	95	95	95	95	95
Coolant temperature after engine, alarm	R	°C	97	97	97	97	97	97
Coolant temperature after engine, shutdown	L	°C	99	99	99	99	99	99
Coolant antifreeze content, max. permissible	L	%	50	50	50	50	50	50
Pressure loss in the external cooling system, max. permissible	L	bar	0.7	0.7	0.7	0.7	0.7	0.7

COOLING SYSTEM (LT circuit)

Number of cylinders			**20**	**20**	**20**	**20**	**20**	**20**
Coolant temperature before intercooler (at engine inlet from cooling equipment)	A	°C	55	55	55	55	55	55
Coolant antifreeze content, max. permissible	L	%	50	50	50	50	50	50
Pressure loss in the external cooling system, max. permissible	L	bar	0.7	0.7	0.7	0.7	0.7	0.7

LUBE OIL SYSTEM

Number of cylinders			**20**	**20**	**20**	**20**	**20**	**20**
Lube oil operating temperature before engine, from	R	°C	85	85	85	85	86	86
Lube oil operating temperature before engine, to	R	°C	95	95	95	95	95	95
Lube oil temperature before engine, alarm	R	°C	95	95	95	95	95	95
Lube oil temperature before engine, shutdown	L	°C	--	--	--	--	--	--
Lube oil operating pressure before engine, from	R	bar	4.8	4.8	4.8	4.8	4.8	4.8
Lube oil operating pressure before engine, to	R	bar	6.0	6.0	6.0	6.0	6.0	6.0
Lube oil pressure before engine, alarm	R	bar	4.5	4.5	4.5	4.5	4.5	4.5
Lube oil pressure before engine, shutdown	L	bar	4.0	4.0	4.0	4.0	4.0	4.0

FUEL SYSTEM

Number of cylinders			**20**	**20**	**20**	**20**	**20**	**20**
Fuel pressure at supply connection to engine (when engine is starting), min. admissible	L	bar	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Fuel pressure at supply connection to engine (when engine is starting), max. admissible	L	bar	1.5	1.5	1.5	1.5	1.5	1.5

GENERAL OPERATING DATA

Number of cylinders			**20**	**20**	**20**	**20**	**20**	**20**
Cold start capability: air temperature (w/o start aid, w/o preheating) (case A)	R	°C	5	5	5	5	10	5
Coolant preheating, preheating temperature (min.)	R	°C	32	32	32	32	32	32
Firing speed, from	R	rpm	80	80	80	80	80	80
Firing speed, to	R	rpm	120	120	120	120	120	120

CAPACITIES

Number of cylinders			**20**	**20**	**20**	**20**	**20**	**20**
Engine coolant capacity (without cooling equipment)	R	liter	205	205	205	205	205	205
Intercooler coolant capacity	R	liter	55	55	55	55	55	55
Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	R	liter	390	390	390	390	390	390
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	liter	340	340	340	340	340	340
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	245	245	245	245	245	245
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	340	340	340	340	340	340

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			**20**	**20**	**20**	**20**	**20**	**20**
Engine weight, dry (basic engine configuration acc. to scope of supply specification)	R	kg	9450	9450	9450	9450	9450	9450

ACOUSTICS

Number of cylinders			**20**	**20**	**20**	**20**	**20**	**20**
Exhaust noise, unsilenced, CP, (sound power level LW, ISO 6798)	R	db(A)	approx. 127	approx. 128	approx. 128	approx. 129	approx. 129	approx. 131
Engine surface noise with attenuated intake noise (filter), CP, (sound power level LW, ISO 6798)	R	db(A)	approx. 125	approx. 126	approx. 125	approx. 125	approx. 126	approx. 126

2.6.3 20V 4000 engine data: Continuous operation, limited 3C, optimized fuel consumption G22/G62, optimized exhaust emission (TA-Luft) G22/G62

Explanation:
- DL Ref. value: Continuous power (CP)
- BL Ref. value: Fuel stop power (FSP)
- A Design value
- G Guaranteed value
- R Guideline value
- L Limit value, up to which the engine can be operated, without change (e.g. of power setting)
- N Not yet defined value
- \- Not applicable
- X Applicable

REFERENCE CONDITIONS

Engine model			**20V 4000G22**	**20V 4000G62**	**20V 4000G22**	**20V 4000G62**
Application group			3C	3C	3C	3C
Intake air temperature		°C	25	25	25	25
Charge-air coolant temperature		°C	55	55	55	55
Raw water inlet temperature		°C	-	-	-	--
Barometric pressure		mbar	1000	1000	1000	1000
Site altitude above sea level		m	100	100	100	100

POWER-RELATED DATA (power ratings are net brake power to ISO 3046)

Number of cylinders			**20**	**20**	**20**	**20**
Engine rated speed	A	rpm	1500	1500	1500	1500
Fuel stop power ISO 3046	A	kW	2420	2662	2420	2662

GENERAL CONDITIONS (for maximum power)

Number of cylinders			**20**	**20**	**20**	**20**
Intake air depression (new filter) (design)	A	mbar	25	25	25	25
Intake air depression (limit value)	L	mbar	50	50	50	50
Exhaust backpressure (design)	A	mbar	30	30	30	30
Exhaust backpressure (limit value)	L	mbar	50	50	50	50

MODEL-RELATED DATA (basic design)

Number of cylinders			**20**	**20**	**20**	**20**
Engine with exhaust turbocharging (ETC) and charge air cooling (CAC)			X	X	X	X
Exhaust piping, non-cooled			X	X	X	X
Working method: four-cycle, diesel, single-acting			X	X	X	X
Combustion method: Direct fuel injection			X	X	X	X
Cooling system: conditioned water			X	X	X	X
Direction of rotation: c.c.w. (facing driving end)			X	X	X	X
Number of cylinders			20	20	20	20
Cylinder configuration: V angle		degrees	90	90	90	90
Bore		mm	165	165	165	165
Stroke		mm	210	210	210	210
Cylinder displacement		liter	4.49	4.49	4.49	4.49
Total displacement		liter	89.81	89.81	89.81	89.81
Compression ratio			15.5	15.5	15.5	15.5
Cylinder heads: single-cylinder			X	X	X	X
Cylinder liners: Wet, replaceable			X	X	X	X
Number of inlet valves, per cylinder			2	2	2	2
Number of exhaust valves, per cylinder			2	2	2	2
Standard flywheel housing flange (engine main PTO)		SAE	00	00	00	00
Flywheel interface		DISC	21"	21"	21"	21"

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			**20**	**20**	**20**	**20**
Charge air pressure before cylinder, FSP	R	bar ABS	3.0	3.3	3.7	3.8

COOLING SYSTEM (HT circuit)

Number of cylinders			**20**	**20**	**20**	**20**
Coolant temperature (at engine outlet to cooling equipment)	A	°C	95	95	95	95
Coolant temperature after engine, alarm	R	°C	97	97	97	97
Coolant temperature after engine, shutdown	L	°C	99	99	99	99
Coolant antifreeze content, max. permissible	L	%	50	50	50	50
Pressure loss in the external cooling system, max. permissible	L	bar	0.7	0.7	0.7	0.7

COOLING SYSTEM (LT circuit)

Number of cylinders			**20**	**20**	**20**	**20**
Coolant temperature before intercooler (at engine inlet from cooling equipment)	A	°C	55	55	55	55
Coolant antifreeze content, max. permissible	L	%	50	50	50	50
Pressure loss in the external cooling system, max. permissible	L	bar	0.7	0.7	0.7	0.7

LUBE OIL SYSTEM

Number of cylinders			**20**	**20**	**20**	**20**
Lube oil operating temperature before engine, from	R	°C	85	85	85	85
Lube oil operating temperature before engine, to	R	°C	95	95	95	95
Lube oil temperature before engine, alarm	R	°C	95	95	95	95
Lube oil temperature before engine, shutdown	L	°C	--	--	--	--
Lube oil operating pressure before engine, from	R	bar	4.8	4.8	4.8	4.8
Lube oil operating pressure before engine, to	R	bar	6.0	6.0	6.0	6.0
Lube oil pressure before engine, alarm	R	bar	4.5	4.5	4.5	4.5
Lube oil pressure before engine, shutdown	L	bar	4.0	4.0	4.0	4.0

FUEL SYSTEM

Number of cylinders			**20**	**20**	**20**	**20**
Fuel pressure at supply connection to engine (when engine is starting), min. admissible	L	bar	-0.1	-0.1	-0.1	-0.1
Fuel pressure at supply connection to engine (when engine is starting), max. admissible	L	bar	1.5	1.5	1.5	1.5

GENERAL OPERATING DATA

Number of cylinders			**20**	**20**	**20**	**20**
Cold start capability: air temperature (w/o start aid, w/o preheating) (case A)	R	°C	5	5	5	5
Coolant preheating, preheating temperature (min.)	R	°C	32	32	32	32
Firing speed, from	R	rpm	80	80	80	80
Firing speed, to	R	rpm	120	120	120	120

CAPACITIES

Number of cylinders			**20**	**20**	**20**	**20**
Engine coolant capacity (without cooling equipment)	R	liter	205	205	205	205
Intercooler coolant capacity	R	liter	55	55	55	55
Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	R	liter	390	390	390	390
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	liter	340	340	340	340
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	245	245	245	245
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	340	340	340	340

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			**20**	**20**	**20**	**20**
Engine weight, dry (basic engine configuration acc. to scope of supply specification)	R	kg	9450	9450	9450	9450

ACOUSTICS

Number of cylinders			**20**	**20**	**20**	**20**
Exhaust noise, unsilenced, FSP, (sound power level LW, ISO 6798)	R	db(A)	approx. 127	approx. 128	approx. 128	approx. 129
Engine surface noise with attenuated intake noise (filter), FSP, (sound power level LW, ISO 6798)	R	db(A)	approx. 125	approx. 126	approx. 125	approx. 125

2.6.4 20V 4000 engine data: Standby operation 3D, optimized fuel consumption G22/G62, optimized exhaust emission (EPA) G42/G82

Explanation:
CP Ref. value: Continuous power (CP)
FSP Ref. value: Fuel stop power (FSP)
A Design value
G Guaranteed value
R Guideline value
L Limit value, up to which the engine can be operated, without change (e.g. of power setting)
N Not yet defined value
- Not applicable
X Applicable

REFERENCE CONDITIONS

Engine model			**20V 4000 G22**	**20V 4000 G62**	**20V 4000 G42**	**20V 4000 G82**
Application group			3D	3D	3D	3D
Intake air temperature		°C	25	25	25	25
Charge-air coolant temperature		°C	55	55	55	55
Raw water inlet temperature		°C	-	-	-	-
Barometric pressure		mbar	1000	1000	1000	1000
Site altitude above sea level		m	100	100	100	100

POWER-RELATED DATA (power ratings are net brake power to ISO 3046)

Number of cylinders			**20**	**20**	**20**	**20**
Engine rated speed	A	rpm	1500	1500	1800	1800
Fuel stop power ISO 3046	A	kW	2420	2670	2740	3010

GENERAL CONDITIONS (for maximum power)

Number of cylinders			**20**	**20**	**20**	**20**
Intake air depression (new filter) (design)	A	mbar	25	25	25	25
Intake air depression (limit value)	L	mbar	50	50	50	50
Exhaust backpressure (design)	A	mbar	30	30	30	30
Exhaust backpressure (limit value)	L	mbar	50	50	50	50

MODEL-RELATED DATA (basic design)

Number of cylinders			**20**	**20**	**20**	**20**
Engine with exhaust turbocharging (ETC) and charge air cooling (CAC)			X	X	X	X
Exhaust piping, non-cooled			X	X	X	X
Working method: four-cycle, diesel, single-acting			X	X	X	X
Combustion method: Direct fuel injection			X	X	X	X
Cooling system: conditioned water			X	X	X	X
Direction of rotation: c.c.w. (facing driving end)			X	X	X	X
Number of cylinders			20	20	20	20
Cylinder configuration: V angle		degrees	90	90	90	90
Bore		mm	165	165	165	165
Stroke		mm	210	210	210	210
Cylinder displacement		liter	4.49	4.49	4.49	4.49
Total displacement		liter	89.81	89.81	89.81	89.81
Compression ratio			15.5	15.5	15.5	15.5
Cylinder heads: single-cylinder			X	X	X	X
Cylinder liners: Wet, replaceable			X	X	X	X
Number of inlet valves, per cylinder			2	2	2	2
Number of exhaust valves, per cylinder			2	2	2	2
Standard flywheel housing flange (engine main PTO)		SAE	00	00	00	00
Flywheel interface		DISC	21"	21"	21"	21"

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			**20**	**20**	**20**	**20**
Charge air pressure before cylinder, FSP	R	bar ABS	3.0	3.3	3.2	3.3

COOLING SYSTEM (HT circuit)

Number of cylinders			**20**	**20**	**20**	**20**
Coolant temperature (at engine outlet to cooling equipment)	A	°C	95	95	95	95
Coolant temperature after engine, alarm	R	°C	97	97	97	97
Coolant temperature after engine, shutdown	L	°C	99	99	99	99
Coolant antifreeze content, max. permissible	L	%	50	50	50	50
Pressure loss in the external cooling system, max. permissible	L	bar	0.7	0.7	0.7	0.7

COOLING SYSTEM (LT circuit)

Number of cylinders			**20**	**20**	**20**	**20**
Coolant temperature before intercooler (at engine inlet from cooling equipment)	A	°C	55	55	55	55
Coolant antifreeze content, max. permissible	L	%	50	50	50	50
Pressure loss in the external cooling system, max. permissible	L	bar	0.7	0.7	0.7	0.7

LUBE OIL SYSTEM

Number of cylinders			**20**	**20**	**20**	**20**
Lube oil operating temperature before engine, from	R	°C	85	85	86	86
Lube oil operating temperature before engine, to	R	°C	95	95	95	95
Lube oil temperature before engine, alarm	R	°C	95	95	95	95
Lube oil temperature before engine, shutdown	L	°C	--	--	--	--
Lube oil operating pressure before engine, from	R	bar	4.8	4.8	4.8	4.8
Lube oil operating pressure before engine, to	R	bar	6.0	6.0	6.0	6.0
Lube oil pressure before engine, alarm	R	bar	4.5	4.5	4.5	4.5
Lube oil pressure before engine, shutdown	L	bar	4.0	4.0	4.0	4.0

FUEL SYSTEM

Number of cylinders			**20**	**20**	**20**	**20**
Fuel pressure at supply connection to engine (when engine is starting), min. admissible	L	bar	-0.1	-0.1	-0.1	-0.1
Fuel pressure at supply connection to engine (when engine is starting), max. admissible	L	bar	1.5	1.5	1.5	1.5

GENERAL OPERATING DATA

Number of cylinders			**20**	**20**	**20**	**20**
Cold start capability: air temperature (w/o start aid, w/o preheating) (case A)	R	°C	5	5	10	5
Coolant preheating, preheating temperature (min.)	R	°C	32	32	32	32
Firing speed, from	R	rpm	80	80	80	80
Firing speed, to	R	rpm	120	120	120	120

CAPACITIES

Number of cylinders			**20**	**20**	**20**	**20**
Engine coolant capacity, engine side (without cooling equipment)	R	liter	205	205	205	205
Charge-air coolant capacity, engine side	R	liter	55	55	55	55
Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	R	liter	390	390	390	390
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	liter	340	340	340	340
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	245	245	245	245
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	340	340	340	340

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			**20**	**20**	**20**	**20**
Engine weight, dry (basic engine configuration in accordance with scope of delivery specifications)	R	kg	9450	9450	9450	9450

ACOUSTICS

Number of cylinders			**20**	**20**	**20**	**20**
Exhaust noise, unsilenced, FSP, (sound power level LW, ISO 6798)	R	db(A)	approx. 128	approx. 129	approx. 131	approx. 132
Engine surface noise with attenuated intake noise (filter), FSP (sound power level LW, ISO 6798)	R	db(A)	approx. 126	approx. 126	approx. 126	approx. 127

3 Operation

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

Preconditions

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

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

Item	Task
Engine	Depreserve (→ MTU Fluids and Lubricants Specification A001061/..).
Valve Gear	Lubricate valve gear (→ Page 87);
Lube oil system	Check oil level (→ Page 120);
Fuel prefilter	Prime (→ Page 111).
Fuel prefilter, pressure gauge	Align adjustable pointer with position of pressure indicator (→ Page 106).
Fuel system	Vent (→ Page 103).
Cooling system	If engine is out of service for more than one year, change engine coolant (→ Page 124); Change charge-air coolant (→ Page 133).
Cooling system	Check engine coolant level (→ Page 128); Check charge-air coolant level (→ Page 134).
Cooling system	Preheat coolant with preheating unit.
ECU	Check plug-in connections (→ Page 144).
Monitoring equipment	Carry out lamp test (see manufacturer's documentation).
Engine/generator control system	Switch ON; Select operating mode, e.g. MANUAL OPERATION, AUTOMATIC OPERATION.

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

Preconditions

- Engine is stopped and starting disabled.

Putting the engine into operation

Item	Task
Lube oil system	Check oil level (→ Page 120);
Cooling system	Check engine coolant level (→ Page 128); Check charge-air coolant level (→ Page 134).
Cooling system	Preheat coolant with preheating unit.
Fuel prefilter	Drain (→ Page 107).
Monitoring equipment	Carry out lamp test (see manufacturer's documentation).
Engine/generator control system	Switch ON; Select operating mode, e.g. MANUAL OPERATION, AUTOMATIC OPERATION.

3.3 Starting the engine in manual mode

Preconditions

- Generator is not connected to network.
- External start interlock is not activated.

DANGER	Unguarded rotating and moving engine components. **Risk of serious injury — danger to life!** • Before barring or starting the engine, ensure that nobody is in the danger zone.

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

Preparation

Item	Task
Operating mode selector switch (if provided)	Change to manual mode.
Preheating pump (if provided)	Switch ON.

Starting the engine

Item	Task
Switching cabinet, control panel etc. (depending on manufacturer)	If coolant temperature is • > 40 °C (with preheating pump), or • > 10 °C (60 Hz generator, without preheating pump), or • > 5 °C (50 Hz generator, without preheating pump): Press start button. • Automatic starting procedure is performed; • Tachometer indicates increasing crankshaft speed; • After the starting procedure is completed, engine is running at rated speed.

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

Item	Task
Switching cabinet, control panel etc. (depending on manufacturer)	Close the generator circuit breaker.
Engine	Run engine at 10 to 15 % of rated power to reach operating temperature. Apply full load only after engine has reached operating temperature (coolant temperature approx. 75 °C).

3.4 Emergency start (override mode)

CAUTION	Safety functions and engine shutdown alarms will be disregarded. **Serious damage to plant!** • Initiate emergency start only in emergency situations.

Preparation

Item	Task
Operating mode selector switch (if provided)	Change to manual mode.

Emergency start

Item	Task
Switching cabinet, control panel etc. (depending on manufacturer)	Actuate switch/button for override input of ECU.
Switching cabinet, control panel etc. (depending on manufacturer)	Press start button. • Automatic starting procedure is performed; All safety functions are deactivated and engine shutdown alarms disregarded; • Tachometer indicates increasing crankshaft speed; • After the starting procedure is completed, engine is running at rated speed.

Connecting the generator to network

Item	Task
Switching cabinet, control panel etc. (depending on manufacturer)	If generator is not connected to network: Close the generator circuit breaker.
Engine	Run at rated power.

3.5 Operational checks

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

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

Operational checks

Item	Task
Control and display panels	Check indicated operating parameters (speed, temperatures, pressures).
Engine under load Engine at nominal speed	Check engine/system and lines for leak-tightness, perform maintenance work on lines showing leakage while motor is turned off (exhaust manifolds and turbocharger turbine housing may be glowing with heat. If maximum exhaust temperatures are within the limit, restricted engine operation is not required); Check for abnormal running noises and vibrations.
HP pump	Check relief bore (→ Page 95).
Fuel prefilter	Check if suction-side pressure indicated at the fuel prefilter pressure gauge is within the limit (→ Page 106).
Exhaust system	Check exhaust color (→ Page 63).
Intercooler	Check condensate drain(s) for water discharge and obstruction (→ Page 113).
Air filter	Check signal ring position of service indicator (→ Page 116); Replace air filter (→ Page 114), if the signal ring is completely visible in the service indicator control window.
Engine coolant pump	Check relief bore (→ Page 129).
Charge-air coolant pump	Check relief bore (→ Page 135).
Compressed-air system (if installed)	Check operating pressure at pressure gauge. Fill compressed-air tank to maximum pressure. Drain condensate from compressed-air tank, pressure drop must not exceed 1 bar.

3.6 Stopping the engine in manual mode

Preconditions

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

CAUTION	Stopping the engine when it is running at full load causes extreme stress to the engine. **Risk of overheating, damage to components!** • Before stopping the engine, operate it at idle speed until operating temperatures decrease and stable values are indicated.

Preparation

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

Stopping the engine

Item	Task
Switching cabinet, control panel etc. (depending on manufacturer)	Press stop button. • Automatic stopping procedure is performed; • Engine is stopped.

After stopping the engine

Item	Task
Cooling pump	Operate for approx. 5 minutes after engine stop.

3.7 Emergency stop

CAUTION

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

Emergency stop from LOP

Item	Task
EMERGENCY STOP button	Press. • Engine is stopped by switching off power supply to ECU; • Signalization (e.g. by horn, flashing lamp) is released.

After emergency stop from LOP

Item	Task
Switching cabinet, control panel etc. (depending on manufacturer)	Press button for alarm acknowledgement. • Audible and visual signalization stops.

3.8 After stopping the engine – engine remains ready for operation

After stopping the engine

Item	Task
Engine/generator control system	Select operating mode, e.g. MANUAL OPERATION, AUTOMATIC OPERATION.

3.9 After stopping the engine – putting the engine out of service

Preconditions

- MTU Fluids and Lubricants Specification (A001061/..) is available.

After stopping the engine

Item	Task
Cooling system	Drain engine coolant (→ Page 127); Drain charge-air coolant (→ Page 132) if: • freezing temperatures are expected and the engine is to remain out of service for an extended period and coolant has no antifreeze additive; • the engine room is not heated; • the coolant is not maintained at a suitable temperature; • the antifreeze concentration is insufficient for the engine-room temperature; • antifreeze concentration is 50% and engine-room temperature is below -40°C.
Engine/generator control system	Switch OFF.
Air intake and exhaust system	If the engine is to remain out of service for more than 1 week, seal the engine's air and exhaust sides. If the engine is to remain out of service for more than 1 month, carry out preservation (→ MTU Fluids and Lubricants Specification A001061/..).

4 Maintenance

4.1 Preface

MTU maintenance concept

The MTU maintenance system is based on a preventive maintenance concept. Preventive maintenance permits advance operational planning and increases availability.

The maintenance schedule refers to the load profile/load factor specified below. The time intervals at which the maintenance work is to be carried out, and the relevant checks and tasks involved, are average results based on operational experience and therefore represent guidelines only. Special operating conditions and technical requirements may require additional maintenance work and/or modification of the maintenance intervals. In order to be authorized to carry out the individual maintenance jobs, maintenance personnel must have achieved a level of training and qualification appropriate to the complexity of the task in hand. The various Qualification Levels QL1 to QL4 reflect the levels of training offered in MTU courses and the contents of the tool kits required.

QL1: Operational monitoring and maintenance which can be carried out during a break in operation without disassembling the engine.
QL3: Maintenance work which requires partial disassembly of the engine.
QL4: Maintenance work which requires complete disassembly of the engine.

The maintenance schedule matrix normally finishes with extended component maintenance. After a major overhaul, the maintenance tasks must continue to be performed in accordance with the specified schedule.

The "Task" numbers stated in the list of jobs to be done/action to be taken indicate the relevant maintenance item. They provide a reference to the scope of parts required and appear on the labels of the appropriate replacement parts.

Preventive maintenance instructions

Specifications for fluids and lubricants, guideline values for their maintenance and change intervals and lists of recommended fluids and lubricants are contained in the MTU Fluids and Lubricants Specifications A001061 and in the fluids and lubricants specifications produced by the component manufacturers. They are therefore not included in the maintenance schedule (exception: deviations from the Fluids and Lubricants Specifications). Use only fluids and lubricants which comply with the MTU Fluids and Lubricants Specification / are approved by the relevant component manufacturer.

The user/customer must perform the following additional maintenance tasks:

- Protect components made of rubber or synthetic material from oil. Never treat them with organic detergents. Wipe with a dry cloth only.
- Fuel prefilter:

  Maintenance depends on fuel quality (purity). The paper inserts in fuel prefilters must be changed every two years at the latest (Task 9998).
- Battery:

  Maintenance depends on load and ambient conditions of the batteries. The specifications of the battery manufacturer are binding.

The appropriate manufacturer’s instructions apply with regard to the servicing and maintenance of any components not covered in this maintenance schedule.

Out-of-service periods

If the engine is to remain out of service for more than 1 month, carry out engine preservation procedures according to the Fluids and Lubricants Specifications, MTU Publication No. A001061.

Application group

Application group

3A	Continuous operation, unlimited, load factor: 100%
3B	Continuous operation, variable, load factor: < 75%
3C	Continuous operation, limited in time
3D	Standby operation, load factor: < 85%

Load profile

Load profile table, application group 3A

Load factor	110%	100%	80%
Corresponding operating time	5%	90%	5%

Load profile table, application group 3B

Load factor	110%	100%	75%	20%
Corresponding operating time	1%	5%	90%	4%

Load profile table, application group 3C

Load factor	110%	100%	75%	15%
Corresponding operating time	1%	20%	70%	9%

Load profile table, application group 3D

Load factor	100%	85%	65%
Corresponding operating time	5%	90%	5%

4.2 Maintenance schedule matrix

Maintenance schedule matrix for application group 3A, 0 to 10,500 operating hours

Item	Limit years	Operating hours [h]																					
		Daily	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	5,500	6,000	6,500	7,000	7,500	8,000	8,500	9,000	9,500	10,000	10,500
Engine oil filter	2																						
Engine operation	-	X																					
Centrifugal oil filter	2		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fuel filter	2			X		X		X		X		X		X		X		X		X		X	
Valve gear	-				X			X			X			X			X			X			X
Belt drive	2				X			X			X			X			X			X			X
Air filter	3							X						X						X			
Fuel injector	-																X						
Combustion chambers	4																X						
Exhaust turbocharger	18																					X	
Component maintenance	18																					X	
Fuel delivery pump	18																					X	
Crankcase breather	18																					X	
Cylinder head	18																						
Extended component maintenance	-																						

11,000 to 21,500 operating hours

Item	Limit years	Operating hours [h]																					
		11,000	11,500	12,000	12,500	13,000	13,500	14,000	14,500	15,000	15,500	16,000	16,500	17,000	17,500	18,000	18,500	19,000	19,500	20,000	20,500	21,000	21,500
Engine oil filter	2																						
Engine operation	-																						
Centrifugal oil filter	2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fuel filter	2	X		X		X		X		X		X		X		X		X		X		X	
Valve gear	-			X			X			X			X			X			X			X	
Belt drive	2			X			X			X			X			X			X			X	
Air filter	3			X						X						X						X	
Fuel injector	-									X													
Combustion chambers	4									X													
Exhaust turbocharger	18																			X			
Component maintenance	18																			X			
Fuel delivery pump	18																			X			
Crankcase breather	18																			X			
Cylinder head	18									X													
Extended component maintenance	-																						

22,000 to 30,000 operating hours

Item	Limit years	Operating hours [h]																					
		22,000	22,500	23,000	23,500	24,000	24,500	25,000	25,500	26,000	26,500	27,000	27,500	28,000	28,500	29,000	29,500	30,000					
Engine oil filter	2																						
Engine operation	-																						
Centrifugal oil filter	2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					
Fuel filter	2	X		X		X		X		X		X		X		X		X					
Valve gear	-		X			X			X			X			X			X					
Belt drive	2		X			X			X			X			X			X					
Air filter	3					X						X						X					
Fuel injector	-		X															X					
Combustion chambers	4		X															X					
Exhaust turbocharger	18																	X					
Component maintenance	18																	X					
Fuel delivery pump	18																	X					
Crankcase breather	18																	X					
Cylinder head	18																	X					
Extended component maintenance	-																	X					

Maintenance schedule matrix for application group 3B, 0 to 10,500 operating hours

Item	Limit years	Operating hours [h]																					
		Daily	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	5,500	6,000	6,500	7,000	7,500	8,000	8,500	9,000	9,500	10,000	10,500
Engine oil filter	2																						
Engine operation	-	X																					
Centrifugal oil filter	2		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Valve gear	-			X		X		X		X		X		X		X		X		X		X	
Fuel filter	2			X		X		X		X		X		X		X		X		X		X	
Belt drive	2				X			X			X			X			X			X			X
Air filter	3							X						X						X			
Fuel injector	-													X									
Combustion chambers	4													X									
Exhaust turbocharger	18																			X			
Component maintenance	18																			X			
Fuel delivery pump	18																			X			
Cylinder head	18																			X			
Crankcase breather	18																					X	
Extended component maintenance	18																						

11,000 to 18,000 operating hours

Item	Limit years	Operating hours [h]																						
		11,000	11,500	12,000	12,500	13,000	13,500	14,000	14,500	15,000	15,500	16,000	16,500	17,000	17,500	18,000								
Engine oil filter	2																							
Engine operation	-																							
Centrifugal oil filter	2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X								
Valve gear	-	X		X		X		X		X		X		X		X								
Fuel filter	2	X		X		X		X		X		X		X		X								
Belt drive	2			X			X			X			X			X								
Air filter	3			X						X						X								
Fuel injector	-			X												X								
Combustion chambers	4			X												X								
Exhaust turbocharger	18															X								
Component maintenance	18															X								
Fuel delivery pump	18															X								
Cylinder head	18															X								
Crankcase breather	18																							
Extended component maintenance	18															X								

Maintenance schedule matrix for application group 3C, 0 to 9,000 operating hours

Item	Limit years	Operating hours [h]																					
		Daily	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	5,500	6,000	6,500	7,000	7,500	8,000	8,500	9,000			
Engine oil filter	2																						
Engine operation	-	X																					
Centrifugal oil filter	2		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Valve gear	-			X		X		X		X		X		X		X		X		X			
Fuel filter	2			X		X		X		X		X		X		X		X		X			
Belt drive	2			X		X		X		X		X		X		X		X		X			
Air filter	3							X						X						X			
Fuel injector	-													X									
Combustion chambers	4													X									
Exhaust turbocharger	18																			X			
Component maintenance	18																			X			
Fuel delivery pump	18																			X			
Crankcase breather	18																			X			
Cylinder head	18																			X			
Extended component maintenance	18																			X			

Maintenance schedule matrix for application group 3D, 0 to 6,000 operating hours

Item	Limit years	Operating hours [h]																					
		Daily	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	5,500	6,000									
Engine oil filter	2																						
Engine operation	-	X																					
Centrifugal oil filter	2		X	X	X	X	X	X	X	X	X	X	X	X									
Valve gear	-			X		X		X		X		X		X									
Fuel filter	2			X		X		X		X		X		X									
Belt drive	2			X		X		X		X		X		X									
Air filter	3							X						X									
Fuel injector	-													X									
Exhaust turbocharger	18													X									
Component maintenance	18													X									
Fuel delivery pump	18													X									
Crankcase breather	18													X									
Cylinder head	18													X									
Extended component maintenance	18													X									
Combustion chambers	4													X									

4.3 Maintenance tasks

Table of maintenance tasks for the 3A, 3B, 3C, 3D application groups measures

Qual-ifica-tion	Interval		Item	Maintenance tasks	TASK
	[hours]	[years]			
QL1			Engine oil filter	Replace engine oil filter when changing engine oil or when the time limit (years) has been reached, at the latest (→ Page 121) .	W1008
QL1			Engine operation	Check engine oil level (→ Page 45).	W0500
				Visually check engine for leaks and general condition.	W0501
				Check intercooler drain line (if fitted) (→ Page 45).	W0502
				Check service indicator of the air filter (→ Page 45).	W0503
				Check telltale bore of the HP fuel pump (→ Page 45).	W0504
				Check relief bores of the water pump(s) (→ Page 45).	W0505
				Check for abnormal running noise, exhaust gas color (→ Page 45) and vibrations.	W0506
				Drain water and contaminants at the drain cock of the fuel prefilter (if fitted) (→ Page 45).	W0507
				Check reading on differential pressure gauge of fuel prefilter (if fitted) (→ Page 45).	W0508
QL1			Centrifugal oil filter	Centrifugal oil filter (if fitted): Check layer thickness of the oil residue, clean out and replace filter sleeve (→ Page 122).	W1009
QL1			Fuel filter	Replace fuel filter or fuel filter element (→ Page 104).	W1001
QL1			Valve gear	Check valve clearance (→ Page 88).	W1002
QL1			Belt drive	Check drive belt condition (→ Page 136) and tension, replace if necessary (→ Page 138).	W1003
QL1			Air filter	Replace air filter (→ Page 114).	W1005
QL1			Fuel injectors	Replace fuel injectors (→ Page 96).	W1006
QL1			Combustion chambers	Perform endoscopic examination (→ Page 82).	W1011
QL3			Exhaust turbocharger	Overhaul exhaust turbocharger (→ Workshop Manual).	W1038
QL3			Component maintenance	Before starting maintenance work, drain coolant and flush coolant circuits (→ Workshop Manual).	W2000
				Check rocker arms, valve bridge, swing follower and swing follower bearing for wear (→ Workshop Manual). Check swing follower and camshaft running surfaces visually through pushrod bore using an endoscope (→ Workshop Manual).	W2001
				Clean air ducting (→ Workshop Manual).	W2002
				Clean intercooler and check for leaks (→ Workshop Manual).	W2003
				Replace fuel HP sensor (→ Workshop Manual).	W2004
				Overhaul engine coolant pump (→ Workshop Manual) and overhaul charge-air coolant pump (→ Workshop Manual).	W2005
				Check engine coolant thermostat and replace thermal actuator (→ Workshop Manual).	W2006

Qual-ifica-tion	Interval		Item	Maintenance tasks	TASK
	[hours]	[years]			
				Check charge air coolant thermostat and replace thermal actuator (→ Workshop Manual).	W2007
				Check centrifugal oil filter for wear (if fitted) (→ Workshop Manual).	W2009
				Overhaul starter (→ Workshop Manual) and (→ Workshop Manual).	W2010
				Replace sealing material of all disassembled components.	W2062
QL3			Crankcase breather	Crankcase breather: Replace oil separator (→ Workshop Manual).	W1055
QL3			Cylinder head	Overhaul cylinder heads, visually inspect piston crowns and running pattern of cylinder liners (→ Workshop Manual).	W1063
QL3			Fuel delivery pump	Replace fuel delivery pump (→ Workshop Manual).	W1051
QL4			Extended component maintenance	Perform complete engine disassembly. Inspect engine components acc. to assembly instructions; repair or replace as necessary (→ Workshop Manual).	W3000
				Replace all elastomeric parts and seals.	W3001
				Replace piston rings (→ Workshop Manual).	W3002
				Replace conrod bearings (→ Workshop Manual).	W3003
				Replace crankshaft bearings (→ Workshop Manual).	W3004
				Replace cylinder liners (→ Workshop Manual).	W3005
				Replace auxiliary PTO antifriction bearing (→ Workshop Manual).	W3006
				Replace HP fuel pump (→ Workshop Manual).	W3007
				Overhaul battery-charging generator (→ Workshop Manual).	W3042

5 Troubleshooting

5.1 Troubleshooting

Engine does not turn when starter is actuated

Component	Probable Cause	Task
Battery	Low or defective	Charge or replace (see manufacturer's documentation).
	Cable connections defective	Check if cable connections are properly secured (see manufacturer's documentation).
Starter	Engine wiring or starter defective	Check if cable connections are properly secured, contact Service.
Engine wiring	Defective	Check (→ Page 141).
Engine/generator control system	Secure seating of assemblies or connectors not provided	Perform visual inspection (see manufacturer's documentation).
ECU	Plug-in connections are loose	Check plug-in connections (→ Page 144).
Engine	Running gear blocked (engine cannot be barred manually)	Contact Service.

Engine turns but does not fire

Component	Probable Cause	Task
Starter	Poor rotation by starter: Battery low or defective	Charge or replace battery (see manufacturer's documentation).
Engine wiring	Defective	Check (→ Page 141).
Fuel system	Not vented	Vent fuel system (→ Page 103).
ECU	Defective	Contact Service.

Engine fires unevenly

Component	Probable Cause	Task
Fuel injection equipment	Injector defective	Replace (→ Page 96).
Engine wiring	Defective	Check (→ Page 141).
Fuel system	Not vented	Vent fuel system (→ Page 103).
ECU	Defective	Contact Service.

Engine does not reach nominal speed

Component	Probable Cause	Task
Fuel supply	Fuel prefilter clogged	Replace (→ Page 111).
	Fuel filter clogged	Replace (→ Page 104).
Air supply	Air filter clogged	Check signal ring position of service indicator (→ Page 116).
Fuel injection equipment	Injector defective	Replace (→ Page 96).
Engine wiring	Defective	Check (→ Page 141).
Engine	Overloaded	Contact Service.

Engine speed not steady

Component	Probable Cause	Task
Fuel injection equipment	Injector defective	Replace (→ Page 96).
Speed sensor	Defective	Contact Service.
Fuel system	Not vented	Vent fuel system (→ Page 103).
ECU	Defective	Contact Service.

Charge-air temperature too high

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

Charge air pressure too low

Component	Probable Cause	Task
Air supply	Air filter clogged	Check signal ring position of service indicator (→ Page 116).
Intercooler	Contaminated	Contact Service.
Exhaust turbocharger	Defective	Contact Service.

Coolant leaks on intercooler

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

Exhaust gas black

Component	Probable Cause	Task
Air supply	Air filter clogged	Check signal ring position of service indicator (→ Page 116).
Fuel injection equipment	Injector defective	Replace (→ Page 96).
Engine	Overloaded	Contact Service.

Exhaust gas blue

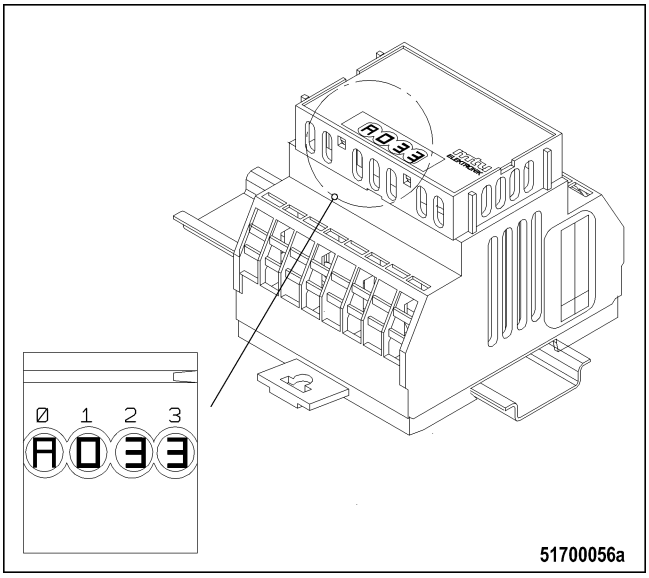
Component	Probable Cause	Task
Engine oil	Too much oil in engine	Drain engine oil (→ Page 118).
	Oil separator of crankcase breather contaminated	Replace (→ Page 85).
Exhaust turbocharger, cylinder head, piston rings, cylinder liner	Defective	Contact Service.

Exhaust gas white

Component	Probable Cause	Task
Engine	Not at operating temperature	Run engine to reach operating temperature.
Fuel system	Water in fuel	Check fuel system on fuel prefilter. Drain fuel prefilter (→ Page 107).
Intercooler	Leaking	Contact Service.

5.2 ECU alarms

The ECU generates alarms which are indicated in different ways depending on the equipment configuration:
- as four-digit code on a PIM
- as alarm text on a display
- as four-digit code on a dialog PC



The four-digit code consists of one letter and three figures:
- The letter encodes when the fault occurred the last time:
  A = currently present
  B = within the last operating hour
  C = one to four operating hours ago
  D = four to twelve operating hours ago
  Alarms that occurred more than twelve hours ago are deleted automatically.
- The three figures encode the fault itself as listed in the table below.

Alarms can also be caused by defective sensors / actuators. If troubleshooting in accordance with the following table is not successful, contact Service to have the sensors / actuators checked and, if required, replaced.

Fault code	Alarm text	Meaning	Task
005	L1 T-CHARGE AIR	Charge-air temperature too high (1st limit)	Reduce power.
006	L2 T-CHARGE AIR	Charge-air temperature too high (2nd limit)	Reduce power.
009	L1 T-INTER-COOLER	Charge-air coolant temperature too high (1st limit)	Reduce power.
015	L1 P-LUBE OIL	Lube-oil pressure too low (1st limit)	Check engine-oil level and top up, if required; (→ Page 120);
016	L2 P-LUBE OIL	Lube-oil pressure too low (2nd limit) automatic engine shutdown	1 Check engine-oil level and top up, if required; (→ Page 120); 2 Try to re-start the engine (→ Page 43). 3 Contact Service.
023	L1 COOLANT LEVEL	Engine coolant level too low	Check coolant level and top up, if required (→ Page 128) .

Fault code	Alarm text	Meaning	Task
024	L2 COOLANT LEVEL	Engine coolant level too low	Check coolant level and top up, if required (→ Page 128) .
030	ENGINE OVERSPEED	Engine overspeed; automatic engine shutdown	1 Acknowledge alarm. 2 Try to re-start the engine (→ Page 43). 3 Contact Service.
044	L1 LEVEL INTERCOOLER	Charge-air coolant level too low (1st limit)	Check coolant level and top up, if required (→ Page 134) .
045	L2 LEVEL INTERCOOLER	Charge-air coolant level too low (2nd limit)	1 Check coolant level and top up, if required (→ Page 134) . 2 If fault occurs repeatedly: Contact Service.
051	L1 T-LUBE OIL	Lube-oil temperature too high (1st limit)	Reduce power.
052	L2 T-LUBE OIL	Lube-oil temperature too high (2nd limit)	1 Reduce power. 2 If fault occurs repeatedly: Contact Service.
065	L1 P-FUEL	Fuel supply pressure too low (1st limit)	1 Check fuel lines for leaks; repair defective lines. 2 Clean fuel prefilter (→ Page 105). 3 Flush fuel prefilter (→ Page 109). 4 Replace filter element of fuel prefilter (→ Page 111). 5 Replace filter element of fuel prefilter (→ Page 104). 6 If fault is not rectified: Contact Service.
066	L2 P-FUEL	Fuel supply pressure too low (2nd limit)	1 Check fuel lines for leaks; repair defective lines. 2 Clean fuel prefilter (→ Page 105). 3 Flush fuel prefilter (→ Page 109). 4 Replace filter element of fuel prefilter (→ Page 111). 5 Replace filter element of fuel prefilter (→ Page 104). 6 If fault is not rectified: Contact Service.
067	L1 T-COOLANT	Coolant temperature too high (1st limit); warning	Reduce power.
068	L2 T-COOLANT	Coolant temperature too high (2nd limit); automatic engine shutdown	1 Allow the engine to cool down. 2 Check coolant cooler (elements etc.) and clean contaminated parts (see manufacturer's documentation). 3 Re-start the engine (→ Page 43). 4 If fault occurs repeatedly: Contact Service.
069	L1 T-EXTERN 1	Violation of first limit for external temperature channel 1	(Depending on the corresponding measuring point, which is read via CAN bus)

Fault code	Alarm text	Meaning	Task
070	L2 T-EXTERN 1	Violation of second limit for external temperature channel 1	(Depending on the corresponding measuring point, which is read via CAN bus)
071	L1 T-EXTERN 2	Violation of first limit for external temperature channel 2	(Depending on the corresponding measuring point, which is read via CAN bus)
072	L2 T-EXTERN 2	Violation of second limit for external temperature channel 2	(Depending on the corresponding measuring point, which is read via CAN bus)
073	L1 P-EXTERN 1	Violation of first limit for external pressure channel 1	(Depending on the corresponding measuring point, which is read via CAN bus)
074	L2 P-EXTERN 1	Violation of second limit for external pressure channel 1	(Depending on the corresponding measuring point, which is read via CAN bus)
075	L1 P-EXTERN 2	Violation of first limit for external pressure channel 2	(Depending on the corresponding measuring point, which is read via CAN bus)
076	L2 P-EXTERN 2	Violation of second limit for external pressure channel 2	(Depending on the corresponding measuring point, which is read via CAN bus)
077	LIM EXT.COOLANT LEV.	Alarm from external coolant level monitoring	(Depending on the corresponding measuring point, which is read via CAN bus)
078	LIM INTERCOOLER LEV.	Alarm from external charge-air coolant level monitoring	(Depending on the corresponding measuring point, which is read via CAN bus)
079	L Bin-EXTERN 3	Alarm from external binary channel 3	(Depending on the corresponding measuring point, which is read via CAN bus)
080	L Bin-EXTERN 4	Alarm from external binary channel 4	(Depending on the corresponding measuring point, which is read via CAN bus)
081	RAIL LEAKAGE	HP fuel system leaking, system contains air	Contact Service.
082	RAIL PRESSURE HIGH	Pressure in HP fuel system exceeds specified value; Solenoid valve of HP fuel control block jamming or wiring to solenoid valve defective	Contact Service.

Fault code	Alarm text	Meaning	Task
083	RAIL PRESSURE LOW	Pressure in HP fuel system lower than the specified value; HP fuel control block defective or system leaking NOTE: With very large generators having a run-out time of more than > 20 sec this alarm is not a relevant fault.	Contact Service.
089	ENGINE SPEED LOW	Engine speed lower than 200 rpm; automatic engine shutdown	Re-start the engine (→ Page 43).
090	IDLE SPEED LOW	Idle speed not reached within a specified period; Termination of starting procedure.	Note further alarms.
091	RUN UP SPEED LOW	Run-up speed not reached within a specified period; Termination of starting procedure.	Note further alarms.
092	START SPEED LOW	Starter speed not reached within a specified period; Termination of starting procedure.	Note further alarms.
093	PREHEAT TEMP. LIMIT2	Coolant preheating temperature too low during starting (2nd limit) Termination of starting procedure (depending on project design)	Check preheating pump / preheating system (see manufacturer's documentation).
094	PREHEAT TEMP. LIMIT1	Coolant preheating temperature too low during starting (1st limit)	Check preheating pump / preheating system (see manufacturer's documentation).
100	EDM NOT VALID	Check sum error of measuring-point data in EDM	If fault occurs repeatedly: Contact Service.
101	IDM NOT VALID	Check sum error of measuring-point data in IDM	If fault occurs repeatedly: Contact Service.
102	INVALID FUEL CONS. 1	Check sum error of accumulated fuel consumption data in EDM (redundant data record 1)	If fault occurs repeatedly: Contact Service.
103	INVALID FUEL CONS. 2	Check sum error of accumulated fuel consumption data in EDM (redundant data record 2)	If fault occurs repeatedly: Contact Service.

Fault code	Alarm text	Meaning	Task
104	OP HOURS1 NOT VALID	Check sum error of hour meter data in EDM	If fault occurs repeatedly: Contact Service.
105	OP HOURS2 NOT VALID	Check sum error of hour meter data in IDM	If fault occurs repeatedly: Contact Service.
106	ERR REC1 NOT VALID	Check sum error of fault memory in EDM (redundant data record 1)	If fault occurs repeatedly: Contact Service.
107	ERR REC2 NOT VALID	Check sum error of fault memory in EDM (redundant data record 2)	If fault occurs repeatedly: Contact Service.
118	L1 SUPPLY VOLT. LOW	Supply voltage too low (1st limit)	Check ECU supply voltage.
119	L2 SUPPLY VOLT. LOW	Supply voltage too low (2nd limit)	Check ECU supply voltage.
120	L1 SUPPLY VOLT. HIGH	Supply voltage too high(1st limit)	Check ECU supply voltage.
121	L2 SUPPLY VOLT. HIGH	Supply voltage too high (2nd limit); automatic engine shutdown (depending on project design)	Check ECU supply voltage. If engine was stopped: Start engine (→ Page 43).
122	L1 T-ELECTRONIC	Temperature in ECU housing too high (1st limit)	1 Improve engine room ventilation. 2 Reduce engine power.
134	15V POS ECU DEFECT	Electronic equipment defective; automatic engine shutdown	Contact Service.
136	15V NEG ECU DEFECT	Electronic equipment defective; automatic engine shutdown	Contact Service.
137	L1 5V BUFFER TEST	Power supply for pressure sensors defective.	1 Disconnect connectors X2 and X3 from ECU. If alarm does not disappear: Contact Service. 2 Check wiring (pressure sensors). 3 Contact Service.
138	SENSORPOW-ERDEFECT	Power supply for pressure sensors defective.	1 Disconnect connectors X2 and X3 from ECU. If alarm does not disappear: Contact Service. 2 Check wiring (pressure sensors). 3 Contact Service.
139	L1 TE BUFFER TEST	Internal electronic fault (temperature sensors)	Contact Service.
140	TE BUF. ECU DEFECT	Internal electronic fault (temperature sensors)	Contact Service.
142	BANK1 ECU DEFECT	Internal electronic fault; Engine does not start	Contact Service.

Fault code	Alarm text	Meaning	Task
144	BANK2 ECU DEFECT	Internal electronic fault; Engine does not start	Contact Service.
145	15V_GOOD ECU DEFECT	Electronic equipment defective; automatic engine shutdown	Contact Service.
146	L1 AD-TEST1 SUPPLY	A/D-converter supply voltage too low	Contact Service.
147	AD-TEST1 ECU DEFECT	Electronic equipment defective; automatic engine shutdown	Contact Service.
148	L1 AD-TEST2 SUPPLY	A/D-converter supply voltage too low	Contact Service.
149	AD-TEST2 ECU DEFECT	Electronic equipment defective; automatic engine shutdown	Contact Service.
150	L1 AD-TEST3 SUPPLY	A/D-converter supply voltage too low	Contact Service.
151	AD-TEST3 ECU DEFECT	Electronic equipment defective; automatic engine shutdown	Contact Service.
170	MI MODULE FAIL	Module in maintenance predictor either defective or missing	Contact Service.
171	MI NOT ACTIVE	Maintenance predictor no more activated	Contact Service.
173	MODULE WRITE LIMIT	EEPROM write limit reached	Contact Service.
180	CAN1 NODE LOST	At least one device not detected on Default CAN bus	1Check wiring (CAN bus). 2Contact Service.
181	CAN2 NODE LOST	At least one device not detected on Redundant CAN bus	1Check wiring (CAN bus). 2Contact Service.
182	CAN WRONG PARAMETERS	Consistency error in CAN parameters	Contact Service.
183	CAN NO PU-DATA	Error during loading of CAN project design data into ECU.	Contact Service.
184	CAN PU-DATA EE-FAIL	Error during project design data download in EEPROMs	Contact Service.
185	CAN LESS MAILBOXES	Error during CAN initialization.	Contact Service.
186	CAN1 BUS OFF	Severe fault on Default CAN bus; automatic change-over to Redundant CAN bus	Contact Service.

Fault code	Alarm text	Meaning	Task
187	CAN1 ERROR PASSIVE	Light fault on Default CAN bus (e.g.shortage overload)	(none)
188	CAN2 BUS OFF	Severe fault on Redundant CAN bus; automatic change-over to Default CAN bus	Contact Service.
189	CAN2 ERROR PASSIVE	Light fault on Redundant CAN bus (e.g.short-time overload)	(none)
201	SD T-COOLANT	Sensor defect (coolant temperature)	1Check wiring. 2Contact Service.
202	SD T-FUEL	Sensor defect (Fuel temperature)	1Check wiring. 2Contact Service.
203	SD T-CHARGE AIR	Sensor defect (charge-air temperature)	1Check wiring. 2Contact Service.
205	SD T-COOLANT INTERC.	Sensor defect (charge-air coolant temperature)	1Check wiring. 2Contact Service.
208	SD P-CHARGE AIR	Sensor defect (charge-air pressure)	1Check wiring. 2Contact Service.
211	SD P-LUBE OIL	Sensor defect (lube oil pressure)	1Check wiring. 2Contact Service.
215	SD P-RAIL FUEL	Sensor defect (common rail pressure); HP controller in emergency mode	1Check wiring. 2Contact Service.
216	SD T-LUBE OIL	Sensor defect (lube oil temperature)	1Check wiring. 2Contact Service.
220	SD COOLANT LEVEL	Sensor defect (coolant level)	1Check wiring. 2Contact Service.
223	SD LEVEL INTERCOOLER	Sensor defect (charge-air coolant level)	1Check wiring. 2Contact Service.
229	SD ENG.SPEED SENSORS	Sensor defect (crankshaft speed) and sensor defect (camshaft speed)	1Check wiring. 2Contact Service.
230	SD CRANKSHAFT SPEED	Sensor defect (crankshaft speed)	1Check wiring. 2Contact Service.
231	SD CAMSHAFT SPEED	Sensor defect (camshaft speed)	1Check wiring. 2Contact Service.
240	SD P-FUEL	Sensor defect (fuel pressure)	1Check wiring. 2Contact Service.
245	SD POWER SUPPLY	Sensor defect (ECU operating voltage)	Contact Service.
246	SD T-ELECTRONIC	Sensor defect (temperature in ECU)	Contact Service.

Fault code	Alarm text	Meaning	Task
250	SD CAN SPEED DEMAND	Sensor defect (CAN nominal speed demand)	1Check speed transmitter. 2Check wiring (CAN bus). 3Contact Service.
266	SD SPEED DEMAND AN.	Sensor defect (analog nominal speed demand)	1Check speed transmitter. 2Check wiring. 3Contact Service.
267	SD SP.DEM.TEST BENCH	Sensor defect (analog speed demand); NOTE: Only used in test-stand operation.	1Check speed transmitter. 2Check wiring. 3Contact Service.
270	SD SPEED DEMAND FI1	Sensor defect (frequency input for speed demand);	1Check speed transmitter. 2Check wiring. 3Contact Service.
271	SD T-EXTERN 1	External device defective (CAN T-EXTERN 1)	Contact Service.
272	SD T-EXTERN 2	External device defective (CAN T-EXTERN 2)	Contact Service.
273	SD P-EXTERN 1	External device defective (CAN P-EXTERN 1)	Contact Service.
274	SD P-EXTERN 2	External device defective (CAN P-EXTERN 2)	Contact Service.
275	SD EXT.COOLANT LEVEL	External coolant-level monitoring defective (CAN)	Contact Service.
276	SD INTERCOOLER LEVEL	External charge-air coolant-level monitoring defective (CAN)	Contact Service.
277	SD BIN-EXTERN 3	External device defective (CAN BIN-EXTERN 3)	Contact Service.
278	SD BIN-EXTERN 4	External device defective (CAN BIN-EXTERN 4)	Contact Service.
301	TIMING CYLINDER A1	Injection timing fault cylinder A1	If fault occurs repeatedly: Contact Service.
302	TIMING CYLINDER A2	Injection timing fault cylinder A2	If fault occurs repeatedly: Contact Service.
303	TIMING CYLINDER A3	Injection timing fault cylinder A3	If fault occurs repeatedly: Contact Service.
304	TIMING CYLINDER A4	Injection timing fault cylinder A4	If fault occurs repeatedly: Contact Service.
305	TIMING CYLINDER A5	Injection timing fault cylinder A5	If fault occurs repeatedly: Contact Service.
306	TIMING CYLINDER A6	Injection timing fault cylinder A6	If fault occurs repeatedly: Contact Service.

Fault code	Alarm text	Meaning	Task
307	TIMING CYLINDER A7	Injection timing fault cylinder A7	If fault occurs repeatedly: Contact Service.
308	TIMING CYLINDER A8	Injection timing fault cylinder A8	If fault occurs repeatedly: Contact Service.
309	TIMING CYLINDER A9	Injection timing fault cylinder A9	If fault occurs repeatedly: Contact Service.
310	TIMING CYLINDER A10	Injection timing fault cylinder A10	If fault occurs repeatedly: Contact Service.
311	TIMING CYLINDER B1	Injection timing fault cylinder B1	If fault occurs repeatedly: Contact Service.
312	TIMING CYLINDER B2	Injection timing fault cylinder B2	If fault occurs repeatedly: Contact Service.
313	TIMING CYLINDER B3	Injection timing fault cylinder B3	If fault occurs repeatedly: Contact Service.
314	TIMING CYLINDER B4	Injection timing fault cylinder B4	If fault occurs repeatedly: Contact Service.
315	TIMING CYLINDER B5	Injection timing fault cylinder B5	If fault occurs repeatedly: Contact Service.
316	TIMING CYLINDER B6	Injection timing fault cylinder B6	If fault occurs repeatedly: Contact Service.
317	TIMING CYLINDER B7	Injection timing fault cylinder B7	If fault occurs repeatedly: Contact Service.
318	TIMING CYLINDER B8	Injection timing fault cylinder B8	If fault occurs repeatedly: Contact Service.
319	TIMING CYLINDER B9	Injection timing fault cylinder B9	If fault occurs repeatedly: Contact Service.
320	TIMING CYLINDER B10	Injection timing fault cylinder B10	If fault occurs repeatedly: Contact Service.
321	WIRING CYLINDER A1	Faulty wiring to solenoid valve cylinder A1; Misfiring	1Check wiring. 2Contact Service.
322	WIRING CYLINDER A2	Faulty wiring to solenoid valve cylinder A2; Misfiring	1Check wiring. 2Contact Service.
323	WIRING CYLINDER A3	Faulty wiring to solenoid valve cylinder A3; Misfiring	1Check wiring. 2Contact Service.
324	WIRING CYLINDER A4	Faulty wiring to solenoid valve cylinder A4; Misfiring	1Check wiring. 2Contact Service.
325	WIRING CYLINDER A5	Faulty wiring to solenoid valve cylinder A5; Misfiring	1Check wiring. 2Contact Service.

Fault code	Alarm text	Meaning	Task
326	WIRING CYLINDER A6	Faulty wiring to solenoid valve cylinder A6; Misfiring	1Check wiring. 2Contact Service.
327	WIRING CYLINDER A7	Faulty wiring to solenoid valve cylinder A7; Misfiring	1Check wiring. 2Contact Service.
328	WIRING CYLINDER A8	Faulty wiring to solenoid valve cylinder A8; Misfiring	1Check wiring. 2Contact Service.
329	WIRING CYLINDER A9	Faulty wiring to solenoid valve cylinder A9; Misfiring	1Check wiring. 2Contact Service.
330	WIRING CYLINDER A10	Faulty wiring to solenoid valve cylinder A10; Misfiring	1Check wiring. 2Contact Service.
331	WIRING CYLINDER B1	Faulty wiring to solenoid valve cylinder B1; Misfiring	1Check wiring. 2Contact Service.
332	WIRING CYLINDER B2	Faulty wiring to solenoid valve cylinder B2; Misfiring	1Check wiring. 2Contact Service.
333	WIRING CYLINDER B3	Faulty wiring to solenoid valve cylinder B3; Misfiring	1Check wiring. 2Contact Service.
334	WIRING CYLINDER B4	Faulty wiring to solenoid valve cylinder B4; Misfiring	1Check wiring. 2Contact Service.
335	WIRING CYLINDER B5	Faulty wiring to solenoid valve cylinder B5; Misfiring	1Check wiring. 2Contact Service.
336	WIRING CYLINDER B6	Faulty wiring to solenoid valve cylinder B6; Misfiring	1Check wiring. 2Contact Service.
337	WIRING CYLINDER B7	Faulty wiring to solenoid valve cylinder B7; Misfiring	1Check wiring. 2Contact Service.
338	WIRING CYLINDER B8	Faulty wiring to solenoid valve cylinder B8; Misfiring	1Check wiring. 2Contact Service.
339	WIRING CYLINDER B9	Faulty wiring to solenoid valve cylinder B9; Misfiring	1Check wiring. 2Contact Service.

Fault code	Alarm text	Meaning	Task
340	WIRING CYLINDER B10	Faulty wiring to solenoid valve cylinder B10; Misfiring	1Check wiring. 2Contact Service.
341	OPEN_LOAD CYL. A1	Disconnection in wiring to solenoid valve cylinder A1; Misfiring	1Check wiring. 2Contact Service.
342	OPEN_LOAD CYL. A2	Disconnection in wiring to solenoid valve cylinder A2; Misfiring	1Check wiring. 2Contact Service.
343	OPEN_LOAD CYL. A3	Disconnection in wiring to solenoid valve cylinder A3; Misfiring	1Check wiring. 2Contact Service.
344	OPEN_LOAD CYL. A4	Disconnection in wiring to solenoid valve cylinder A4; Misfiring	1Check wiring. 2Contact Service.
345	OPEN_LOAD CYL. A5	Disconnection in wiring to solenoid valve cylinder A5; Misfiring	1Check wiring. 2Contact Service.
346	OPEN_LOAD CYL. A6	Disconnection in wiring to solenoid valve cylinder A6; Misfiring	1Check wiring. 2Contact Service.
347	OPEN_LOAD CYL. A7	Disconnection in wiring to solenoid valve cylinder A7; Misfiring	1Check wiring. 2Contact Service.
348	OPEN_LOAD CYL. A8	Disconnection in wiring to solenoid valve cylinder A8; Misfiring	1Check wiring. 2Contact Service.
349	OPEN_LOAD CYL. A9	Disconnection in wiring to solenoid valve cylinder A9; Misfiring	1Check wiring. 2Contact Service.
350	OPEN_LOAD CYL. A10	Disconnection in wiring to solenoid valve cylinder A10; Misfiring	1Check wiring. 2Contact Service.
351	OPEN_LOAD CYL. B1	Disconnection in wiring to solenoid valve cylinder B1; Misfiring	1Check wiring. 2Contact Service.
352	OPEN_LOAD CYL. B2	Disconnection in wiring to solenoid valve cylinder B2; Misfiring	1Check wiring. 2Contact Service.
353	OPEN_LOAD CYL. B3	Disconnection in wiring to solenoid valve cylinder B3; Misfiring	1Check wiring. 2Contact Service.

Fault code	Alarm text	Meaning	Task
354	OPEN_LOAD CYL. B4	Disconnection in wiring to solenoid valve cylinder B4; Misfiring	1Check wiring. 2Contact Service.
355	OPEN_LOAD CYL. B5	Disconnection in wiring to solenoid valve cylinder B5; Misfiring	1Check wiring. 2Contact Service.
356	OPEN_LOAD CYL. B6	Disconnection in wiring to solenoid valve cylinder B6; Misfiring	1Check wiring. 2Contact Service.
357	OPEN_LOAD CYL. B7	Disconnection in wiring to solenoid valve cylinder B7; Misfiring	1Check wiring. 2Contact Service.
358	OPEN_LOAD CYL. B8	Disconnection in wiring to solenoid valve cylinder B8; Misfiring	1Check wiring. 2Contact Service.
359	OPEN_LOAD CYL. B9	Disconnection in wiring to solenoid valve cylinder B9; Misfiring	1Check wiring. 2Contact Service.
360	OPEN_LOAD CYL. B10	Disconnection in wiring to solenoid valve cylinder B10; Misfiring	1Check wiring. 2Contact Service.
361	POWER STAGE FAIL 1	Defect in ECU (solenoid valve power stage)	Contact Service.
362	POWER STAGE FAIL 2	Defect in ECU (solenoid valve power stage)	Contact Service.
363	STOP POWER STAGE 1	Solenoid valve or wiring or ECU defective automatic engine shutdown	1Check wiring. 2Try to re-start the engine (→ Page 43). 3Contact Service.
364	STOP POWER STAGE 2	Solenoid valve or wiring or ECU defective automatic engine shutdown	1Check wiring. 2Try to re-start the engine (→ Page 43). 3Contact Service.
365	STOP MV-WIRING	Solenoid-valve wiring faulty; automatic engine shutdown	1Check wiring. 2Try to re-start the engine (→ Page 43). 3Contact Service.
381	TRAN.OUT1 PLANT DEF	Binary transistor output plant 1 defective	Contact Service.
382	TRAN.OUT2 PLANT DEF	Binary transistor output plant 2 defective	Contact Service.
383	TRAN.OUT3 PLANT DEF	Binary transistor output plant 3 defective	Contact Service.

Fault code	Alarm text	Meaning	Task
384	TRAN.OUT4 PLANT DEF	Binary transistor output plant 4 defective	Contact Service.
385	TRAN.OUT5 PLANT DEF	Binary transistor output plant 5 defective	Contact Service.
386	TRAN.OUT6 PLANT DEF	Binary transistor output plant 6 defective	Contact Service.

6 Task Descriptions

6.1 Engine

6.1.1 Engine – Barring manually

Preconditions

- Engine is stopped and starting disabled.

Special tools

Designation / Use	Part No.	Qty.
Barring tool	F6555766	1
Ratchet	F30006212	1

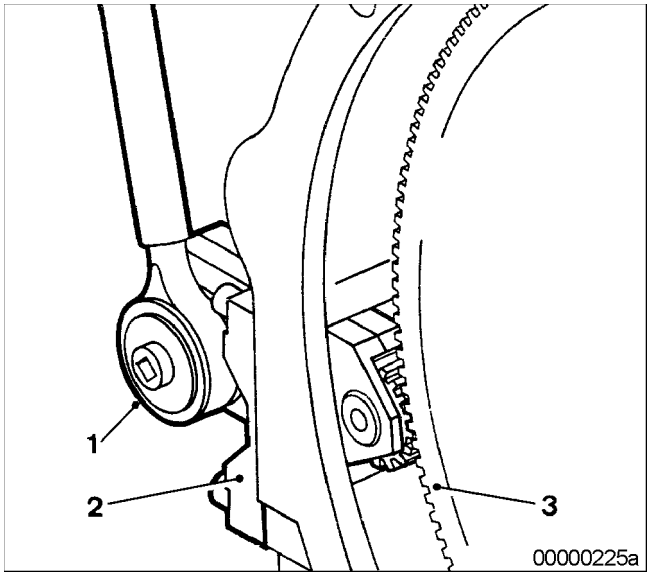
DANGER

Unguarded rotating and moving engine components.
Risk of serious injury — danger to life!

- Before barring the engine, ensure that nobody is in the danger zone.

Engine – Barring manually

1. Remove guard plate.
2. Install barring tool (2).
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 abnormal resistance.
5. For barring-tool removal follow reverse sequence of working steps.



6.1.2 Engine – Barring with starting system

Special tools

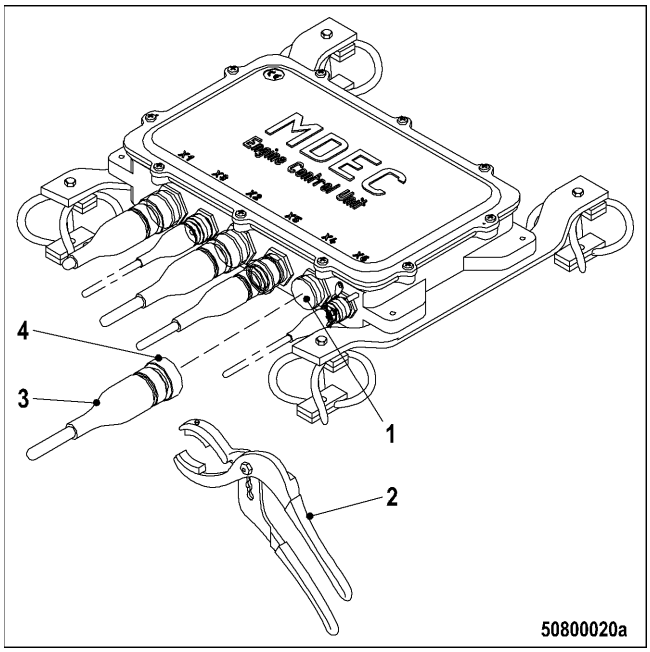
Designation / Use	Part No.	Qty.
Connector pliers	0135315483	1

DANGER

Unguarded rotating and moving engine components.
Risk of serious injury - danger to life!
- Before barring or starting the engine, ensure that nobody is in the danger zone.
- After working on the engine, check that all protective devices have been reinstalled and all tools removed from the engine.

Engine – Barring with starting system

1. Disengage the bayonet ring-nut (4) of connector X4 with connector pliers (2) and withdraw connector (3) from ECU.
2. Bar engine in unloaded condition: Press START button.
3. Let the crankshaft rotate until oil pressure is indicated.
4. Engine start is automatically interrupted when specified starting period is expired. If necessary, re-start the engine after approx. 20 seconds.
5. Plug connector X4 (3) and use connector pliers (2) to secure the bayonet ring (4) by turning it clockwise until it latches into place.



6.1.3 Engine test run

DANGER	Unguarded rotating and moving engine components. **Risk of serious injury — danger to life!** • Before barring or starting the engine, ensure that nobody is in the danger zone.

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

Engine test run

1. Start engine (→ Page 43).
2. Perform test run at not below 1/3 load and at least until steady-state temperature is reached.
3. Carry out operational checks (→ Page 45).
4. Stop engine (→ Page 46).

6.2 Cylinder Liner

6.2.1 Cylinder liner – Endoscopic examination

Preconditions

- Engine is stopped and starting disabled.

Special tools

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

Preparatory steps

1. Remove cylinder-head cover (→ Page 94).
2. Remove injector (→ Page 97).

Positioning crankshaft at BDC

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

Cylinder liner - Endoscopic examination

Findings	Task
• Thin carbon coating on carbon scraper ring • Slight localized additive deposits at top edge • Localized smooth areas at lower edge • Carbon deposits on entire circumference between top piston ring and lower 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
• Darker areas of even or varying color intensity • 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 cannot be faulted • Piston rings cannot be faulted	Further endoscopic examination required as part of maintenance work
• On the entire circumference not only bright discoloration (not critical for operation) clearly visible darker stripes that begin at the top piston ring • Heat discoloration in the direction of stroke and honing pattern damage • Heat discoloration of piston rings	Cylinder liner must be replaced; Service must be contacted

1. Compile endoscopy report using the table.
2. Use technical terms for description of the liner surface (→ Page 83).
3. Depending on findings:
   - Do not take any action or
   - carry out further endoscopic examination as part of maintenance work or
   - contact Service: cylinder liner must be replaced.

Final steps

1. Install injector (→ Page 97).
2. Install cylinder-head cover (→ Page 94).

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

Terms used for endoscopic examination

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

Minor dirt scores	Light scoring can take place 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 from 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.
Polished area	Polished 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 are corrosion pittings.
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. Cylinders with a number of black lines around the running surface have limited service life and should be replaced.
Discolorations (Heat)	These are caused by a disturbance 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 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 heat discoloration starting in the TDC-ring 1 have to be replaced.
Seizures, Seizure marks	Irregular circumference lengths and depths. Can be caused by either 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. Thorough investigation and compliance with the above evaluation criteria allows a definite evaluation. To avoid unnecessary disassembly work, it is recommended that another inspection be carried out after further operation of the engine.

6.3 Crankcase Breather

6.3.1 Crankcase breather – Oil separator replacement, diaphragm check and replacement

Preconditions

- Engine is stopped and starting disabled.

Special tools

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

Spare parts

Designation / Use	Part No.	Qty.
Filter element		
Diaphragm		
Seal		

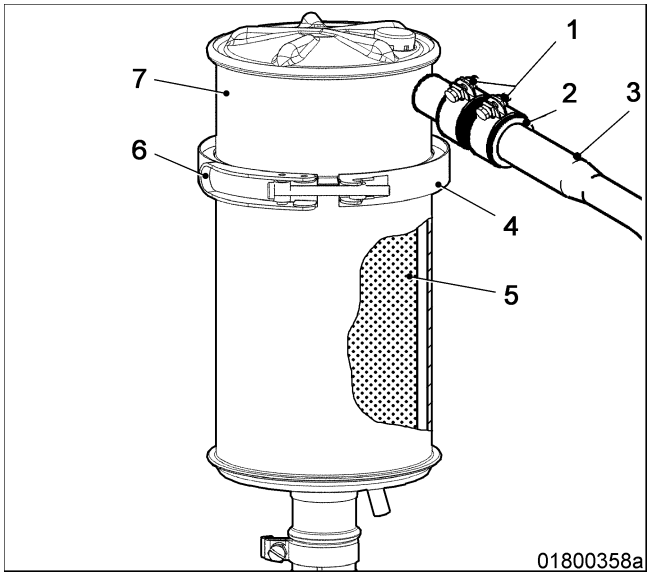
WARNING

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.

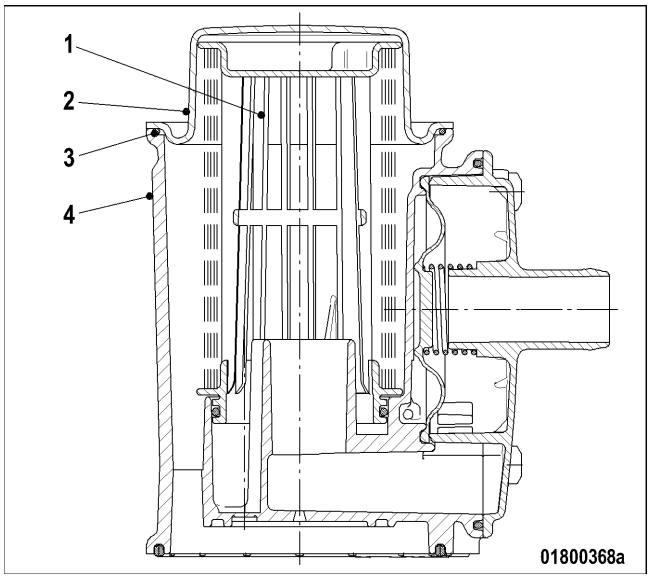
Crankcase breather – Replacing filter element (variant A)

1. Loosen clamps (1).
2. Slide rubber sleeve (2) over pipe (3).
3. Detension band clamp (4) with lever (6).
4. Remove cover (7).
5. Fit new filter element (5).
6. Fit cover (7).
7. Tension band clamp (4) with lever (6).
8. Replace further oil filter elements in the same way.



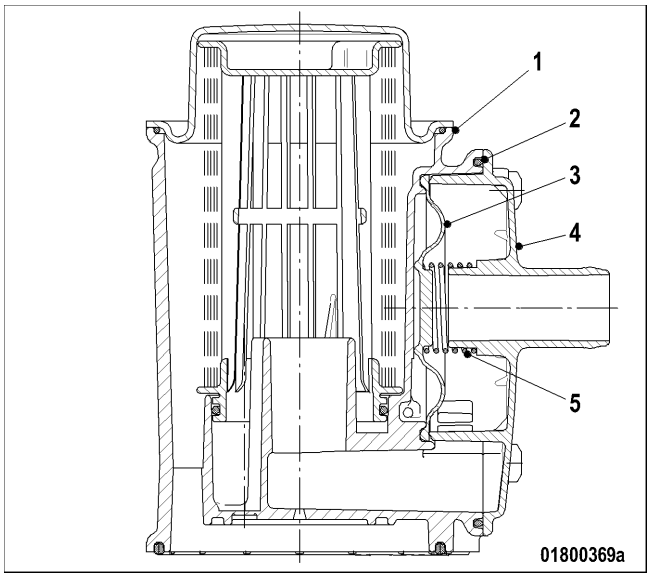
Replacing oil separator insert (variant B)

1. Remove cover (2) with O-ring (3).
2. Remove filter element (1) from housing (4).
3. Insert new filter element in housing (4).
4. Fit cover (2) with new O-ring.
5. Use torque wrench to tighten the screws of cover (2) to specified torque 6 Nm +2 Nm.
6. Replace further oil separators in the same way.



Diaphragm check

1. Remove cover (4).
2. Take off spring (5), seal (2) and diaphragm (3).
3. Check diaphragm (3) for damage, fit new diaphragm if used one is damaged.
4. Mount diaphragm (3) on housing (1).
5. Install new seal (2) and spring (5) together with cover (4).
6. Use torque wrench to tighten the screws of cover (4) to specified torque 6 Nm +2 Nm.
7. Check diaphragms in further oil separators in the same way.



6.4 Valve Gear

6.4.1 Valve gear – Lubrication

Preconditions

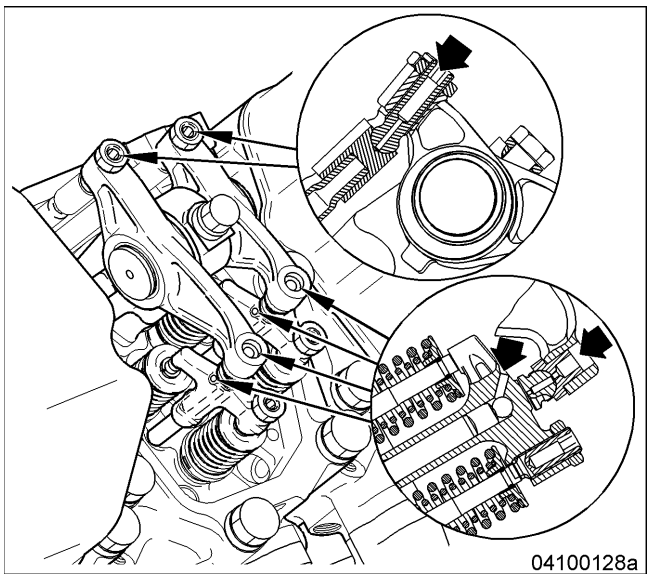
- Engine is stopped and starting disabled.

Material

Designation / Use	Part No.	Qty.
Engine oil		

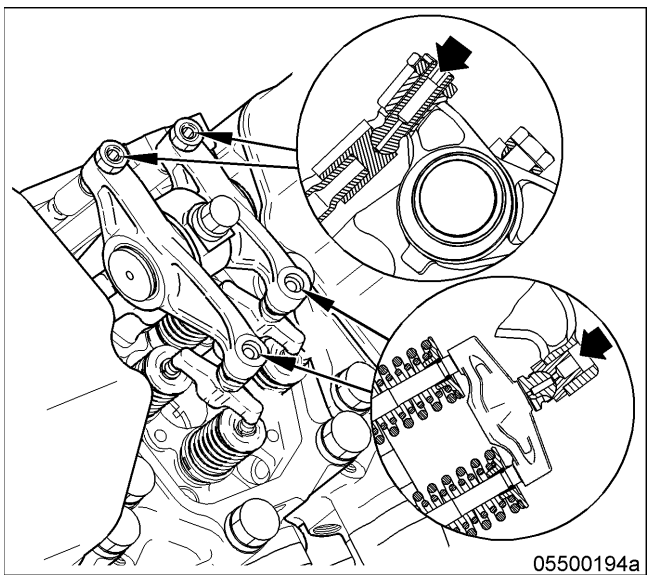
Valve gear – Lubrication (valve bridge with guide)

1. Remove cylinder-head covers (→ Page 94).
2. Fill oil chambers of valve bridges with oil.
3. Fill oil chambers of rocker arms and adjusting screws with oil.
4. Install cylinder-head covers (→ Page 94).



Valve gear – Lubrication (flying valve bridge)

1. Remove cylinder-head covers (→ Page 94).
2. Fill oil chambers of rocker arms and adjusting screws with oil.
3. Install cylinder-head covers (→ Page 94).



6.4.2 Valve clearance – Check and adjustment

Preconditions

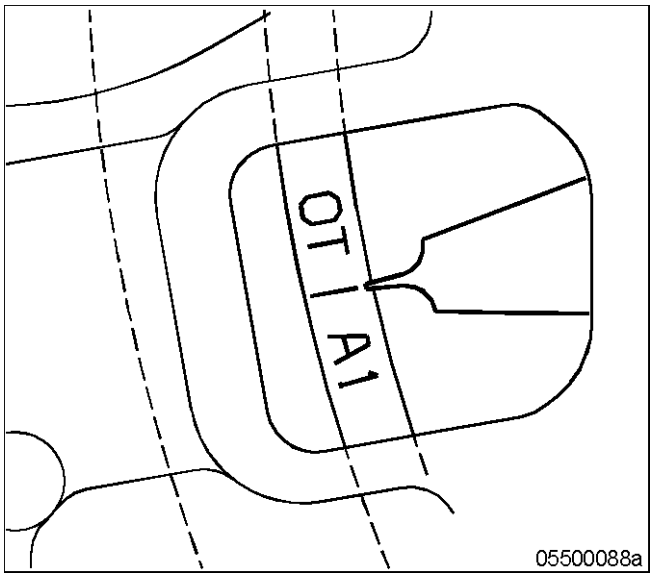
- Engine is stopped and starting disabled.
- Engine coolant temperature is max. 40 °C.
- Valves are closed.

Special tools

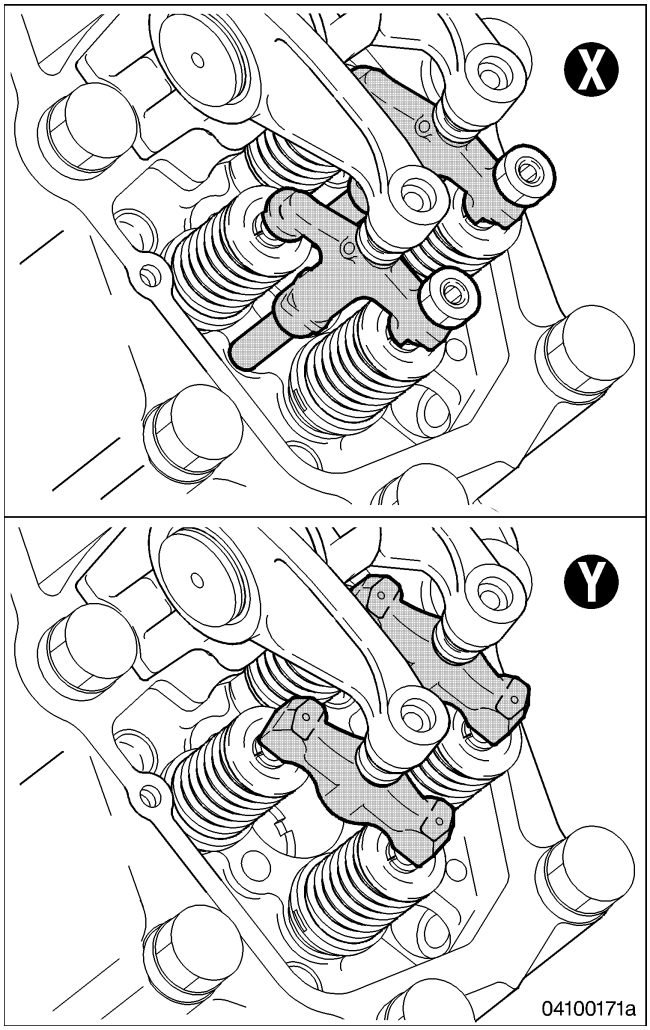
Designation / Use	Part No.	Qty.
Feeler gauge	Y20010128	1
Torque wrench 10-60 Nm	F30510423	1
Torque wrench 60-320 Nm	F30047446	1
Ring wrench adapter	F30039518	1

Preparatory steps

1. Remove cylinder head cover (→ Page 94).
2. Install barring tool (→ Page 79).
3. Rotate crankshaft with barring tool in engine direction of rotation until marking "OT-A1" and pointer are aligned.



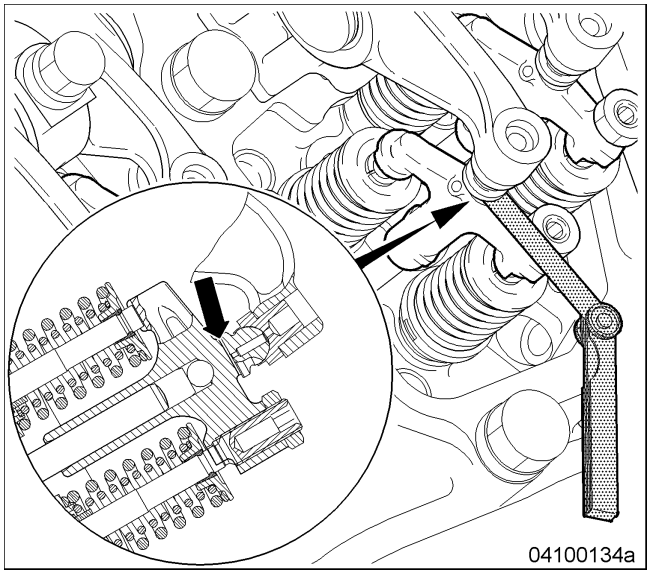
Checking valve-bridge balance



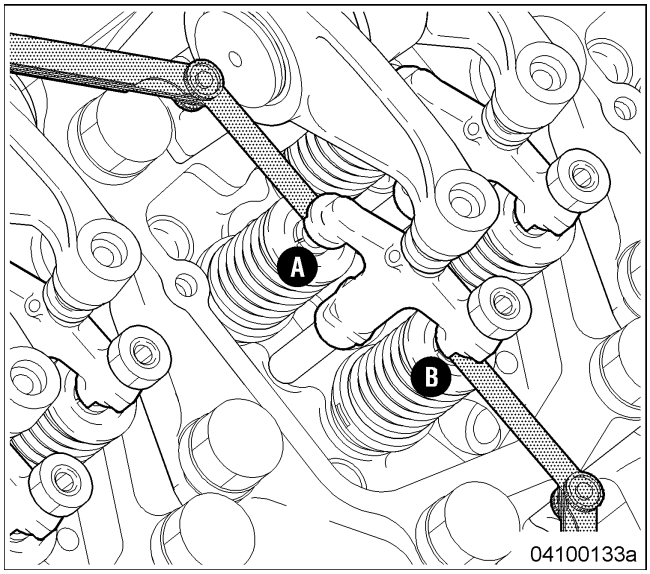
X Valve bridge with guide
Y Flying valve bridge

Note: Not applicable for engines with flying valve bridge.

1. Prior to adjusting valve clearance, check valve-bridge balance on all valve bridges.
2. Use feeler gauge to determine the distance between valve bridge and rocker arm.



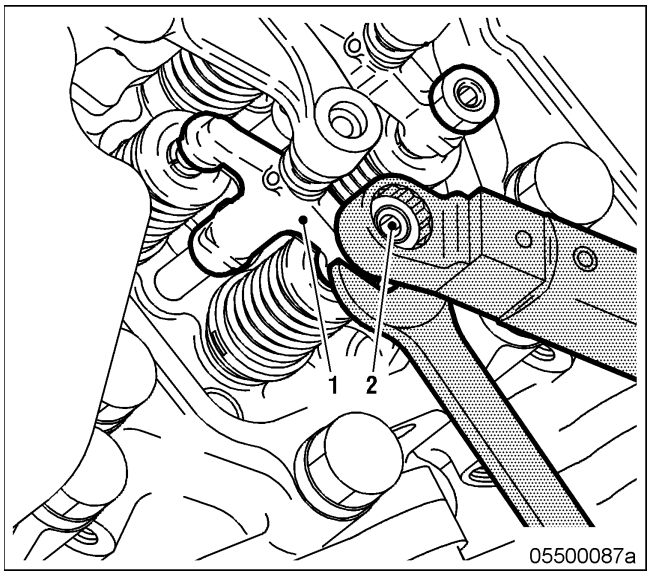
3. Insert feeler gauge with determined value between valve bridge and valve-stem end (A).
4. At the opposite valve-stem end (B), a feeler gauge thicker by 0.05 mm should not fit, otherwise adjust valve bridge balance.



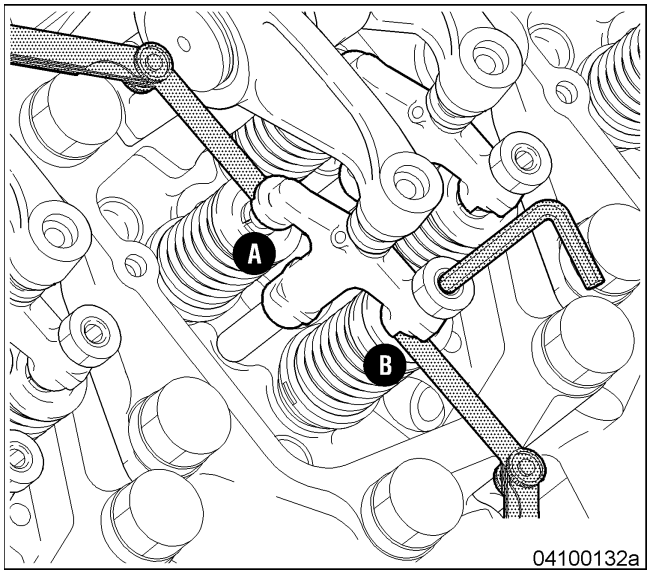
Adjusting valve-bridge balance

Note: Not applicable for engines with flying valve bridge.

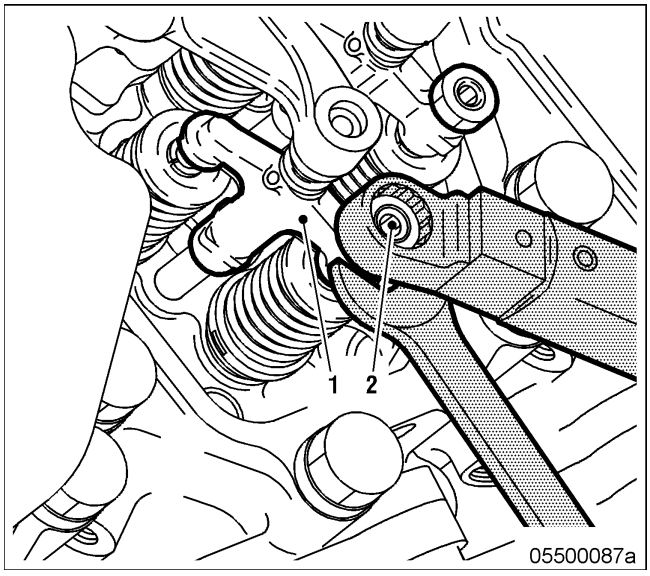
1. Hold valve bridge (1) firmly in position with open-end spanner and release locknut (2).

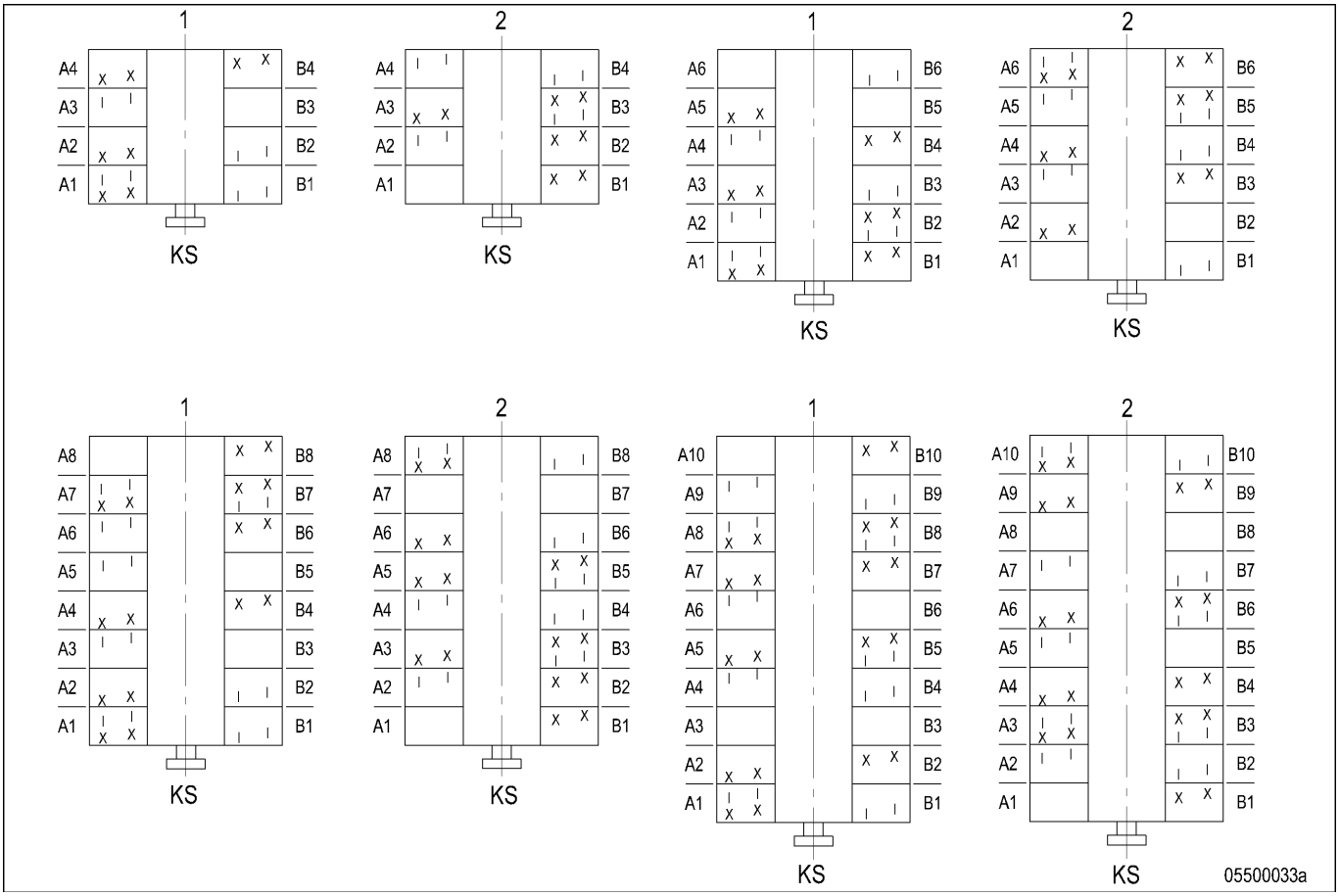


2. Use feeler gauge to determine the distance between valve bridge and rocker arm.
3. Place one feeler gauge (of the determined value) each between valve bridge and the two valve-stem ends (A) and (B).
4. Turn adjusting screw so that both feeler gauges can be just pulled through.
5. Hold adjusting screw securely in position with Allen key and fit locknut by hand on valve bridge.
6. Replace or rectify adjusting screws which do not move freely.



7. Tighten locknut (2) to 35 Nm +5 Nm, holding valve bridge (1) in position with open-end spanner.
8. Check valve bridge balance again.





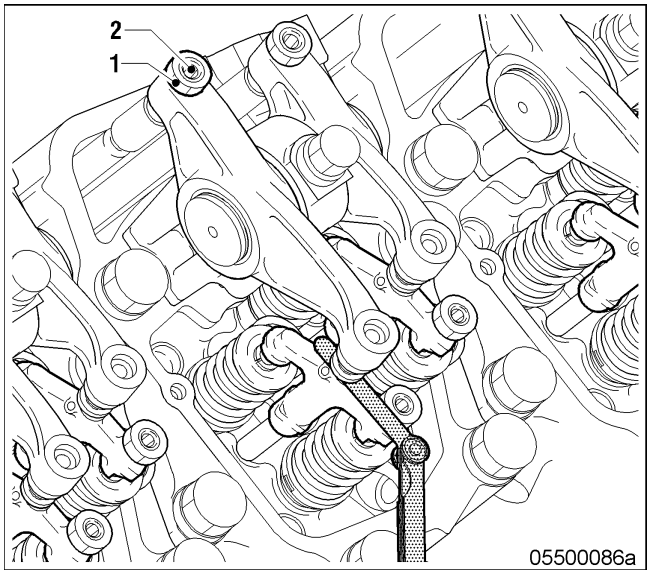
1 Cylinder A1 is in firing TDC
2 Cylinder A1 is in overlap TDC
I Inlet valve
X Exhaust valve

Checking valve clearance at two crankshaft positions

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

Adjusting valve clearance

1. Release locknut (1).
2. Insert feeler gauge between valve bridge and rocker arm.
3. Using Allen key, set adjusting screw (2) so that the specified valve clearance is provided.
4. Feeler gauge must just pass through the gap.
5. Tighten locknut (1) to 90 +9 Nm, holding adjusting screw (2) firm.
6. Replace or rectify adjusting screws and/or locknuts which do not move freely.
7. Check valve clearance.



Final steps

1. Remove barring tool (→ Page 79).
2. Install cylinder head cover (→ Page 94).

6.4.3 Cylinder head cover – Remove and install

Preconditions

- Engine is stopped and starting disabled.

Special tools

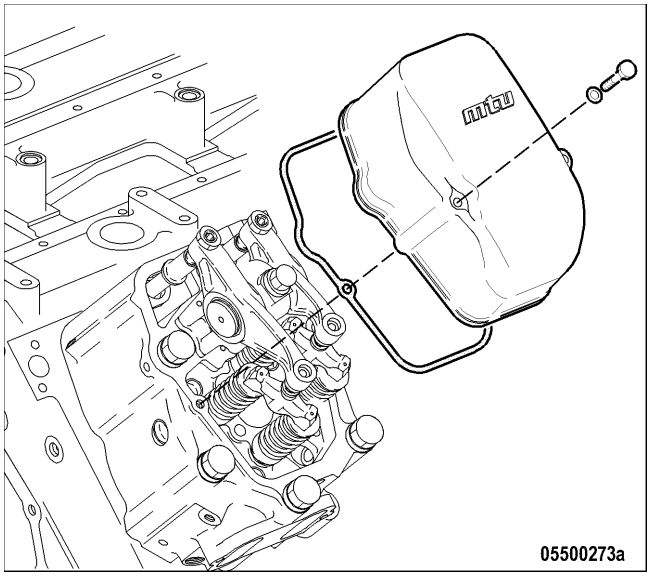
Designation / Use	Part No.	Qty.
Torque wrench 10-60 Nm	F30510423	1

Spare parts

Designation / Use	Part No.	Qty.
Gasket		

Remove cylinder head cover

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



Install cylinder head cover

1. Clean mating faces.
2. Check condition of gasket, replace if necessary.
3. Place gasket and cylinder head cover on cylinder head.
4. Install screws and tighten to 42 Nm.

6.5 Injection Pump / HP Pump

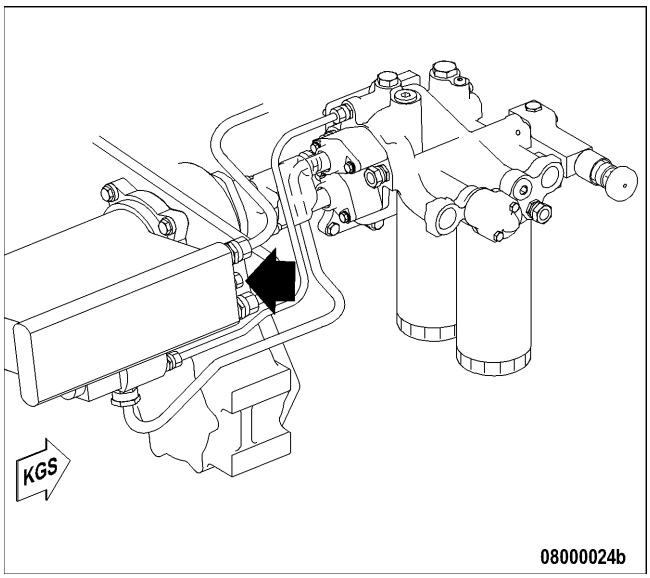
6.5.1 HP pump – relief bore check

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

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

HP pump – relief bore check

1. Check relief bore for fuel discharge by visual inspection.
2. If fuel discharge is found, contact Service.



6.6 Fuel Injector

6.6.1 Injector replacement

Spare parts

Designation / Use	Part No.	Qty.
Injector		

Remove injector and install new one (→ Page 97)**.**

6.6.2 Injector – Removal and installation

Preconditions

- Engine is stopped and starting disabled.

Special tools

Designation / Use	Part No.	Qty.
Puller for injector	F30377769	1
Puller bracket for injector	F6557991	1
Force-in lever for injector	F6557952	1
Lever for force-in lever	F6555197	1
Injector installation jig	F30378403	1
Slotted screwdriver	F30379005	1
Torque wrench 0.5-5 Nm	0015384230	1
Torque wrench 10-60 Nm	F30510423	1
Torque wrench 60-320 Nm	F30047446	1

Material

Designation / Use	Part No.	Qty.
Petroleum jelly		

WARNING

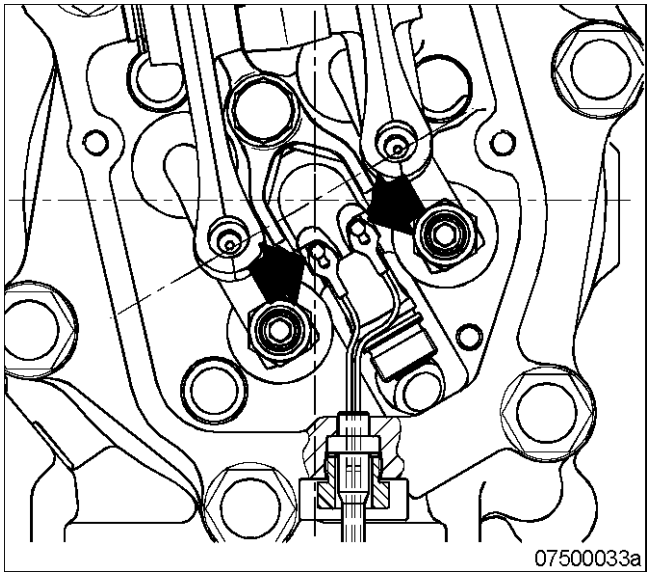
Fuels are combustible.
Risk of fire and explosion!
- Avoid naked flames, electrical sparks and ignition sources.
- Do not smoke.

Preparatory steps

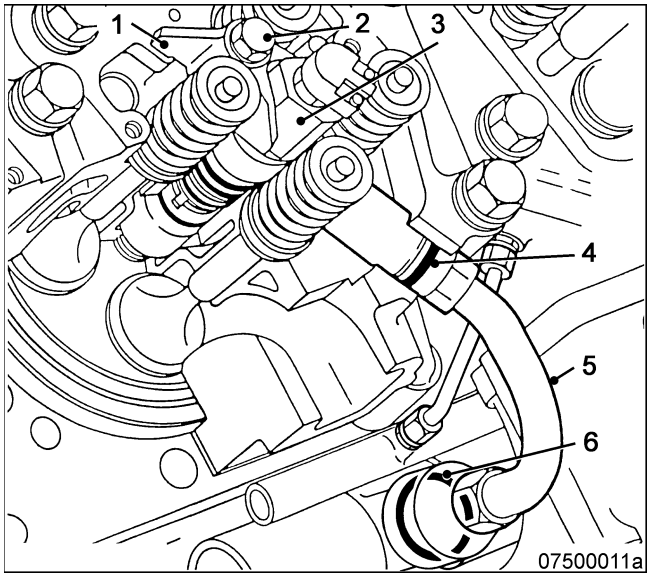
1. Shut off fuel supply to engine.
2. Remove cylinder head cover (→ Page 94).

Injector removal

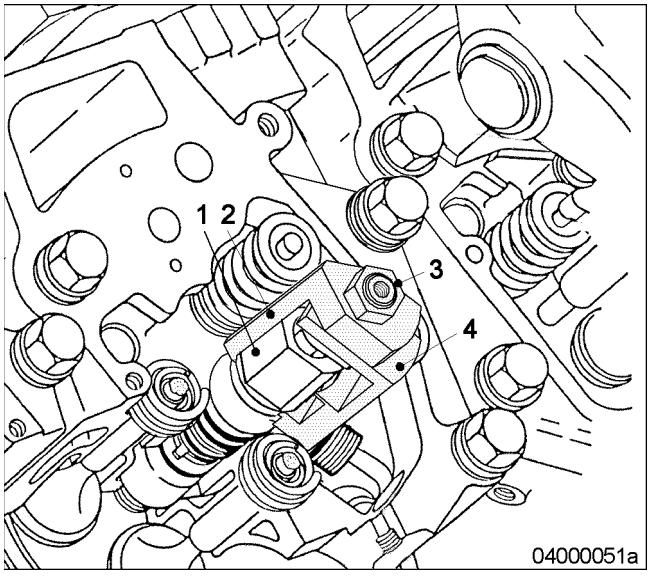
1. Release the cable terminal threaded connection on the injector and remove cable terminals.



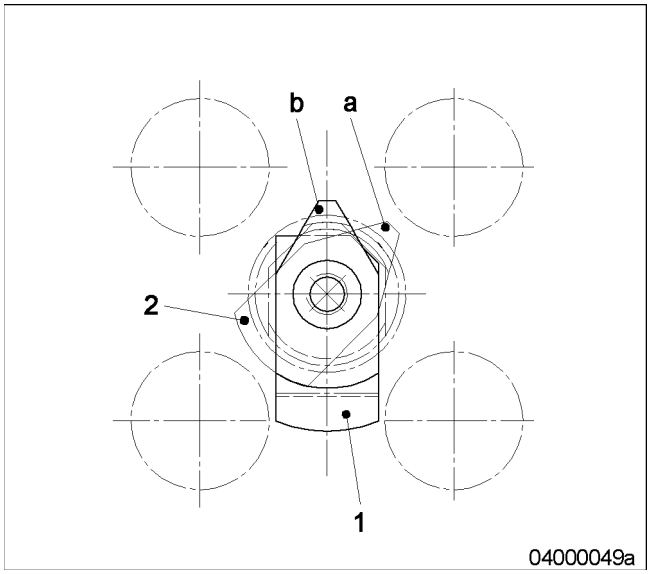
2. Remove screw (2) and take off hold-down clamp (1).
3. Remove high-pressure fuel line (5).



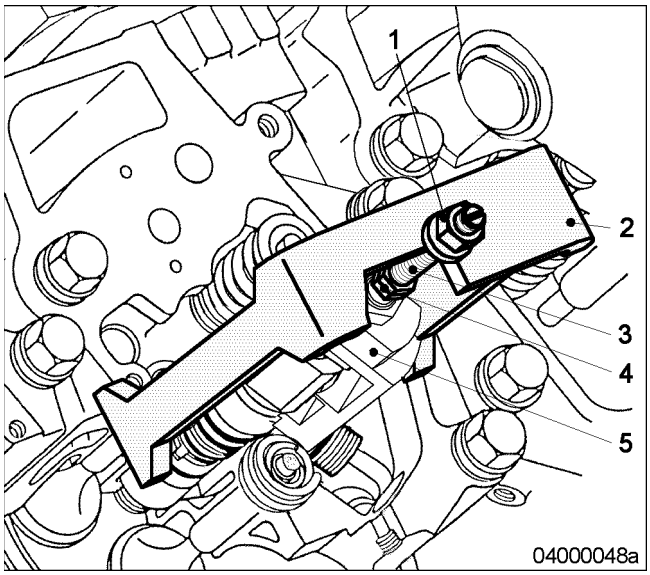
4. Install puller for injector removal. For this purpose, fit part (4) onto injector (1).
5. Slide part (2) over part (4) and turn to correct position - see next illustration.
6. Secure part (2) with nut (3).



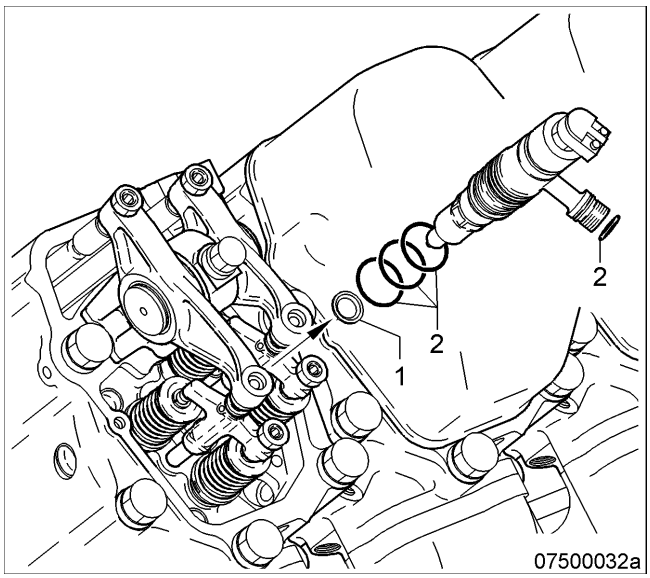
7. Initial position of part (2) is position a.
8. End position is position b.



9. Install puller bracket (2) for injector removal.
10. Turn nut (1) clockwise and withdraw injector.
11. Remove puller bracket from injector.

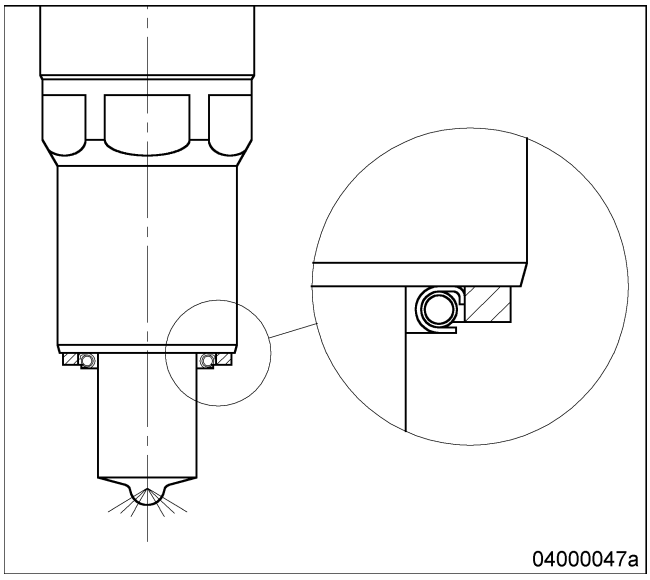


12. Remove sealing ring (1) from injector or use a self-made wire hook to take it out of the cylinder head.
13. Remove O-rings (2) from injector.
14. Cover all connections and bores, or seal with suitable plugs.

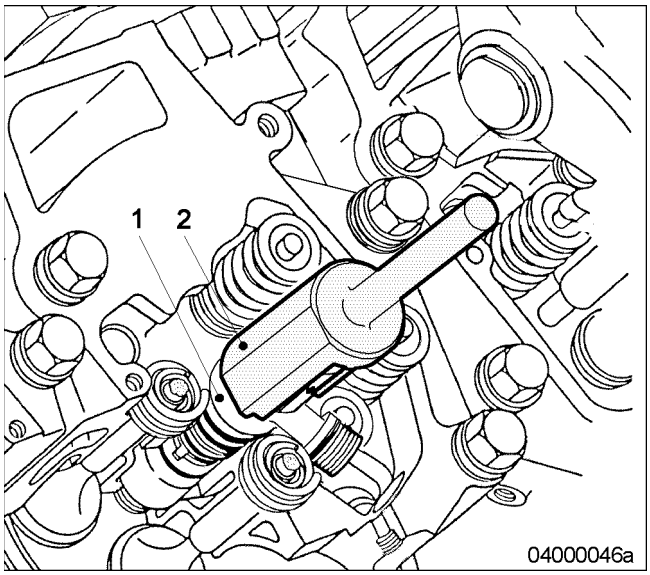


Installing injector

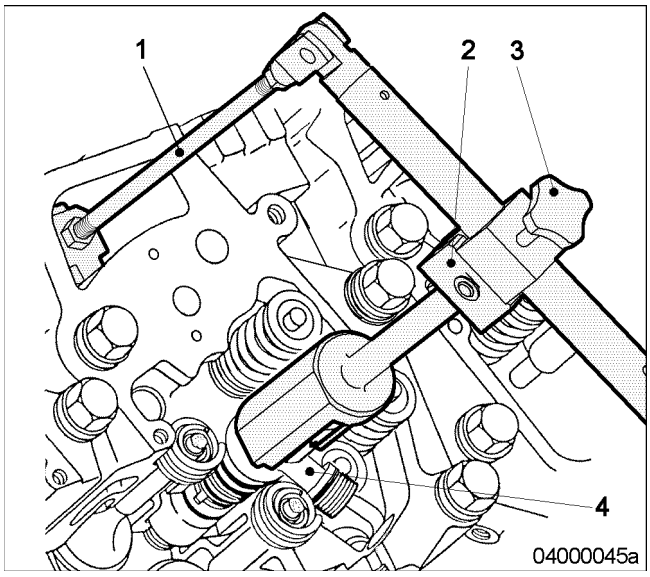
1. Prior to installation, remove all plugs.
2. Coat new O-rings (scope of supply of injector) with petroleum jelly and fit on injector.
3. Fit new sealing ring with petroleum jelly on injector, observe installation position of sealing ring.



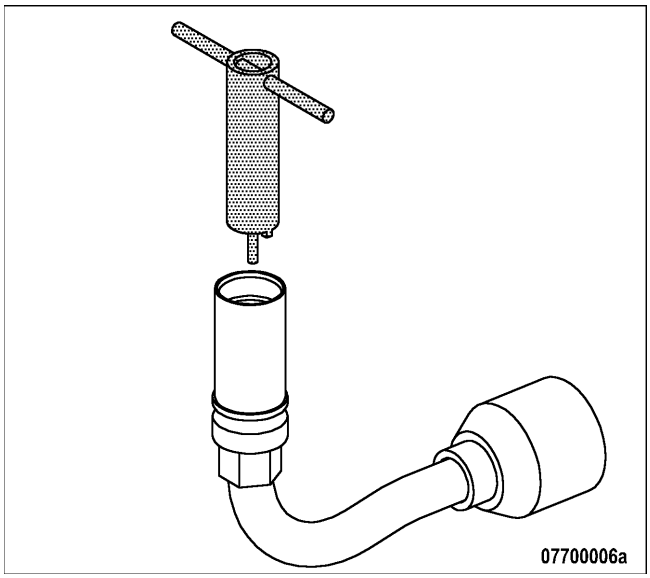
4. Clean sealing surface on cylinder head and protective sleeve.
5. Insert injector (1) into cylinder head, ensuring that the high-pressure fuel line connection is aligned correctly.
6. Fit injector installation jig (2).



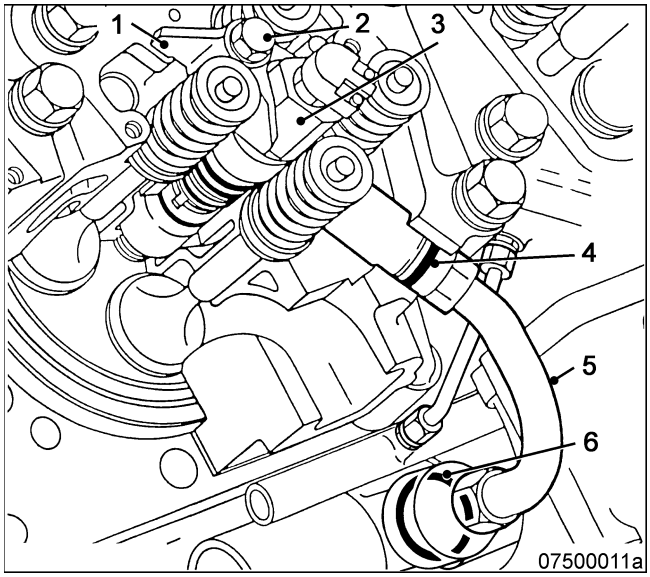
7. Lock force-in lever (1) between pushrods.
8. Release palm grip (3) and move pressure element (2) to correct position of installation jig.
9. Secure palm grip (3) and press injector (4) with force-in lever into cylinder head.
10. Remove force-in tool.



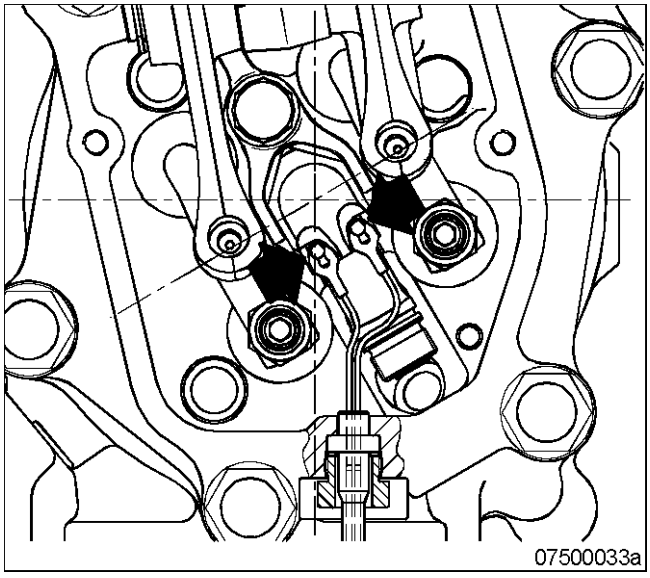
11. Use slotted screwdriver to check thrust ring at both line ends for secure seating.
12. Tighten loose thrust ring to 10 Nm.



13. Fit hold-down clamp (1) in correct position and install screw (2) by hand.
14. Use torque wrench to pretighten screw (2) to between 5 Nm and 10 Nm.
15. Coat new O-rings (4) and (6) with petroleum jelly and fit on high-pressure fuel line (5).
16. Mount high-pressure line (5) and use torque wrench to pretighten to between 5 Nm and 10 Nm.
17. Use torque wrench to tighten screw (2) to specified tightening torque of 100 Nm +10 Nm.
18. Use torque wrench to fasten high-pressure line to specified tightening torque of 140 Nm +10 Nm.



19. Push cable terminals under the screws on the injector and use torque wrench to tighten screws to specified tightening torque of 1 Nm.



Final steps

1. Install cylinder head cover (→ Page 94).
2. Open fuel supply to engine.

6.7 Fuel System

6.7.1 Fuel system venting

Preconditions

- Engine is stopped and starting disabled.

Material

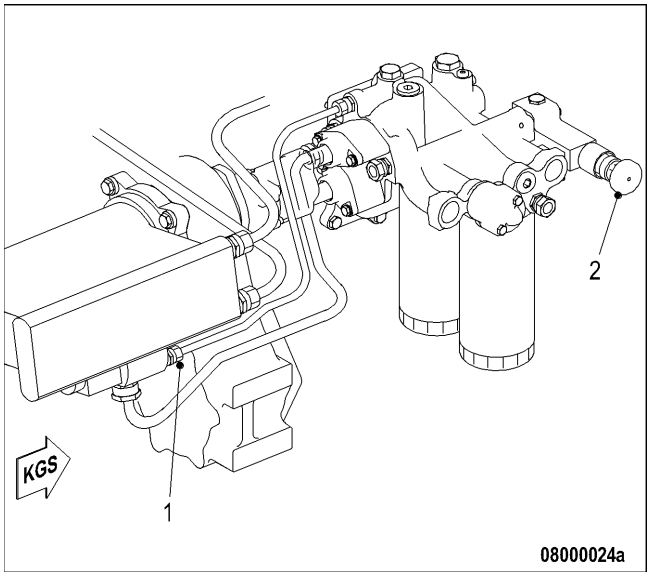
Designation / Use	Part No.	Qty.
Diesel fuel		

WARNING

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

LP fuel system venting

1. Loosen flushing/return line of HP pump at connection (1).
2. Unlock fuel priming pump (2), unscrew handle.
3. Operate the fuel priming pump (2) with the handle until bubble-free fuel comes out of the connection (1).
4. Lock fuel priming pump (2), screw in handle.
5. Verify that fuel priming pump (2) is locked: Handle must be tightened.
6. Tighten connection (1) of flushing/return line.



6.8 Fuel Filter

6.8.1 Fuel filter – Replacement

Preconditions

- Engine is stopped and starting disabled.

Special tools

Designation / Use	Part No.	Qty.
Filter wrench	F30379104	1

Material

Designation / Use	Part No.	Qty.
Engine oil		

Spare parts

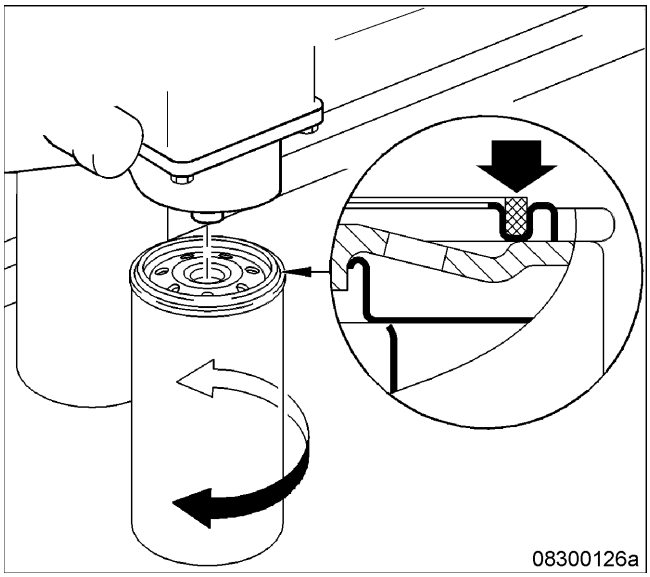
Designation / Use	Part No.	Qty.
Easy-change filter		

WARNING

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

Fuel filter – Replacement

1. Remove easy-change filter using filter wrench.
2. Clean the sealing surface of the filter head.
3. Slightly lubricate seal on the easy-change filter.
4. Screw on easy-change filter by hand until the seal connects and tighten manually.
5. Vent fuel system (→ Page 103).
6. Replace further easy-change filters in the same way.



6.8.2 Fuel prefilter cleaning

Preconditions

- Engine is stopped and starting disabled.

Material

Designation / Use	Part No.	Qty.
Diesel fuel		

Spare parts

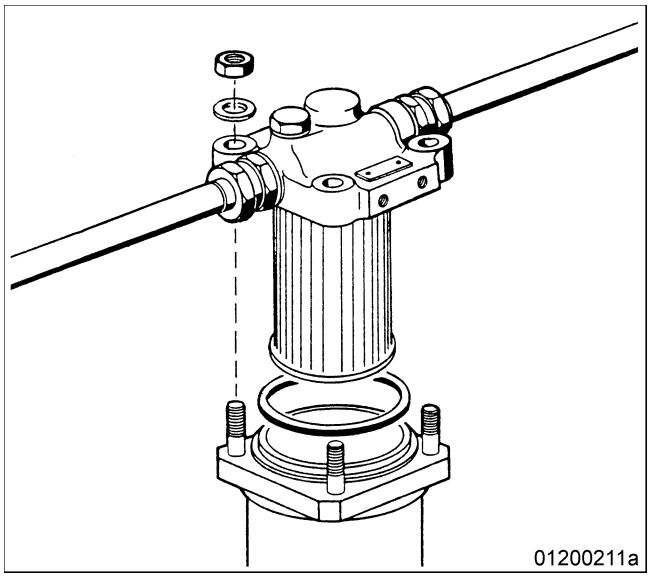
Designation / Use	Part No.	Qty.
Sealing ring		

WARNING

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

Fuel prefilter cleaning

1. Shut off fuel supply.
2. Remove nuts from filter head.
3. Take off filter housing and drain fuel into appropriate container.
4. Remove filter-element securing nut and remove filter element by pulling it downwards.
5. Wash filter element in clean fuel using a smooth brush.
6. Wash filter housing with clean fuel.
7. Insert filter element into filter housing and secure with nut.
8. Place new sealing ring into groove in filter head.
9. Fit cover with seal and secure it with nuts crosswise.
10. Open fuel supply.



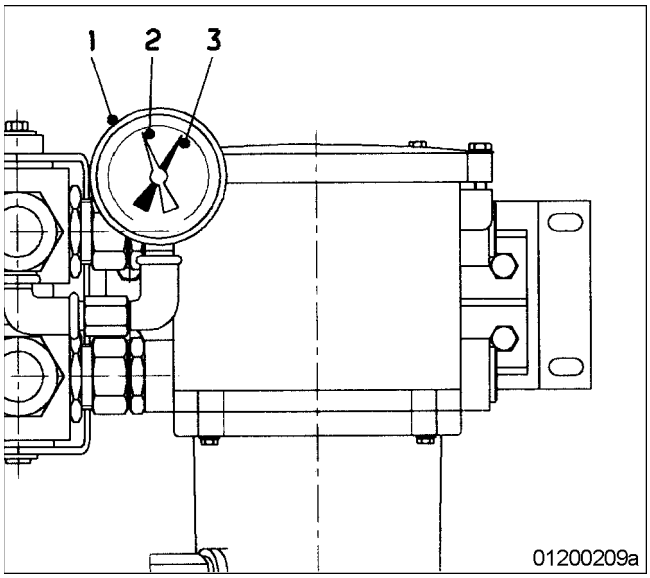
6.8.3 Fuel prefilter – differential pressure check and adjustment of gauge

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

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

Setting adjustable pointer of differential pressure gauge

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



Fuel prefilter – checking differential pressure

1. With the engine running at full load or rated power, read off pressure at gauge (1).
2. If differential pressure as indicated between position of adjustable pointer (2) and pressure-indicating pointer (3) of pressure gauge is ≥ 0.3 bar, flush filter element of the cut-in filter (→ Page 109).

6.8.4 Fuel prefilter – draining

Preconditions

- Engine is stopped and starting disabled.

Material

Designation / Use	Part No.	Qty.
Diesel fuel		

Spare parts

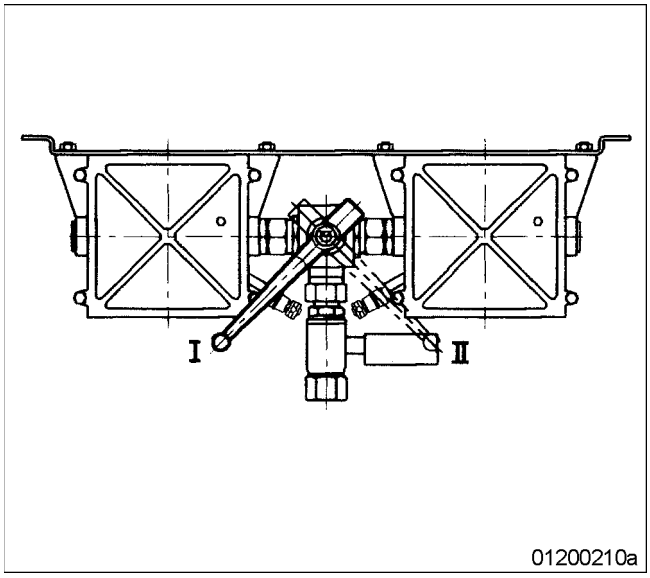
Designation / Use	Part No.	Qty.
Gasket		

WARNING

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

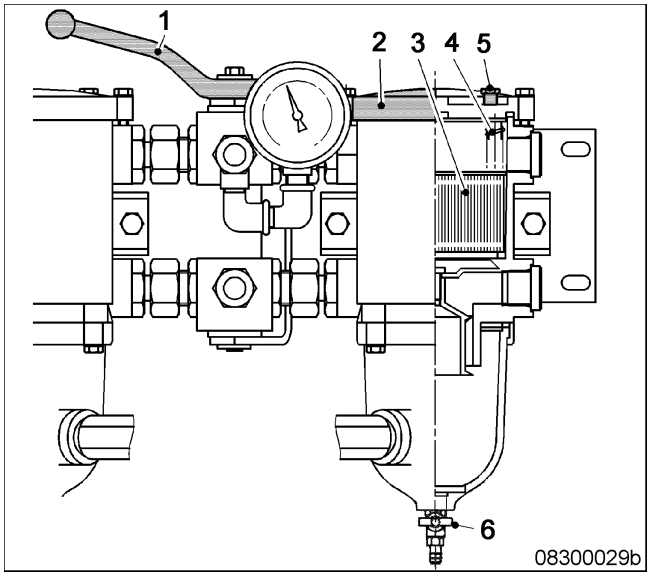
Fuel prefilter – draining

1. Cut out the filter to be drained.



I Left filter cut in
II Right filter cut in

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



6.8.5 Fuel prefilter – flushing

Material

Designation / Use	Part No.	Qty.
Diesel fuel		

Spare parts

Designation / Use	Part No.	Qty.
Gasket		

DANGER

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

WARNING

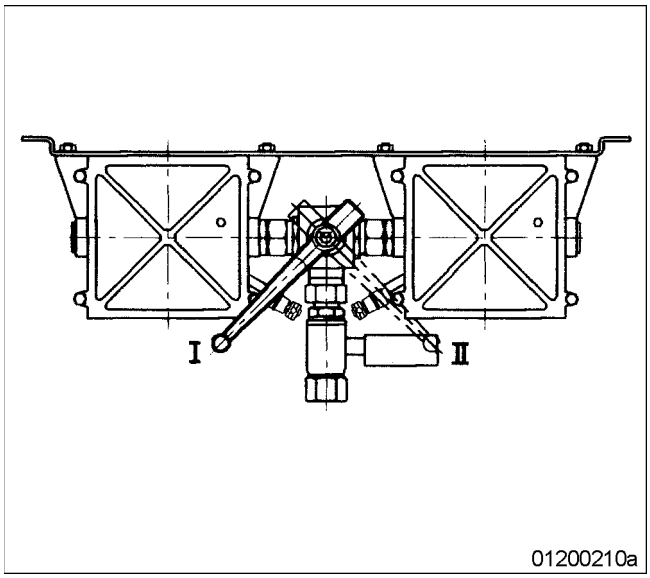
Fuels are combustible.
Risk of fire and explosion!
- Avoid naked flames, electrical sparks and ignition sources.
- Do not smoke.

WARNING

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

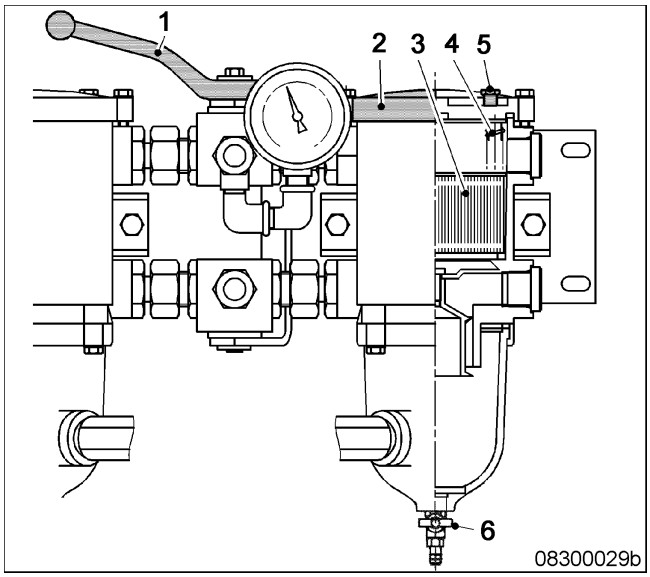
Fuel prefilter – flushing

1. Cut out the contaminated filter.



I Left filter cut in
II Right filter cut in

2. Open vent plug (5) of the filter to be flushed.
3. Unlock drain cock (6) by pressing toggle, open it and drain fuel.
   Result: Fuel flows from filtered side back to the unfiltered side, flushing the filter deposits downwards out of the filter.
4. Close vent plug (5) and drain cock (6).



Fuel prefilter – filling fuel

1. Stop engine (→ Page 46)and disable engine start.
2. Remove screws securing the cover and take off cover (2).
3. Fill filter housing with clean fuel.
4. Place new gasket in cover (2).
5. Fit cover with gasket and secure it with screws.
6. Check differential pressure (→ Page 106).
   Result: If flushing did not lead to an improvement of the differential pressure, replace filter element (→ Page 111).

6.8.6 Fuel prefilter – filter element replacement

Preconditions

- Engine is stopped and starting disabled.

Material

Designation / Use	Part No.	Qty.
Diesel fuel		

Spare parts

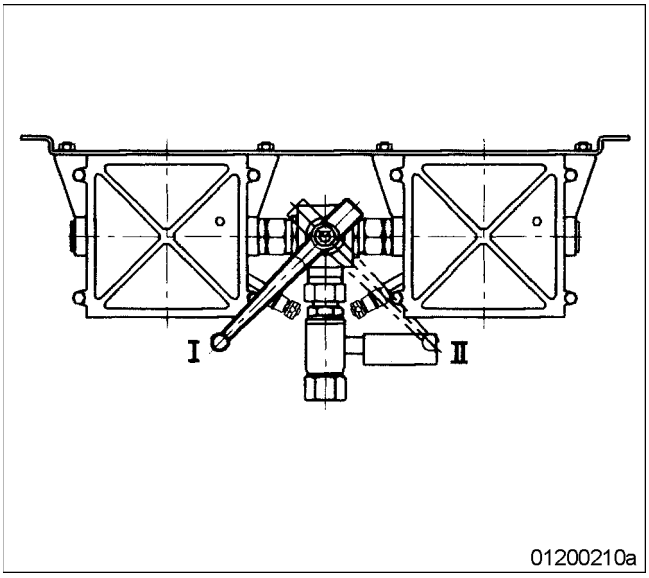
Designation / Use	Part No.	Qty.
Filter element		
Gasket		

WARNING

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

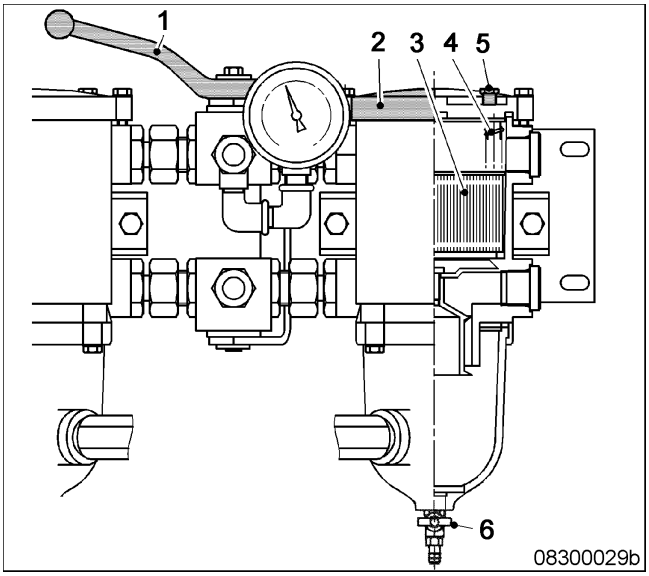
Fuel prefilter – filter element replacement

1. Cut out the contaminated filter.



I Left filter cut in
II Right filter cut in

2. Open vent plug (5) of the contaminated filter.
3. Unlock drain cock (6) by pressing toggle and open it.
4. Drain water and contaminants from the filter.
5. Close drain cock (6).
6. Remove screws securing the cover and take off cover (2).
7. Remove spring (4) and filter element (3).
8. Insert new filter element (3) and spring (4).
9. Fill filter housing with clean fuel.
10. Place new gasket in cover (2).
11. Fit cover with gasket and secure it with screws.
12. Cut the cut-out filter in again.
13. Close vent plug (5) when fuel emerges.
14. Align adjustable pointer of differential pressure gauge with pressure-indicating pointer. (→ Page 106).



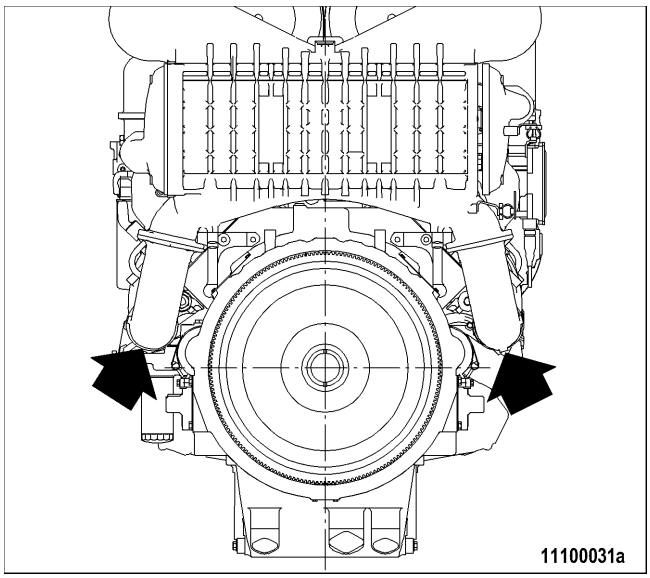
6.9 Charge-air Cooling, General, Left Side

6.9.1 Intercooler – checking condensate drains for coolant discharge and obstruction

DANGER	Unguarded rotating and moving engine components. **Risk of serious injury – danger to life!** • Take special care when working on a running engine.
WARNING	Engine noise above 85 dB (A). **Risk of damage to hearing!** • Wear ear protectors.
WARNING	Compressed air. **Risk of injury!** • Do not direct compressed-air jet at persons. • Wear protective goggles / safety mask and ear protectors.

Intercooler – checking condensate drains for coolant discharge and obstructions

1. With the engine running, verify that air emerges from the condensate drain(s) at driving end, left and right engine side. If no air emerges:
2. Clean condensate drain(s) and blow out with compressed air.
3. If a large amount of coolant is continuously discharged, the intercooler is leaking. Contact Service.



Emergency measures prior to engine start with a leaking intercooler

1. Remove injectors (→ Page 97).
2. Bar engine manually (→ Page 79).
3. Bar engine with starting system to blow out combustion chambers (→ Page 80).
4. Install injectors (→ Page 97).

6.10 Air Filter

6.10.1 Air filter replacement

Spare parts

Designation / Use	Part No.	Qty.
Air filter		

Remove air filter and install new one (→ Page 115)**.**

Reset signal ring of service indicator (→ Page 116)**.**

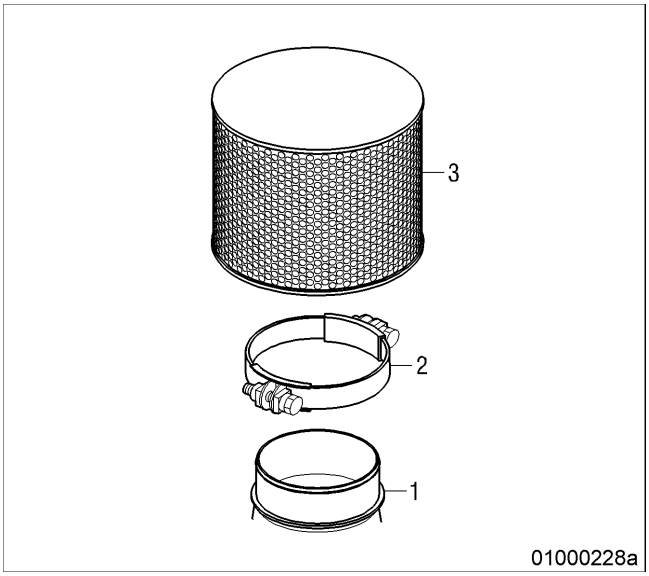
6.10.2 Air filter removal and installation

Preconditions

- Engine is stopped and starting disabled.

Air filter removal and installation

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



6.11 Air Intake

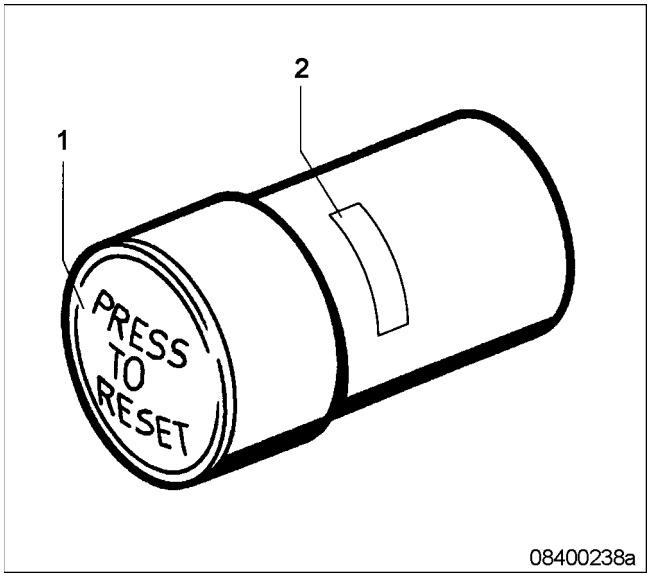
6.11.1 Service indicator – Signal ring position check

Preconditions

- Engine is stopped and starting disabled.

Signal ring position check

1. If the signal ring is completely visible in the control window (2), replace air filter (→ Page 114).
2. After installation of new filter, press reset button (1).
   Result: Engaged piston with signal ring moves back to initial position.



6.12 Starting System

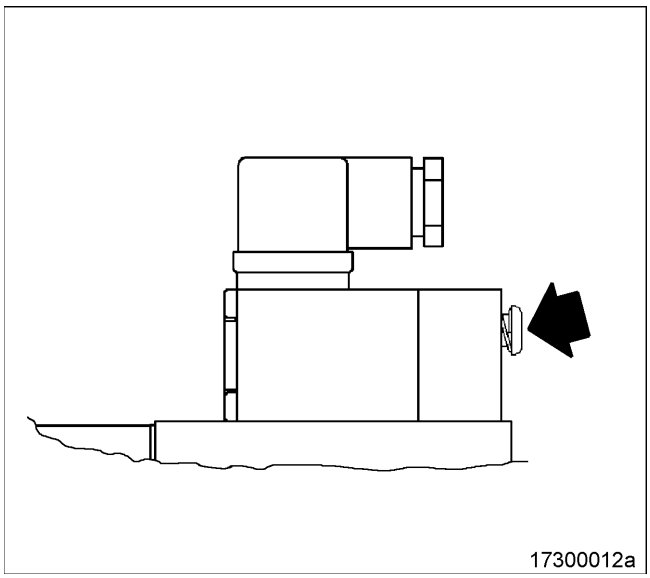
6.12.1 Air starter – manual operation

DANGER	Unguarded rotating and moving engine components. **Risk of serious injury — danger to life!** • Before barring or starting the engine, ensure that nobody is in the danger zone.

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

Air starter – manual operation

1. Press pushbutton for manual start and hold it.
2. Allow compressed air to enter the air starter until the engine fires evenly.
3. Release pushbutton.



6.13 Lube Oil System / Lube Oil Circuit

6.13.1 Engine oil – Change

Preconditions

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

Material

Designation / Use	Part No.	Qty.
Engine oil		

Spare parts

Designation / Use	Part No.	Qty.
Sealing ring		

WARNING

Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!

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

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

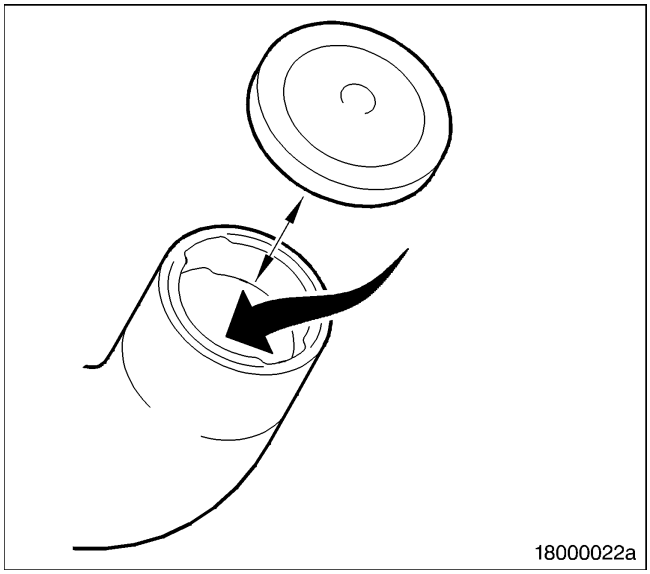
1. Provide a suitable container in which to collect the oil.
2. Remove drain plug and drain oil.
3. Install drain plug with new sealing ring.
4. Replace engine oil filter (→ Page 121).

Oil change using semirotary hand pump: Oil extraction

1. Provide a suitable container in which to collect the oil.
2. Extract all oil from oil pan using the hand pump.
3. Replace engine oil filter (→ Page 121).

Filling new oil

1. Open cover of filler neck.
2. Pour oil in at filler neck up to "max." mark at oil dipstick.
3. Close cover of filler neck.
4. Check engine oil level (→ Page 120).
5. After oil change and oil filter replacement, bar engine with starting system (→ Page 80).



6.13.2 Engine oil – Level check

Preconditions

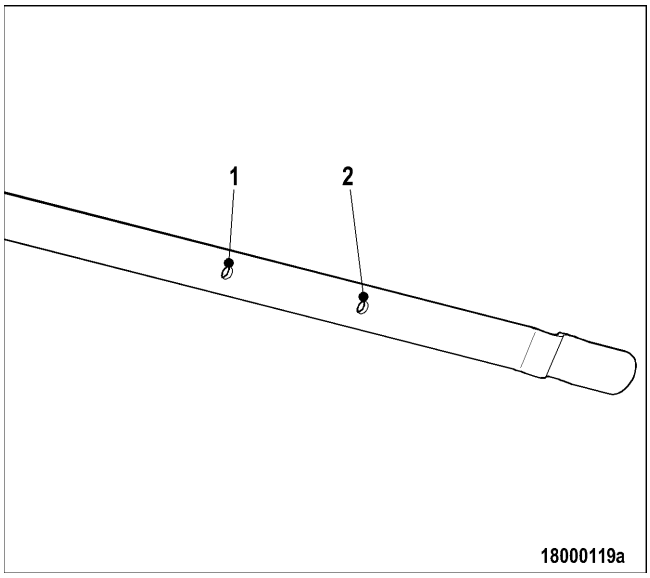
- Engine is stopped and starting disabled.

Checking oil level prior to engine start

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

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

3. The oil level must reach the mark (1) or exceed the mark (1) by up to 2 cm.
4. If necessary, top up to the mark (1) (→ Page 118).
5. Insert dipstick into guide tube up to the stop.



Checking oil level after the engine is stopped

1. 5 minutes after stopping the engine, remove oil dipstick from the guide tube and wipe it.
2. Insert dipstick into guide tube up to the stop, withdraw after approx. 10 seconds and check oil level.
3. Oil level must be between marks (1) and (2).
4. If necessary, top up to the mark (1) (→ Page 118).
5. Insert dipstick into guide tube up to the stop.

6.14 Oil Filtration / Cooling

6.14.1 Engine oil filter – Replacement

Preconditions

- Engine is stopped and starting disabled.

Special tools

Designation / Use	Part No.	Qty.
Filter wrench	F30379104	

Material

Designation / Use	Part No.	Qty.
Engine oil		

Spare parts

Designation / Use	Part No.	Qty.
Oil filter		

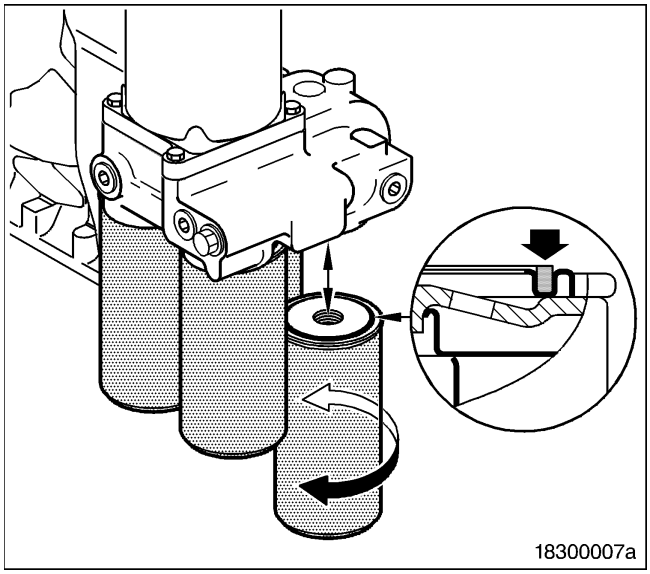
WARNING

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.

Engine oil filter – Replacement

1. Remove oil filter using filter wrench.
2. Clean the sealing surface of the filter head.
3. Check condition of the new sealing ring and coat it with oil.
4. Screw on and tighten new oil filter by hand.
5. Replace further oil filters in the same way.
6. Bar the engine with the starting system after each oil change and each filter replacement (→ Page 80).
7. Check oil level (→ Page 120).



6.14.2 Centrifugal oil filter – Cleaning and filter-sleeve replacement

Preconditions

- Engine is stopped and starting disabled.

Special tools

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

Material

Designation / Use	Part No.	Qty.
Cleaner Hakutex 60		

Spare parts

Designation / Use	Part No.	Qty.
Filter sleeve		
Sealing ring		
Sealing ring		

WARNING

Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!

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

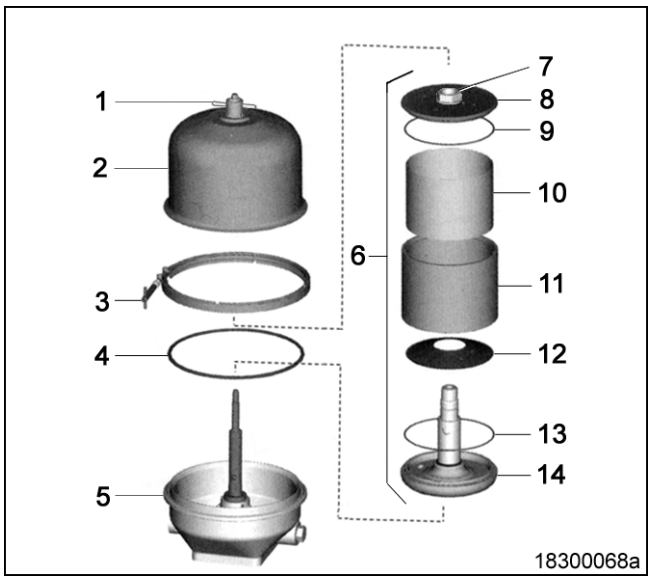
WARNING

Compressed air.
Risk of injury!

- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

Centrifugal oil filter – Cleaning and filter-sleeve replacement

1. Remove clamp (3).
2. Release Tommy nut (1) and take off cover (2).
3. Carefully lift rotor (6), allow oil to drain and remove from housing.
4. Holding the rotor (6) firmly, release rotor cover nut (7).
5. Take off rotor cover (8).
6. Remove filter sleeve (10).
7. Measure thickness of oil residues on filter sleeve (10).
8. If maximum layer thickness of oil residues exceeds 45 mm, shorten maintenance interval.
9. Disassemble rotor tube (11), conical disk (12) and rotor base (14).
10. Wash rotor cover (8), rotor tube (11), conical disk (12) and rotor base (14) with cleaner.



11. Blow out with compressed air.
12. Check sealing ring (13), fit new one if necessary.
13. Assemble rotor tube (11), conical disk (12) and rotor base (14) with sealing ring (13).
14. Insert new filter sleeve (10) in rotor tube (11) with the smooth paper surface facing the wall.
15. Check sealing ring (9), fit new one if necessary.
16. Mount rotor cover (8) with sealing ring (9).
17. Tighten rotor cover nut (7) with 35 Nm to 45 Nm.
18. Place rotor (6) in housing (5) and check for ease of movement.
19. Check sealing ring (4), fit new one if necessary.
20. Fit sealing ring (4) on housing (5).
21. Fit cover (2).
22. Tighten Tommy nut (1) by hand.
23. Fit clamp (3) and tighten with 8 Nm to 10 Nm.
24. Tighten cover nut (1) with 5 Nm to 7 Nm.

6.15 Coolant Circuit, General, HT Circuit

6.15.1 Engine coolant – Change

Material

Designation / Use	Part No.	Qty.
Engine coolant		

Drain engine coolant (→ Page 127).

Fill engine coolant system (→ Page 125).

6.15.2 Engine coolant filling

Preconditions

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

Material

Designation / Use	Part No.	Qty.
Coolant		

WARNING

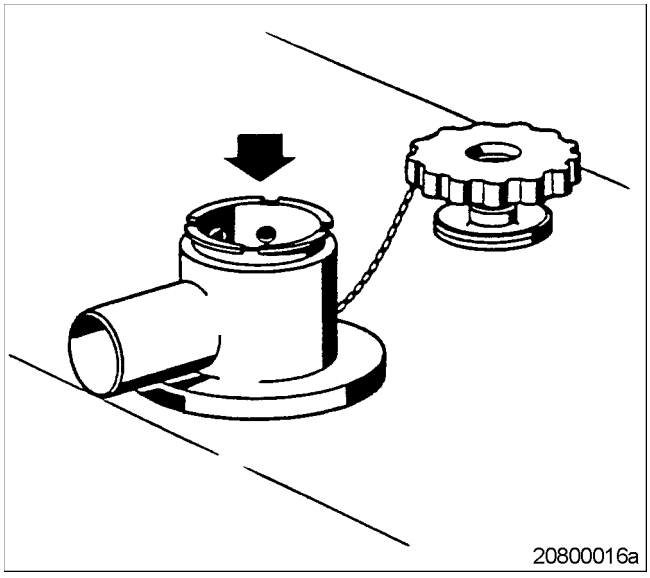
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

CAUTION

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

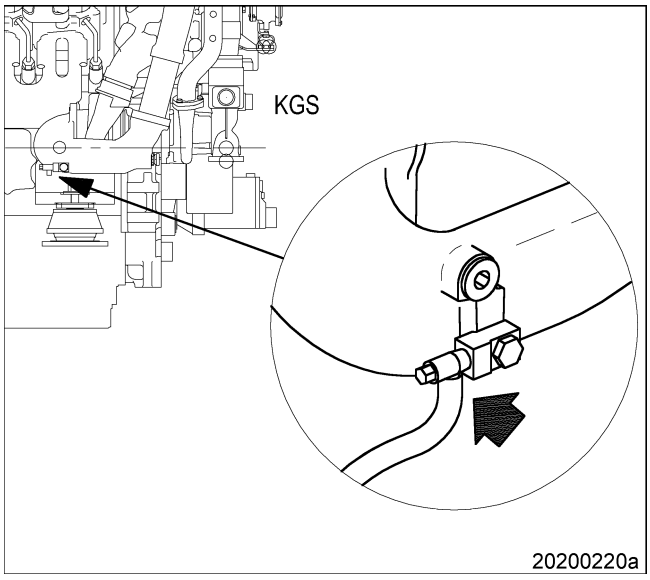
Preparatory steps

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



Filling coolant with pump

1. Connect appropriate pump with hose to drain valve.
2. Open drain valve and pump treated coolant into engine, until coolant level reaches lower edge of cast-in eye or marking plate on filler neck.
3. Close drain valve.
4. Disconnect pump and hose.



Filling coolant through filler neck

1. Alternatively: Fill coolant though filler neck on coolant expansion tank until level reaches cast-in eye or marking plate.
2. Check proper condition of breather valve, clean sealing faces if required.
3. Fit breather valve onto filler neck and close it.

Final steps

1. Start the engine and operate it at idle speed for some minutes.
2. Check coolant level (→ Page 128)and top up, if required.

6.15.3 Engine coolant draining

Preconditions

- Engine is stopped and starting disabled.

WARNING

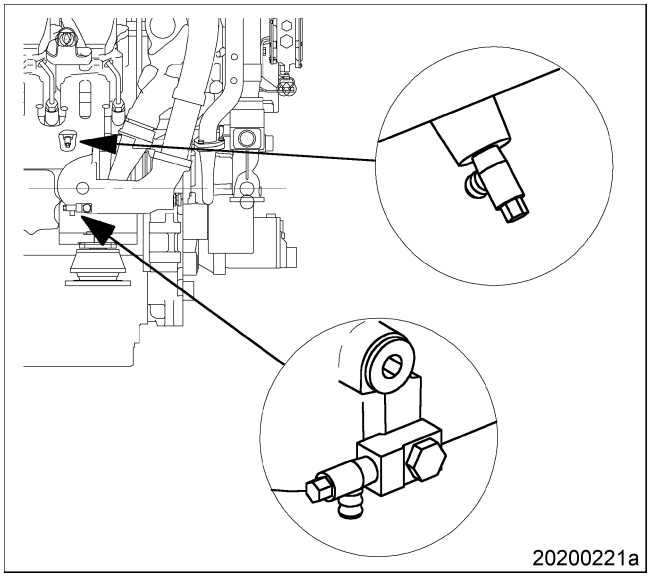
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Preparatory steps

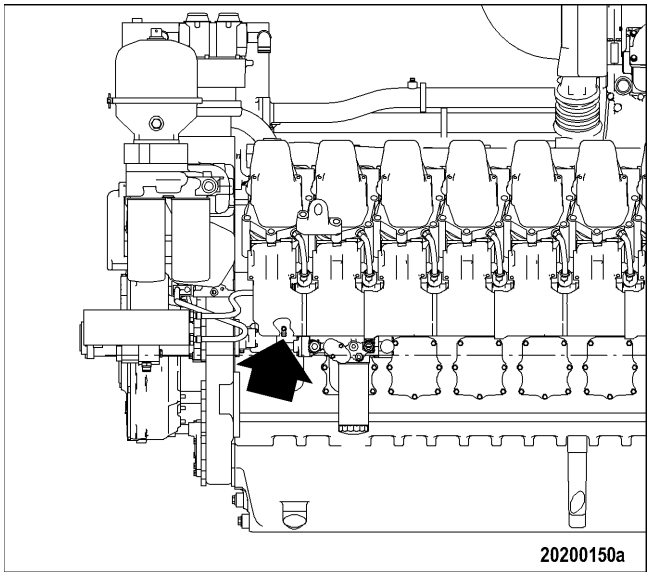
1. Provide an appropriate container to drain the coolant into.
2. Switch off preheating unit.

Engine coolant draining

1. Turn breather valve of filler neck on coolant expansion tank counterclockwise to first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Draw off precipitated corrosion inhibitor oil from the expansion tank through filler neck.
4. Open drain valves and drain plugs and drain coolant at the following points:
   - Preheating unit;
   - HT coolant pump elbow;
   - Crankcase, right side.



5. Additional drain point:
   - Crankcase, left side.
6. Seal all open drain points.
7. Fit breather valve onto filler neck and close it.



6.15.4 Engine coolant – Level check

Preconditions

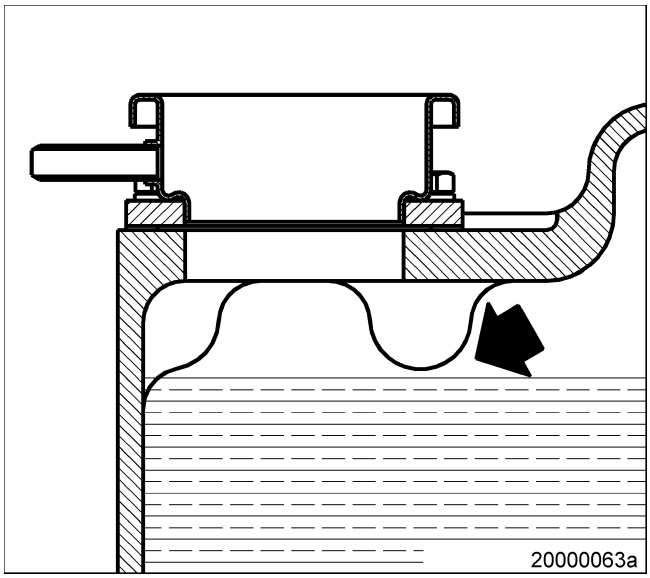
- Engine is stopped and starting disabled.
- MTU Fluids and Lubricants Specification (A001061/..) is available.

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.

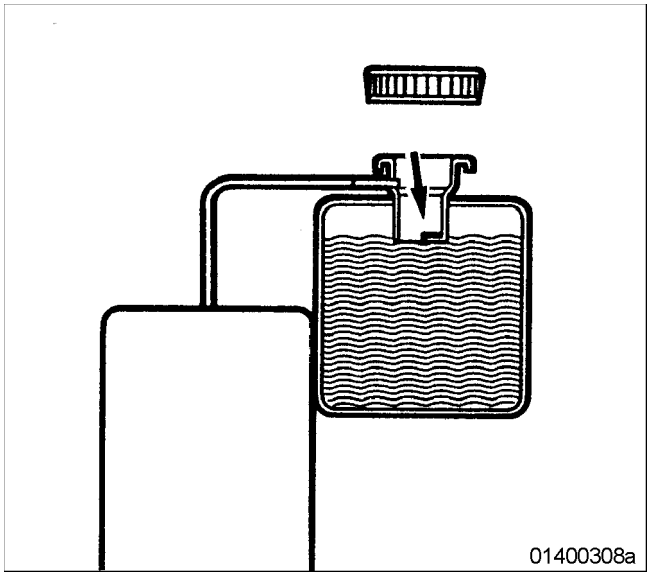
Coolant-level check at filler neck:

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



Coolant-level check at external cooler:

1. Check coolant level (coolant must be visible at marking plate).
2. If required, top up with treated coolant (→ Page 125).
3. Check and clean breather valve.
4. Set breather valve onto filler neck and close it.



Coolant-level check by means of level sensor:

1. Switch on engine control system and check readings on the display.
2. If required, top up with treated coolant (→ Page 125).

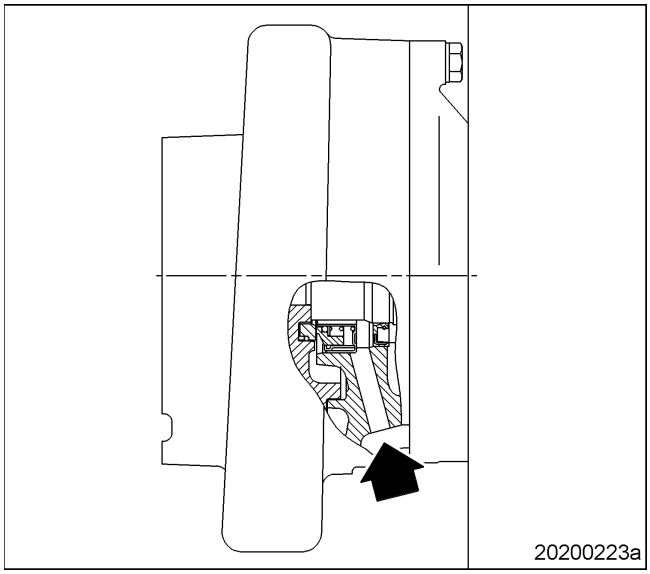
6.15.5 Engine coolant pump – Relief bore check

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

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

Engine coolant pump – Relief bore check

1. Check relief bore for oil and water discharge.
2. Stop engine (→ Page 46) and disable engine start.
3. Clean the relief bore with a wire if it is dirty.
   - Permissible water discharge: up to 10 drops per hour;
   - Permissible oil discharge: up to 5 drops per hour.
4. If discharge exceeds the specified limits: Contact Service.



6.16 LT Circuit

6.16.1 Charge-air coolant filling

Preconditions

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

Material

Designation / Use	Part No.	Qty.
Coolant		

Spare parts

Designation / Use	Part No.	Qty.
Sealing ring		

WARNING

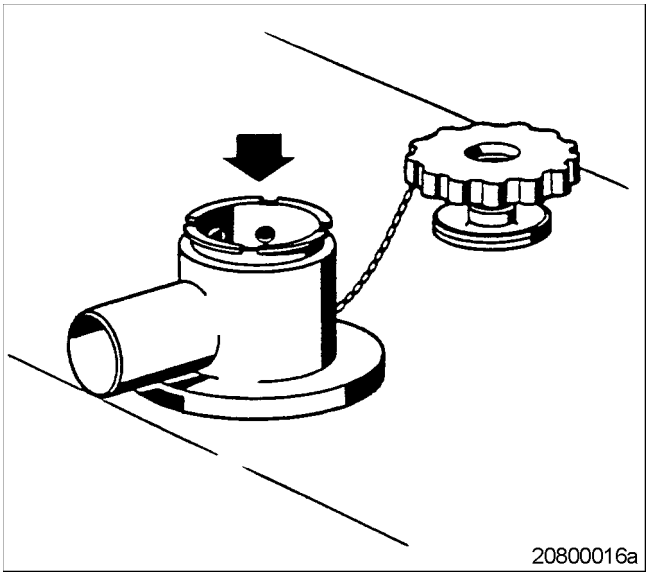
Engine noise above 85 dB (A).
Risk of damage to hearing!
- Wear ear protectors.

CAUTION

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

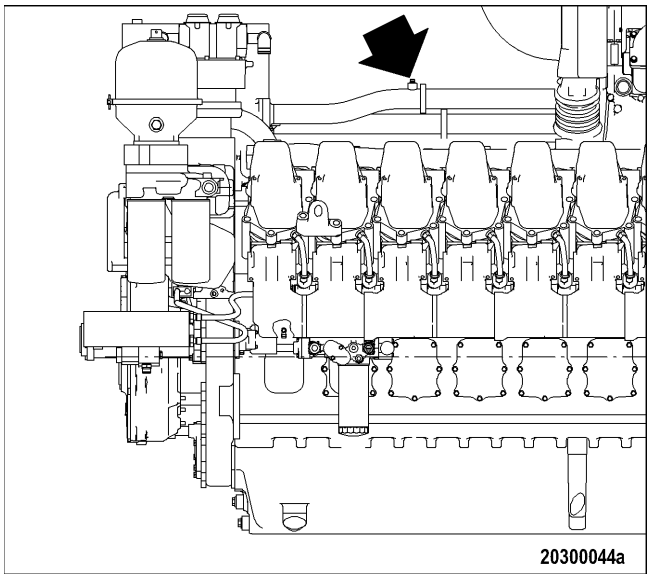
Preparatory steps

1. Turn breather valve of filler neck on coolant expansion tank counterclockwise to first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Remove plug from filling point on coolant line to charge-air cooler.



Charge-air coolant filling

1. Pour treated coolant via the filling point on the coolant line to the intercooler and via the filler neck of the expansion tank until coolant is visible at the marking plate.
2. Install plugs with new sealing rings at the filling points.
3. Check proper condition of breather valve, clean sealing faces if required.
4. Fit breather valve onto filler neck and close it.



Final steps

1. Start the engine and operate it at idle speed for some minutes.
2. Check coolant level (→ Page 134).

6.16.2 Charge-air coolant draining

Preconditions

- Engine is stopped and starting disabled.

Spare parts

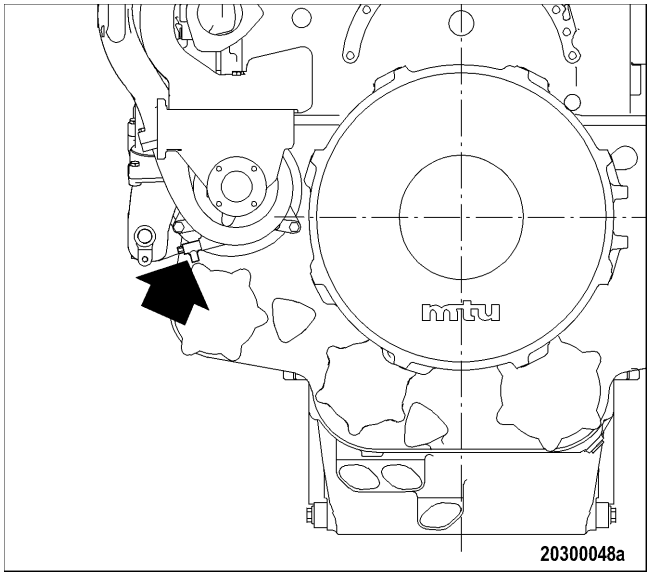
Designation / Use	Part No.	Qty.
Sealing ring		

WARNING

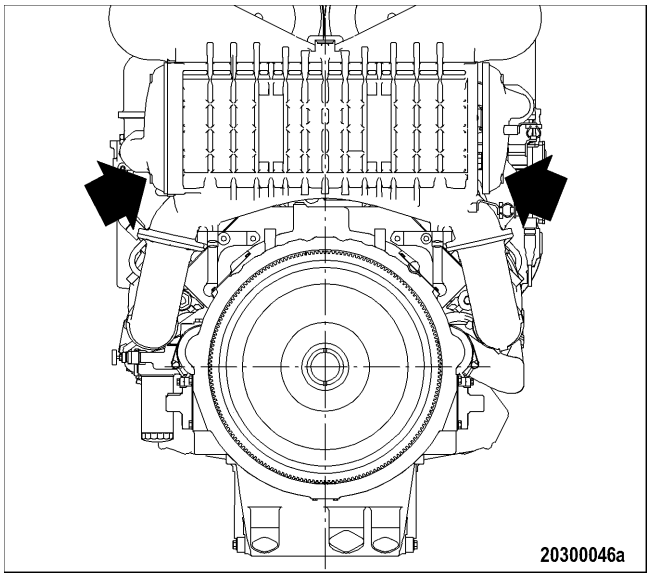
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Charge-air coolant draining

1. Provide an appropriate container to drain the coolant into.
2. Turn breather valve of filler neck on coolant expansion tank counterclockwise to first stop and allow pressure to escape.
3. Continue to turn breather valve counterclockwise and remove.
4. Draw off precipitated corrosion inhibitor oil from the expansion tank through filler neck.
5. Open drain cocks and drain plugs and drain coolant at the following points:
   - at the LT cooling pump



6. Draining of residual coolant:
   - at intercooler, left and right side
7. Close all drain valves and install drain plugs with new sealing rings.
8. Fit breather valve onto filler neck and close it.



6.16.3 Charge-air coolant change

Material

Designation / Use	Part No.	Qty.
Coolant		

Drain charge-air coolant system (→ Page 132)**.**

Fill charge-air coolant system (→ Page 130)**.**

6.16.4 Charge-air coolant level check

Preconditions

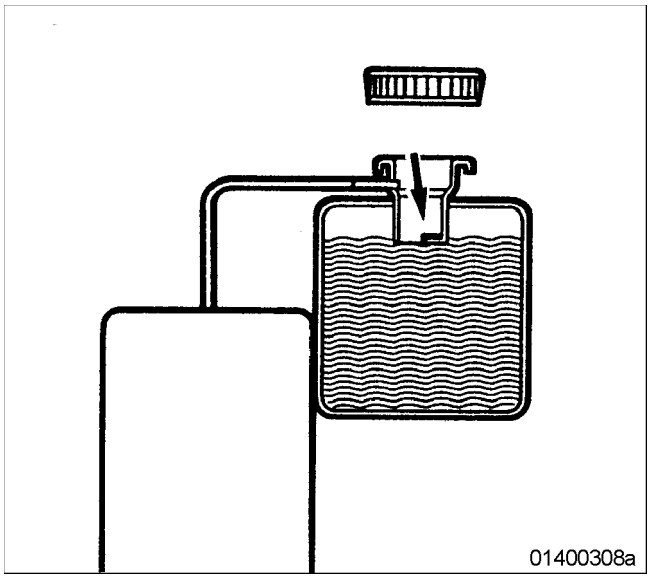
- Engine is stopped and starting disabled.
- MTU Fluids and Lubricants Specification (A001061/..) is available.

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.

Charge-air coolant level check at filler neck:

1. Turn breather valve of filler neck on coolant expansion tank counterclockwise to first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Check coolant level (coolant must be visible at marking plate).
4. If required, top up with treated coolant (→ Page 130).
5. Check proper condition of breather valve, clean sealing faces if required.
6. Fit breather valve onto filler neck and close it.



Charge-air coolant level check by means of level sensor:

1. Switch engine control system ON and check display (coolant level is automatically monitored by the engine control system).
2. If required, top up with treated coolant (→ Page 130).

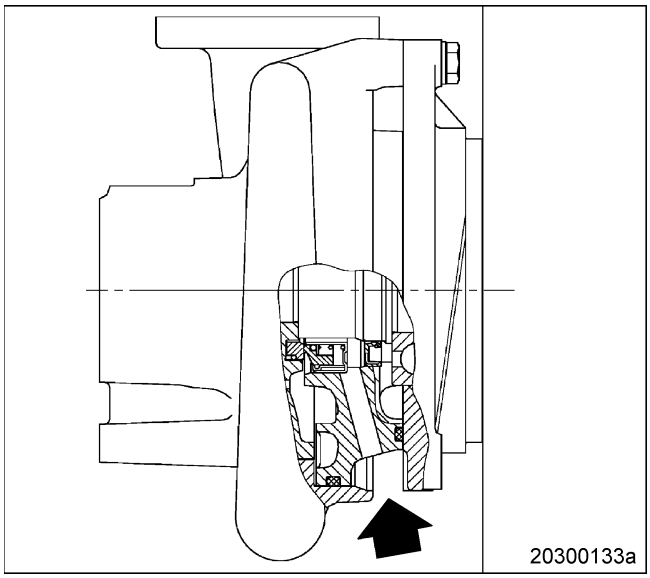
6.16.5 Charge-air coolant pump – Relief bore check

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

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

Charge-air coolant pump – Relief bore check

1. Check relief bore for oil and water discharge.
2. Stop the engine (→ Page 46) and disable engine start, observe general safety instructions.
3. Clean the relief bore with a wire if it is dirty.
   - Permissible water discharge: up to 10 drops per hour;
   - Permissible oil discharge: up to 5 drops per hour;
4. If discharge exceeds the specified limits: Contact Service.

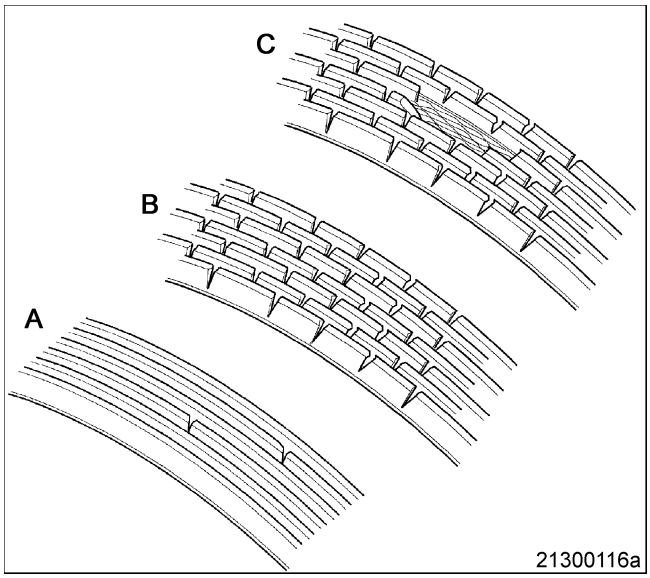


6.17 Belt Drive

6.17.1 Drive belt – Condition check

Preconditions

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



Item	Findings	Task
Drive belt A	Breaks in a few individual places	None
Drive belt	Belt is oily, shows signs of overheating	Replace (→ Page 139)
Drive belt B	Breaks around the entire circumference	
Drive belt C	Areas of belt material missing	

6.18 Battery-charging Generator

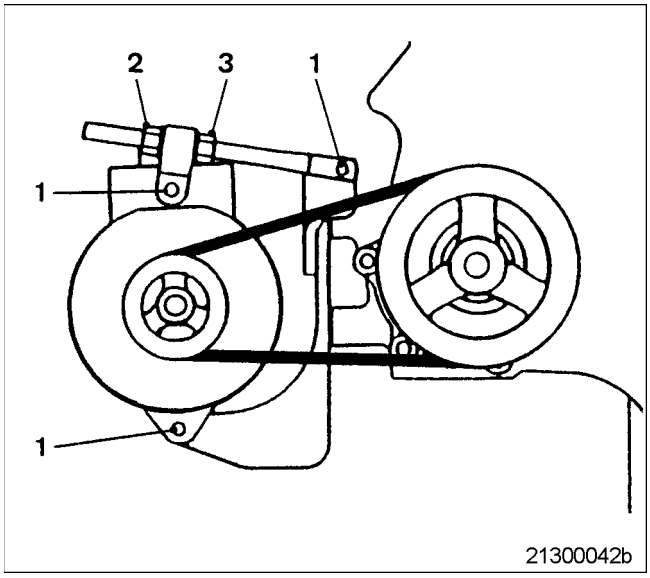
6.18.1 Battery-charging generator drive – Drive belt tension adjustment

Preconditions

- Engine is stopped and starting disabled.

Adjusting belt tension

1. Loosen locknut (2) and screws (1).
2. Tension drive belt with tensioning nut (3) and check belt tension (→ Page 138).
3. Tighten locknut (2).
4. Tighten screws (1).
5. Install guard cover.



6.18.2 Battery-charging generator drive – Drive belt tension check

Preconditions

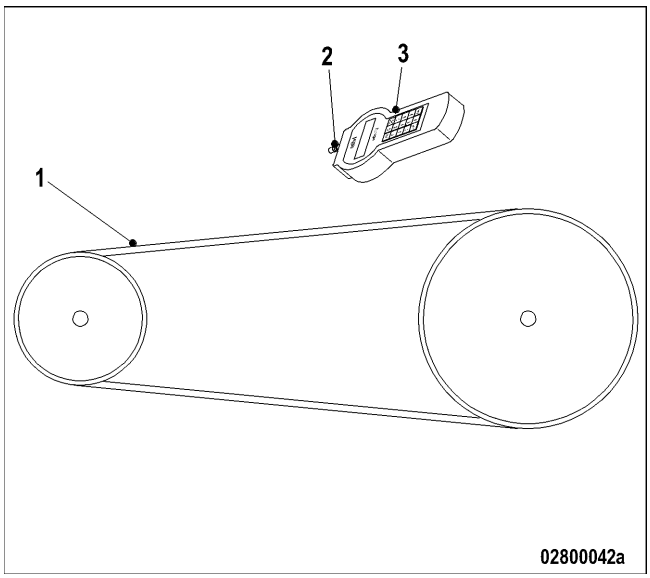
- Engine is stopped and starting disabled.

Special tools

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

Preparatory steps

1. Remove guard cover.
2. Check belt condition visually (→ Page 136).



Checking belt tension

1. Fit measuring head (2) on belt-tension tester (3) and hit drive belt (1) with a suitable tool.
2. Hold belt tension tester over belt drive until the measured value is indicated. For specifications, refer to table below.

Application	Value for new drive belt	Value for used drive belt
Series 4000	92 Hz to 96 Hz	80 Hz to 84 Hz

3. If the measured values deviate from the specifications above, adjust drive belt tension (→ Page 137).

6.18.3 Battery-charging generator drive – Drive belt replacement

Preconditions

- Engine is stopped and starting disabled.

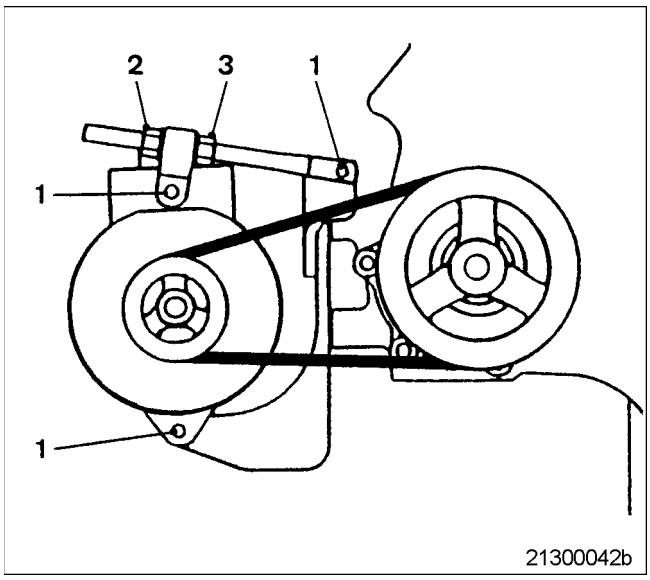
Spare parts

Designation / Use	Part No.	Qty.
Drive belt		

Note: In the event of drive belt failure during engine operation fit a new drive belt as quickly as possible. Noncompliance with these instructions may lead to severe consequential damage to drive unit and gear train, since pretension by the drive belt is no longer provided. Therefore, engine operation without drive-belt connection is not allowed.

Battery-charging generator drive – Drive belt replacement

1. Remove guard cover.
2. Loosen locknut (2) and screws (1).
3. Release drive belt with tensioning nut (3) and take off belt.
4. Clean belt pulleys.
5. Fit new drive belt.
6. Tension drive belt with tensioning nut (3) and check belt tension (→ Page 137).
7. Tighten locknut (2).
8. Tighten screws (1).
9. Install guard cover.
10. Check belt tension after 30 minutes and again after 8 hours engine runtime.



6.19 Engine Mounts

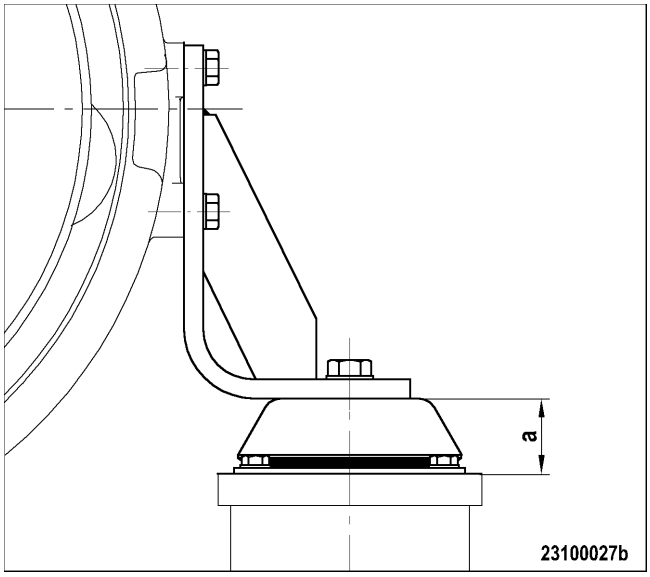
6.19.1 Engine/generator mounting – Resilient element check

Preconditions

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

Engine/generator mounting – Resilient element check

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



Setting dimension check

1. Measure dimension (a) with Vernier caliper.
2. If dimension (a) is less than 57 mm, resilient elements must be replaced. Contact Service.

6.20 Wiring, General, for Engine / Gearbox / Plant

6.20.1 Engine wiring check

Preconditions

- Engine is stopped and starting disabled.

Material

Designation / Use	Part No.	Qty.
Isopropyl alcohol		

Engine wiring check

1. Check securing screws of cable clamps on the engine and tighten loose screw connections.
2. Make certain that cables are securely seated in clamps and cannot move freely.
3. Check cable binders for secure seating, tighten loose cable binders.
4. Replace defective cable binders.
5. Inspect electrical components visually for damage:
   - connector housings;
   - contacts;
   - connector sockets;
   - cables and terminals;
   - plug-in contacts.
6. If conductors are damaged, contact Service.
7. Clean dirty connector housings, sockets and contacts with isopropyl alcohol.

6.21 Accessories for (Electronic) Engine Governor / Control System

6.21.1 ECU and connectors – Cleaning

Preconditions

- Engine is stopped and starting disabled.

Special tools

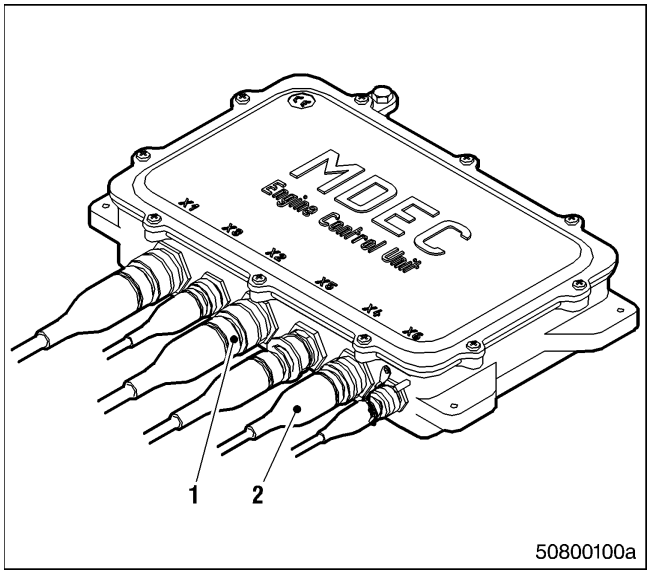
Designation / Use	Part No.	Qty.
Connector pliers	0135315483	1

Material

Designation / Use	Part No.	Qty.
Isopropyl alcohol		

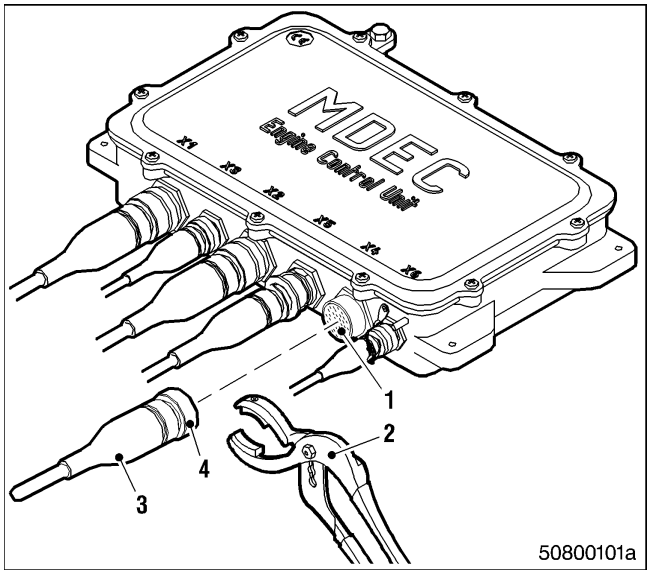
ECU and connectors – Cleaning

1. Remove coarse dirt from housing surface using a cloth moistened with isopropyl alcohol.
2. Remove dirt from surface of connectors (1), connector sockets and shrink sleeves (2) using a cloth moistened with isopropyl alcohol.
3. Check legibility of cable labels. Clean or replace illegible labels.



Cleaning severely contaminated connectors on ECU

1. Use connector pliers (2) to disengage bayonet union nut (4) and withdraw connector (3).
2. Clean connector housings, connector socket housings (1) and all contacts with isopropyl alcohol.
3. When connectors, sockets and all contacts are dry: Install connectors and check plug-in connection on ECU (→ Page 144).



6.21.2 ECU – Checking plug-in connections

Preconditions

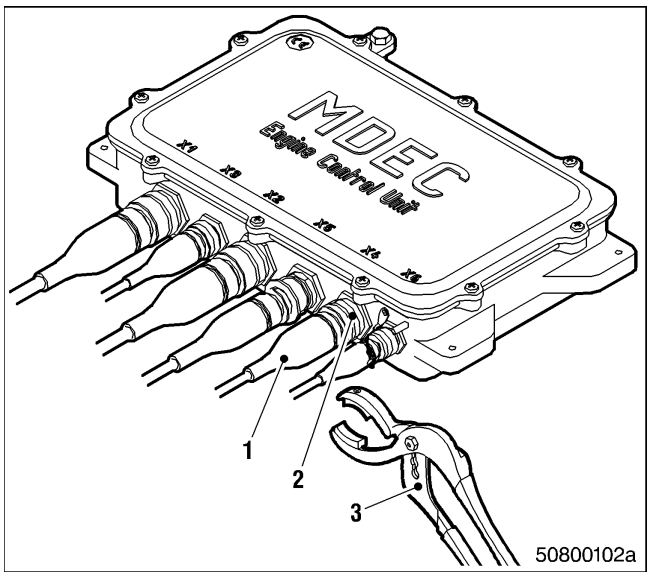
- Engine is stopped and starting disabled.

Special tools

Designation / Use	Part No.	Qty.
Connector pliers	0135315483	1

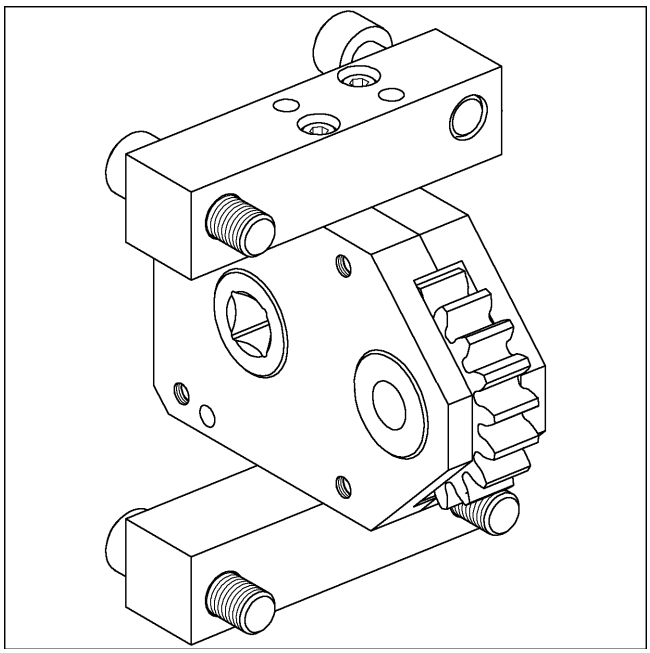
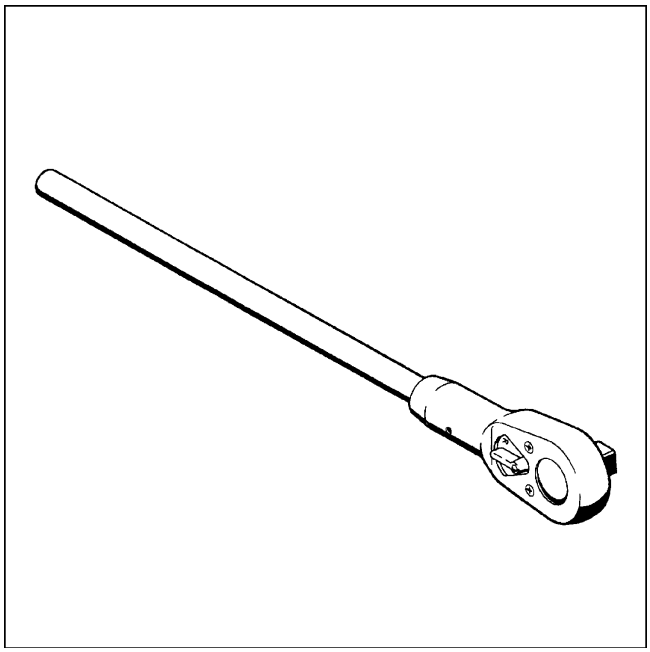
ECU – Checking plug-in connections

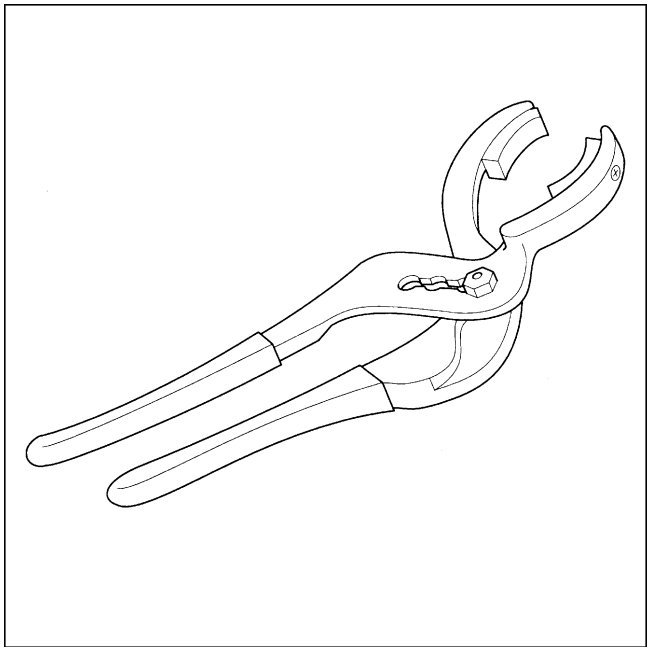
1. Use connector pliers (3) to make certain that all plug-in connections of ECU are securely seated.
2. Tighten loose bayonet union nuts (2) with connector pliers (3) by turning them clockwise until they lock into place.
3. Ensure that unassigned connector sockets are protected with covering caps.
4. If bayonet union nut is defective, contact Service.

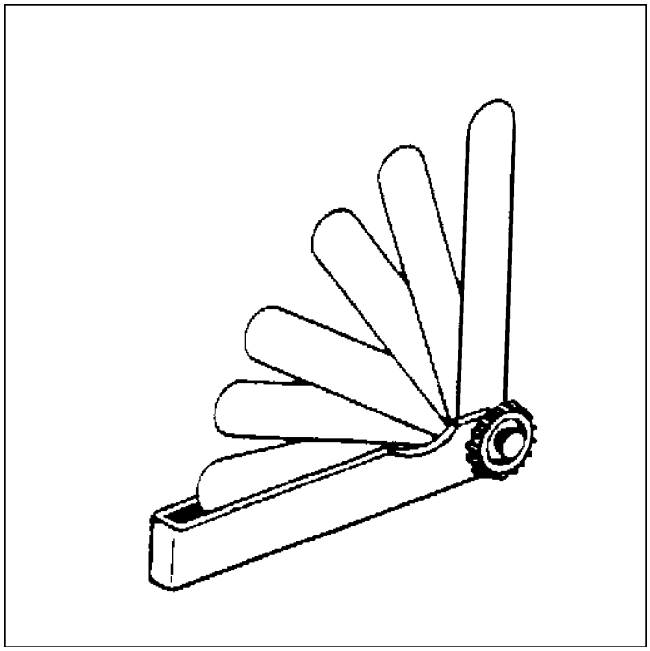


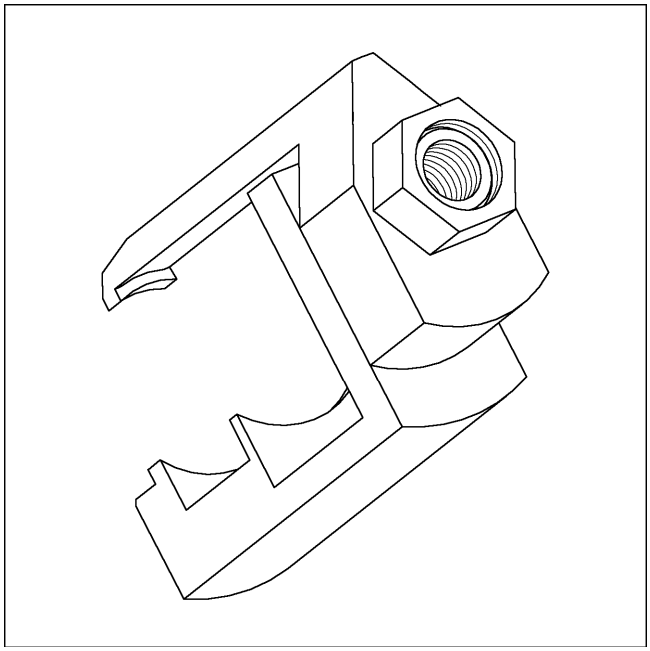
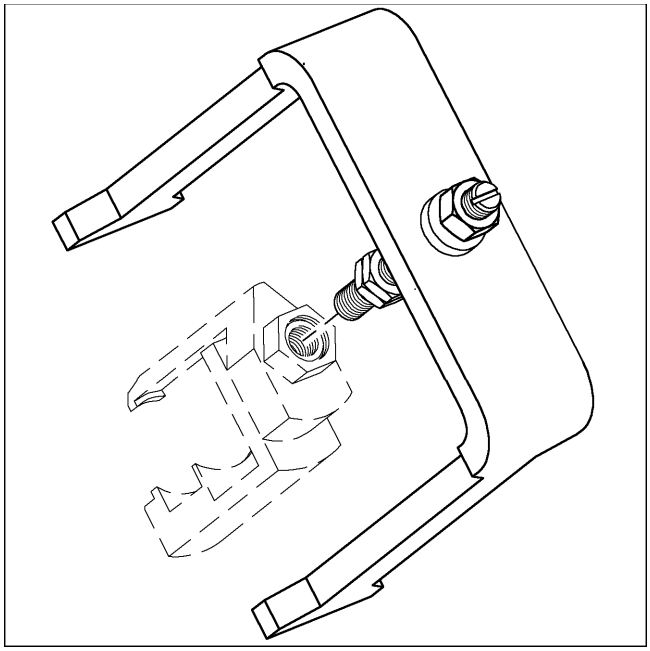
7 Special Tools

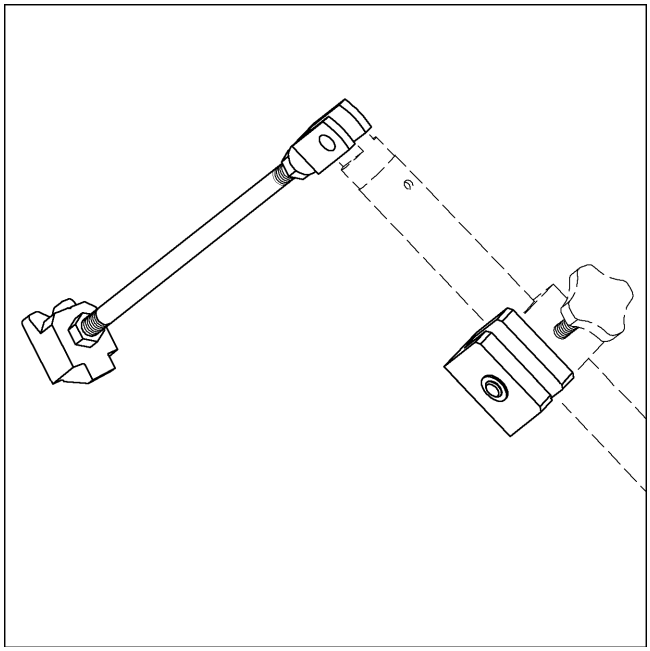
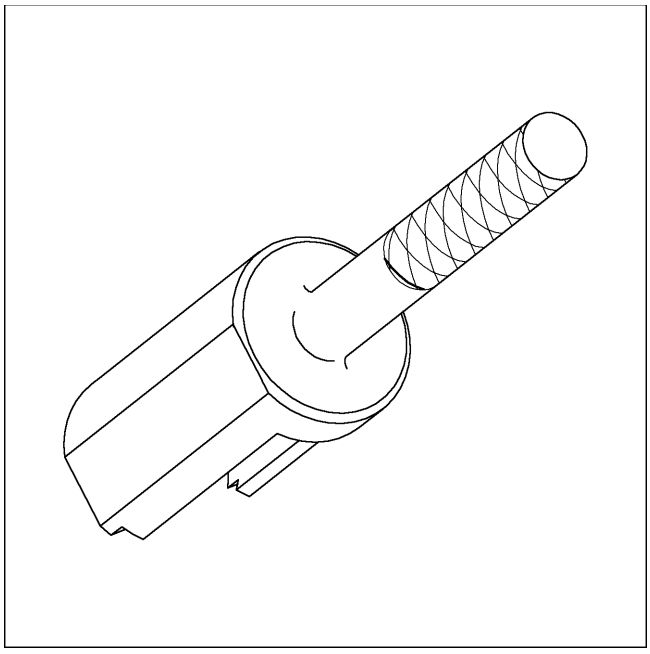
7.1 Special tools

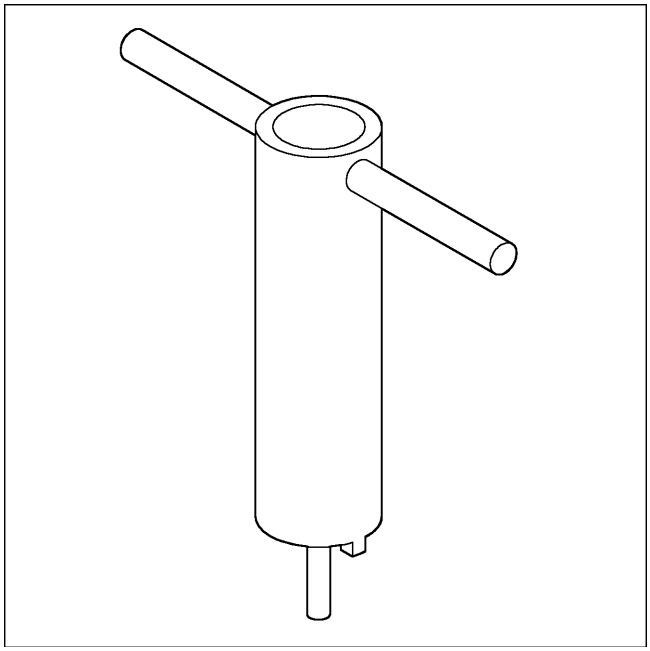
Part No.	Designation / Use	Qty.	
F6555766	Barring tool	1	
F30006212	Ratchet	1	

Part No.	Designation / Use	Qty.	
0135315483	Connector pliers	1	
Y20097353	Rigid endoscope	1	
F30027336	Torque wrench 6-50 Nm	1	

Part No.	Designation / Use	Qty.	
Y20010128	Feeler gauge	1	
F30510423	Torque wrench 10-60 Nm	1	
F30047446	Torque wrench 60-320 Nm	1	
F30039518	Ring wrench adapter	1	
F30510423	Torque wrench 10-60 Nm	1	

Part No.	Designation / Use	Qty.	
F30377769	Puller for injector	1	
F6557991	Puller bracket for injector	1	

Part No.	Designation / Use	Qty.	
F6557952	Force-in lever for injector	1	
F6555197	Lever for force-in lever	1	
F30378403	Injector installation jig	1	

Part No.	Designation / Use	Qty.	
F30379005	Slotted screwdriver	1	
0015384230	Torque wrench 0.5-5 Nm	1	
F30379104	Filter wrench	1	
Y4345711	Optibell 2 belt tension tester	1	

8 Annex

8.1 Manufacturer’s documentation

See Manufacturer’s documentation.

8.2 MTU contact person/service partner

You will find the MTU contact person/service partner for your region at www.mtu-online.com, worldwide, in the left-hand navigation margin.

8.3 Abbreviations

Abbreviation	Meaning	Explanation
A/D	Analog/Digital	Transformer: transforms sensor voltages into numeric values
AFRS	Air Filter Restriction Sensor	
ANSI	American National Standards Institute	
ATL	Abgasturbolader	Exhaust turbocharger (ETC)
ATS	Air Temperature Sensor	
BR	Baureihe	Engine Series
CAN	Controller Area Network	
CEL	Check Engine Light	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
CPS	Coolant pressure sensor	Monitors coolant pressure
CTS	Coolant temperature sensor	Monitors coolant temperature
DDEC	Detroit Diesel Electronic Controls	Engine control system made by Detroit Diesel
DDL	Diagnostic Data Link	
DDR	Diagnostic Data Reader	
DIN	Deutsches Institut für Normung e. V.	German Standardization Organization, at the same time identifier of German standards ("Deutsche Industrie-Norm")
DL	Default Lost	Alarm: Default CAN bus failure
DT	Diagnostic Tool	
ECM	Electronic Control Module	Electronic control unit of the DDEC system
ECU	Engine Control Unit	Engine governor
EDM	Engine Data Module	
EEPROM	Electrically Erasable Programmable Read Only Memory	
EFPA	Electronic Foot Pedal Assembly	
EGR	Exhaust Gas Recirculation	
EMU	Engine Monitoring Unit	
EUI	Electronic Unit Injector	
FLS	Fluids and Lubricants Specification	MTU Publication No. A01061/..
FPS	Fuel Pressure Sensor	Monitors fuel pressure

Abbreviation	Meaning	Explanation
FRS	Fuel Differential Pressure Sensor	
FTS	Fuel Temperature Sensor	Monitors fuel temperature
GND	Ground	
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	
INJ	Injector	
ISO	International Organization for Standardization	
KGS	Kraftgegenseite	Engine free end in accordance with DIN ISO 1204
KS	Kraftseite	Engine driving end in accordance with DIN ISO 1204
LED	Light Emitting Diode	
LO	LOW	Alarm: Measured value lower than 1st minimum limit
LOLO	Low Low	Alarm: Measured value lower than 2nd minimum limit
LSG	Limiting Speed Governor	
N/A	Not Applicable	
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 (TDC)
PAN	Panel	
PIM	Peripheral Interface Module	
PWM	Pulsewidth modulated	
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

Abbreviation	Meaning	Explanation
SEL	Stop Engine Light	1st function: Warning lamp (stop engine and rectify fault) 2nd function: Read out fault codes
SID	System Identifier	
SPC	Spare Parts Catalog	
SRS	Synchronous Reference Sensor	TDC cylinder 1
SS	Safety System	Indicated alarm is initiated by the safety system
TBS	Turbocharger Boost Sensor	Monitors charge-air pressure
TC	Tools Catalog	
TCI	Turbo Compressor Inlet	
TCO	Turbo Compressor Outlet	
TD	Transmitter Deviation	Alarm: Sensor-comparison failure
TPS	Throttle Position Sensor	
TRS	Timing Reference Sensor	
T-xyz	Temperature-xyz	Temperature measuring point xyz
UT	Unterer Totpunkt	Bottom dead center (BDC)
VNT	Variable nozzle turbine	
VSG	Variable Speed Governor	
VSS	Vehicle Speed Sensor	

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