Use and maintenance manual

MTU
Diesel Engine
12V 2000 G23/43/63/83
16V 2000 G23/43/63/83
18V 2000 G63/83

Réf. constructeur : M015560/00E

Réf. GPAO : 33522055801

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 concernant 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.).

Staccare “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.:
No du moteur:
No de motor:
Motore N.:
No. do motor:

Auftragsnr.:
MTU works order No.:
No de commande:
No 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 bugue / 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:

Inbetriebnahmemeldung

Commissioning Note

Notice de mise en service

Aviso de puesta en servicio

Avviso di messa in servizio

Participação da colocação em serviço

Amendment Service!
Any changes in contents will be sent to you in the form of an amendment, provided you complete the reverse of this receipt card and return it to us.

Postcard

MTU Friedrichshafen GmbH
Department SCT
88040 Friedrichshafen
GERMANY

Please mark all filed amendments here.

No.	Date	Name
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		

Please use block capitals!

Receipt Amendment No.

1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
16.	

Publication number: **M015560/00E**

Name .....

Manufacturer .....

Department .....

Fax .....Telephone.....

Street .....

Postal box number .....

(Postal code) City .....

Country .....

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.

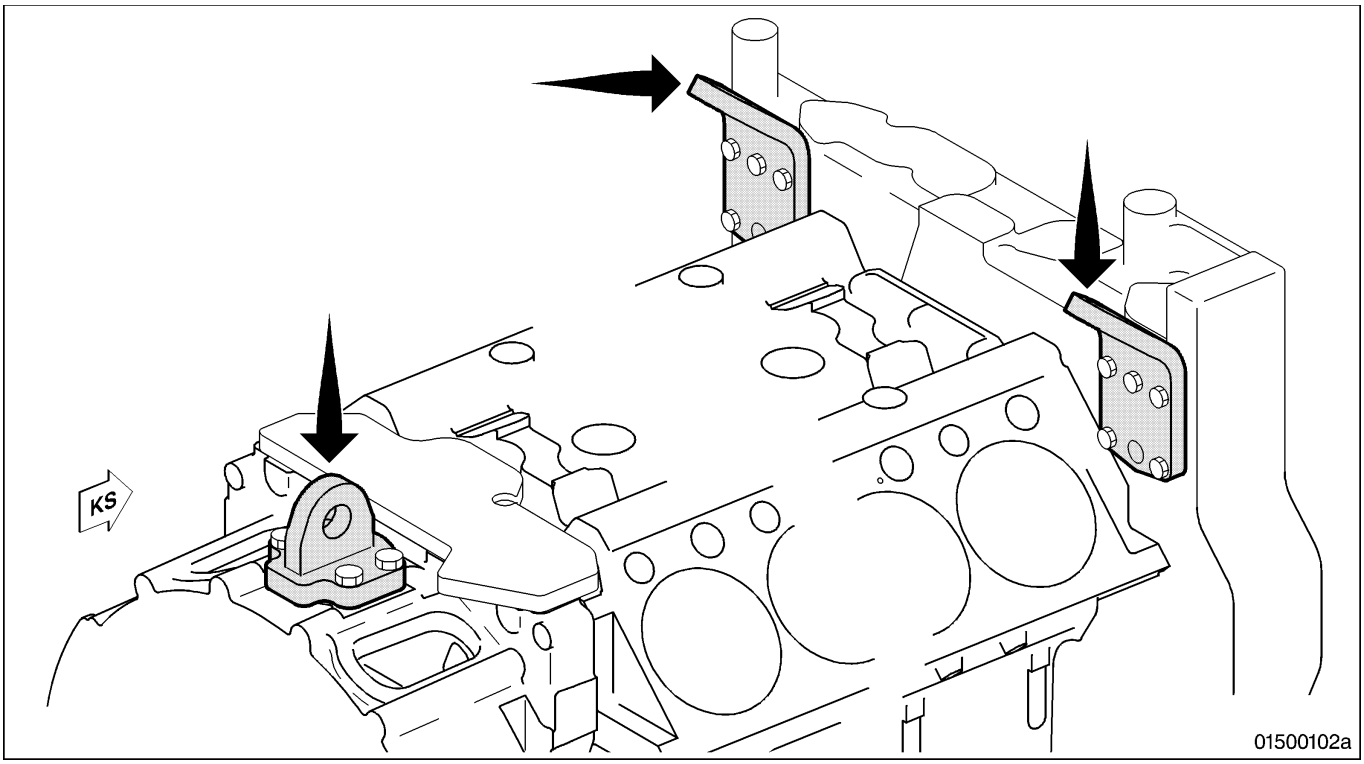
Depending on the kind of work, use additional protective equipment, e.g. protective goggles, gloves, helmet, apron.

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

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.

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

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 transport. 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

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

Compliance with maintenance and repair specifications is an important safety factor.

Unless expressly permitted, no maintenance or repair work must be carried out with the engine running. Secure the engine against inadvertent starting. With electric starter, disconnect the battery. With pneumatic starter, close main shut-off valve of compressed-air system and release pressure from compressed-air supply line. Attach sign "Do not operate" in operating area or to control equipment. 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. Maintenance and repair work must only be carried out by authorized, qualified personnel.

Use only proper, calibrated tools.

Do not work on engines or components which are only held by lifting equipment or crane. Always support these components in accordance with regulations on suitable frames or stands before beginning any maintenance or repair work.

Before barring the engine, make sure that nobody is standing in the danger zone. After working on the engine, check that all guards have been reinstalled and that all tools and loose components 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.

During maintenance and repair work, take care not to damage the fuel lines. 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. When subjected to fire or temperatures above 300 °C the material degenerates, giving off hydrogen fluoride gas. 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!

Do not touch hot components of the compressor and the exhaust system ⇒ Risk of injury!

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 and causing scoring or burning at bearings, sliding surfaces and tooth flanks, which can lead to pitting or other material damage).

Never position the welding power supply cable adjacent to, or crossing MTU plant wiring harnesses. (The welding current could be induced in the cable harnesses and could possibly damage the electrical plant).

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

Authorization must be obtained from the superior prior to commencing maintenance and repair work and switching off parts of the electronic system required for this.

Prior to working on assemblies, the power of the appropriate areas must be switched off. Any measures requiring 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.

Always tighten connectors with connector pliers.

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 fluids near the engine.

Do not weld pipes and components carrying oil or fuel. Before welding, clean with an inflammable 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 noises 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 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 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 in other than spray booths equipped with extractors, ensure good ventilation. Make sure that adjacent work areas are not affected.
- No naked flame!
- No smoking.
- Observe fire prevention regulations!
- It is absolutely necessary to wear masks providing protection against paint and solvent fumes.

Liquid oxygen

- Liquid oxygen is highly inflammable.
- Liquid oxygen should only be stored in small quantities and in regulation containers (without fixed seals)!
- Do not bring liquid oxygen in contact with the body (hands), as this causes frostbite and possibly the loss of tissue.
- No smoking, no naked flame, risk of explosion! Excessive oxygen in the air leads to explosive combustion.

- Do not store combustible substances, e.g. oils and greases, within 5 m of the working area!
- Under no circumstances should clothing be oily or greasy.
- Do not allow vapors to penetrate clothing! Oxygen enrichment in fabric can cause working clothes to ignite suddenly!
- After working with liquid oxygen, do not smoke until clothing is free of vapors!
- Avoid all knocks and jars to the containers, fixtures or workpieces.

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 numbing.
- Wear protective clothing, including gloves and 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 tanks from which it can be extracted.

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

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

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

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

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

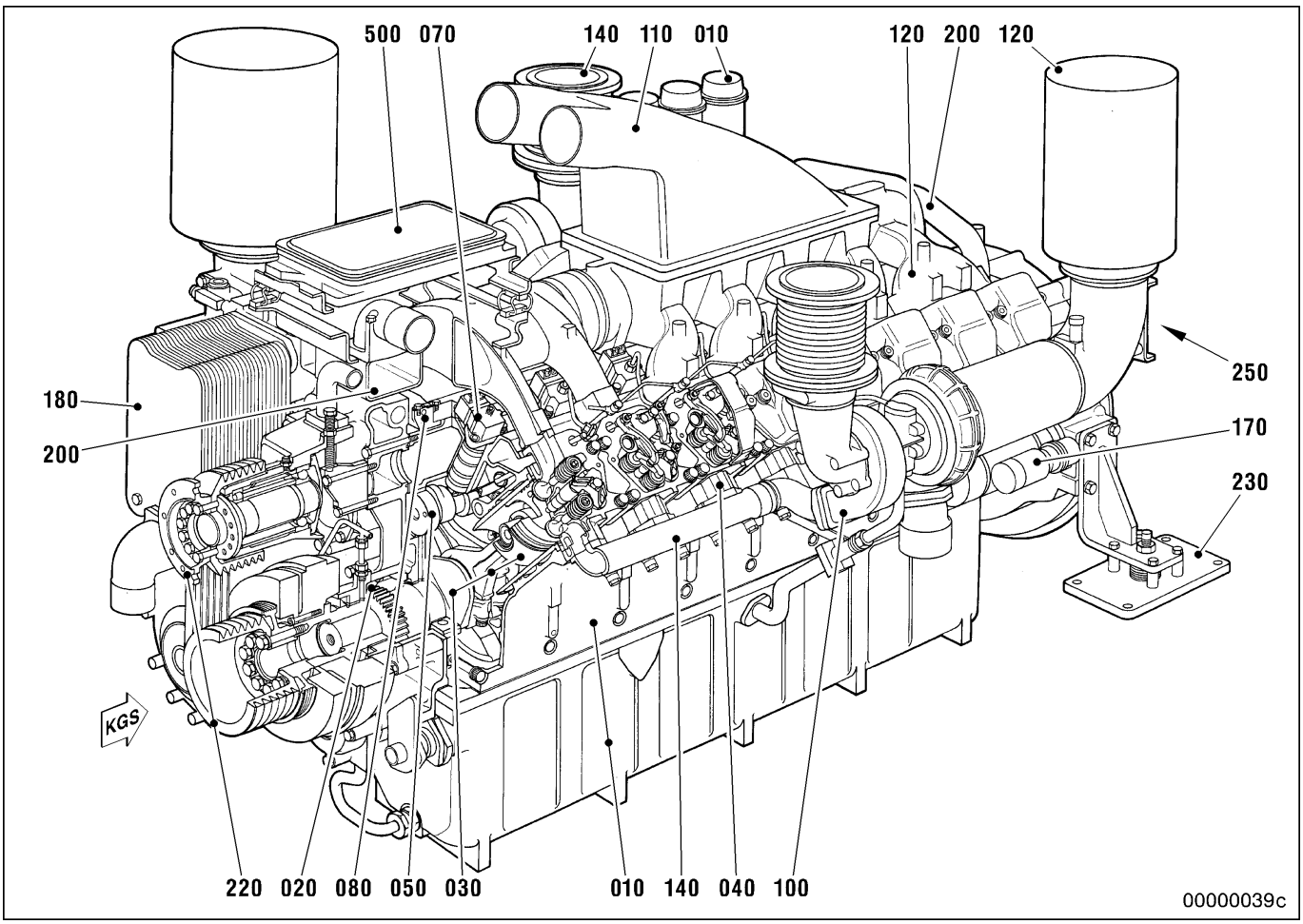
1. Read and become acquainted with all cautions and symbols before operating or repairing this product.
2. Pass on all safety instructions to your operating, maintenance, repair and transport personnel!

2 Product Summary

2.1 Engine Layout

2.1.1 Engine layout

Illustration is applicable to 8/12/16/18V 2000 Gxy engines



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 systems, general electric devices

Engine model designation

Key to the engine model designations 812/16/18V 2000 Gxy

8/12/16/18	Number of cylinders
V	Cylinder configuration: V engine
2000	Series
G	Application
X	Application segment (2, 4, 6, 8)
Y	Design index (0,1, 2,...)

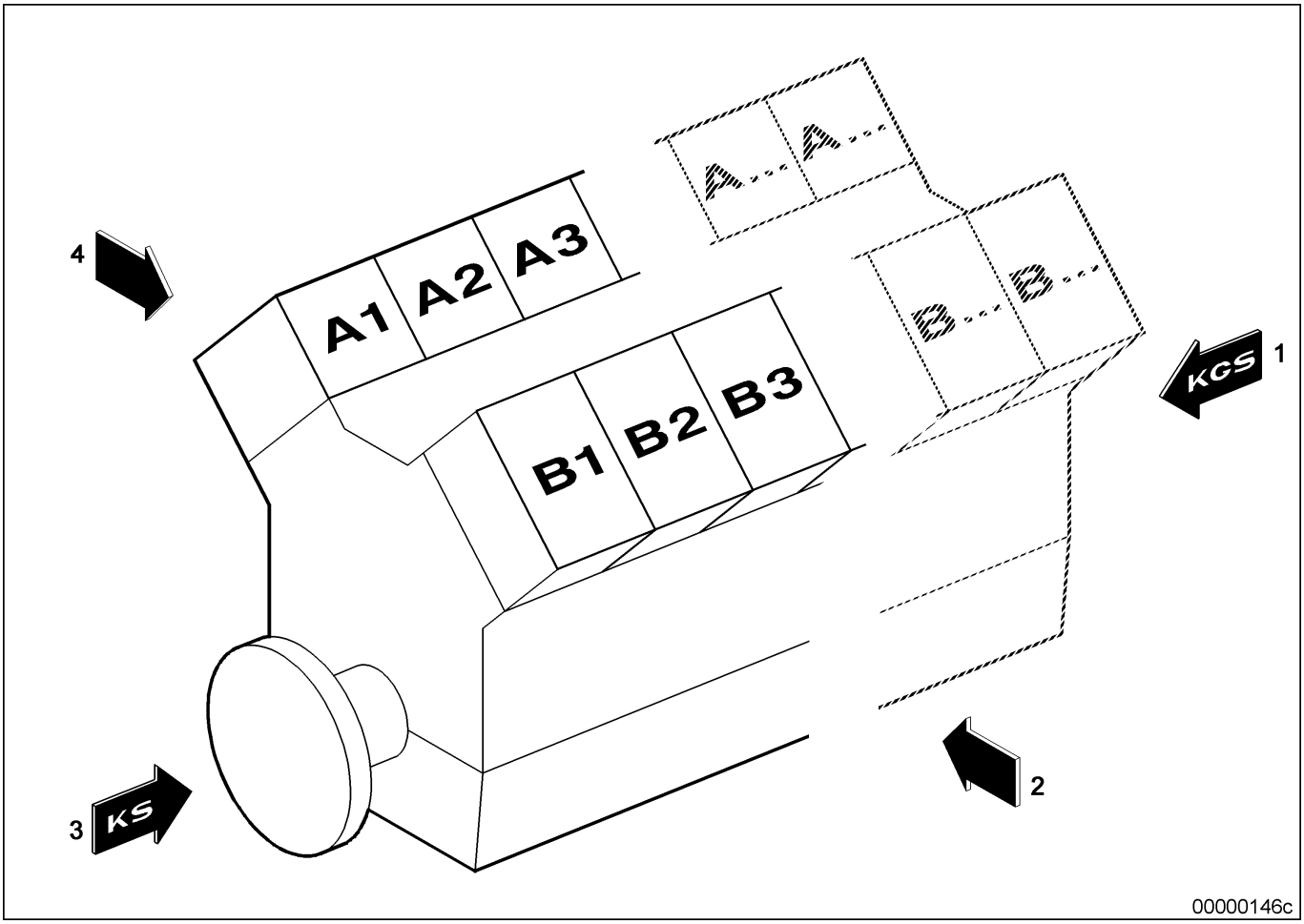
2.2 Engine Side and Cylinder Designations

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.

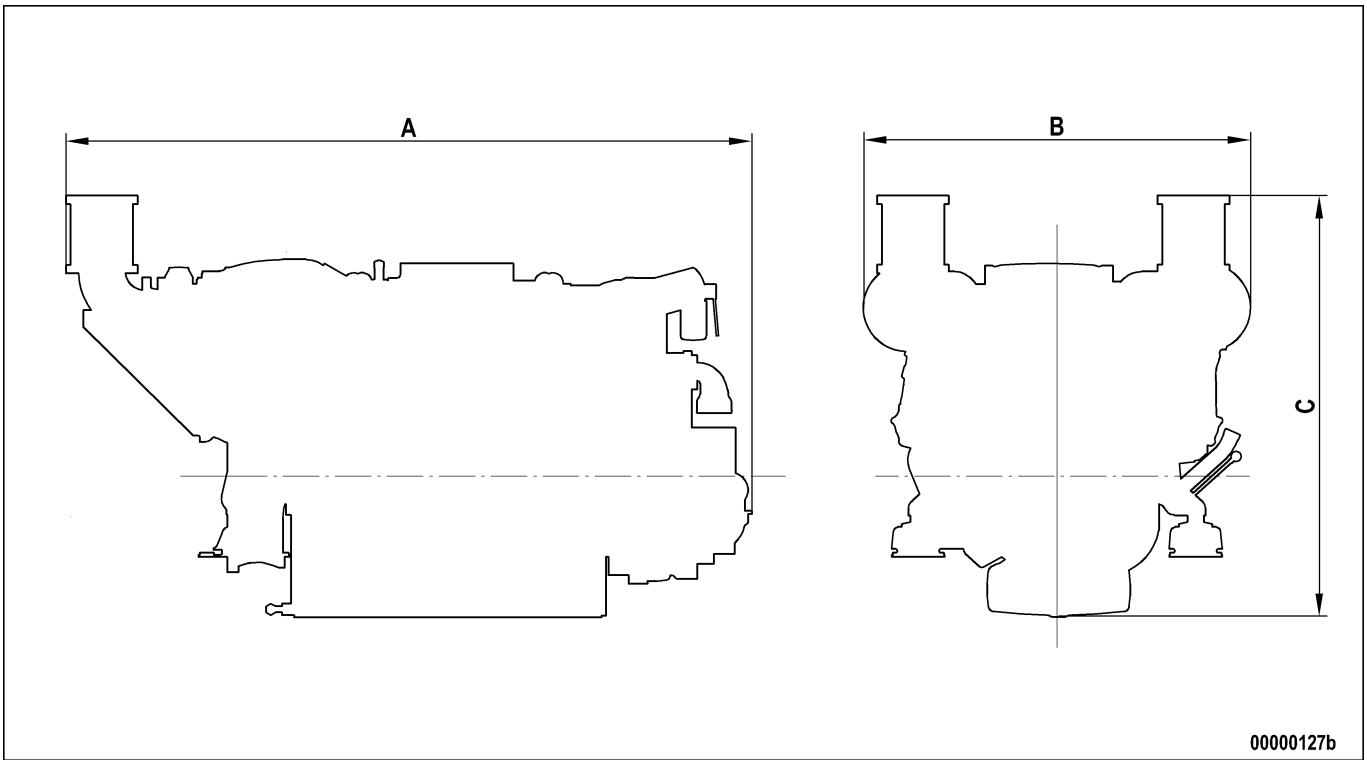


1 KGS = Free end
2 Right side
3 KS = Driving end
4 Left side

2.3 Main Engine Dimensions

2.3.1 Main engine dimensions

Main engine dimensions



Engine model	12V 2000 Gxy	16V 2000 Gxy	18V 2000 Gxy
Length (A)	approx. 2020 mm	approx. 2365 mm	approx. 2400 mm
Width (B)	approx. 1580 mm	approx. 1580 mm	approx. 1580 mm
Height (C)	approx. 1690 mm	approx. 1925 mm	approx. 1605 mm

2.4 Engine Data

2.4.1 12/16/18V 2000 Standby operation: Application Group 3D, Air-cooled charge air, Optimized fuel consumption

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			**12 V 2000G23**	**12 V 2000G63**	**16 V 2000G23**	**16 V 2000G63**	**18 V 2000G63**
Application group			3D	3D	3D	3D	3D
Intake air temperature		°C	25	25	25	25	25
Charge-air coolant temperature		°C	---	---	---	---	---
Raw-water inlet temperature		°C	---	---	---	---	---
Barometric pressure		mbar	1000	1000	1000	1000	1000
Site altitude above sea level		m	100	100	100	100	100

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

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine rated speed	A	rpm	1500	1500	1500	1500	1500
Fuel stop power ISO 3046 FSP	A	kW	625	680	805	895	985

GENERAL CONDITIONS (for maximum power)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Intake air depression (new filter) (design)	A	mbar	15	15	15	15	15
Intake air depression (limit value)	L	mbar	30	30	30	30	30
Exhaust backpressure (design)	A	mbar	30	30	30	30	30
Exhaust backpressure (limit value)	L	mbar	50	50	50	50	50

MODEL-RELATED DATA (basic design)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine with exhaust turbocharging (ETC) and charge air cooling (CAC)			X	X	X	X	X
Exhaust piping, non-cooled			X	X	X	X	X
Working method: four-cycle, diesel, single-acting			X	X	X	X	X
Combustion method: direct fuel injection			X	X	X	X	X
Cooling system: conditioned water			X	X	X	X	X
Direction of rotation: c.c.w. (facing driving end)			X	X	X	X	X
Number of cylinders			12	12	16	16	18
Cylinder configuration: V angle		degrees	90	90	90	90	90
Bore		mm	130	130	130	130	130
Stroke		mm	150	150	150	150	150
Displacement, cylinder		liter	1.99	1.99	1.99	1.99	1.99
Displacement, total		liter	23.88	23.88	31.84	31.84	35.82
Compression ratio			16	16	16	16	16
Cylinder heads: single-cylinder			X	X	X	X	X
Cylinder liners: wet, replaceable			X	X	X	X	X
Number of inlet valves, per cylinder			2	2	2	2	2
Number of exhaust valves, per cylinder			2	2	2	2	2
Standard flywheel housing flange (engine main PTO)		SAE	0	0	0	0	0
Flywheel interface		DISC	18"	18"	18"	18"	18"

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Charge air pressure before cylinder FSP	R	bar ABS	2.7	2.9	2.7	3.0	3.0

COOLING SYSTEM (HT circuit)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Coolant temperature (at engine outlet to cooling equipment)	A	°C	95	95	95	95	95
Coolant temperature after engine, alarm	R	°C	97	97	97	97	97
Coolant temperature after engine, shutdown	L	°C	102	102	102	102	102
Coolant antifreeze content, max. permissible	L	%	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

COOLING SYSTEM (LT circuit)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Pressure loss in the external cooling system, max. permissible	L	bar	---	---	---	---	---

LUBE OIL SYSTEM

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Lube oil operating temperature before engine,from	R	°C	88	88	88	88	88
Lube oil operating temp. before engine, to	R	°C	98	98	98	98	98
Lube oil temperature before engine, alarm	R	°C	103	103	103	103	103
Lube oil temperature before engine, shutdown	L	°C	---	---	---	---	---
Lube oil operating press. bef. engine, from	R	bar	6.2	6.2	5.5	5.5	6.0
Lube oil operating press. bef. engine, to	R	bar	7.5	7.5	6.5	6.5	8.0
Lube oil pressure before engine, alarm	R	bar	4.4	4.4	4.5	4.5	4.4
Lube oil pressure before engine, shutdown	L	bar	3.9	3.9	4.0	4.0	3.9

FUEL SYSTEM

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Fuel pressure at supply connection to engine (when engine is starting), min. admissible	L	bar	-0.3	-0.3	-0.3	-0.3	-0.3
Fuel pressure at supply connection to engine (when engine is starting), max. admissible	L	bar	+0.5	+0.5	+0.5	+0.5	+0.5

GENERAL OPERATING DATA

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Cold start capability: air temperature (w/o start aid, w/o preheating) (case A)	R	°C	0**	0**	0**	0**	0**
Coolant preheating: preheating temperature (min.)	R	°C	32	32	32	32	32
Firing speed, from	R	rpm	100	100	100	100	100
Firing speed, to	R	rpm	120	120	120	120	120

CAPACITIES

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine coolant capacity (without cooling equipment)	R	liter	90	90	110	110	120
Intercooler coolant capacity	R	liter	---	---	---	---	---
Engine oil capacity , initial filling (standard-oil system) (Option: max. operating inclinations)	R	liter	77	77	102	102	130
Oil change quantity, max. (standard oil system)	R	liter	N	N	N	N	N
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	liter	74	74	99	99	114
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	50	50	69	69	87
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	67	67	92	92	110

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine weight, dry (basic engine configuration acc. to scope of supply specification)	R	kg	2490	2490	3100	3100	3500

ACOUSTICS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Exhaust noise, unsilenced FSP (sound power level LW, ISO 6798)	R	db(A)	125	126	125	127	127
Engine surface noise with attenuated FSP intake noise (filter) (sound power level LW, ISO 6798)	R	db(A)	120	121	121	121	122

2.4.2 12/16/18V 2000 Standby operation: Application Group 3D, Air-cooled charge air, Optimized exhaust emission (EPA 40 CFR89 / Tier 1)

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			**12 V 2000G43**	**12 V 2000G83**	**16 V 2000G43**	**16 V 2000G83**	**18 V 2000G83**
Application group			3D	3D	3D	3D	3D
Intake air temperature		°C	25	25	25	25	25
Charge-air coolant temperature		°C	---	---	---	---	---
Raw-water inlet temperature		°C	---	---	---	---	---
Barometric pressure		mbar	1000	1000	1000	1000	1000
Site altitude above sea level		m	100	100	100	100	100

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

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine rated speed	A	rpm	1800	1800	1800	1800	1800
Fuel stop power ISO 3046 FSP	A	kW	735	835	1000	1115	1250

GENERAL CONDITIONS (for maximum power)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Intake air depression (new filter) (design)	A	mbar	15	15	15	15	15
Intake air depression (limit value)	L	mbar	30	30	30	30	30
Exhaust backpressure (design)	A	mbar	30	30	30	30	30
Exhaust backpressure (limit value)	L	mbar	50	50	50	50	50

MODEL-RELATED DATA (basic design)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine with exhaust turbocharging (ETC) and charge air cooling (CAC)			X	X	X	X	X
Exhaust piping, non-cooled			X	X	X	X	X
Working method: four-cycle, diesel, single-acting			X	X	X	X	X
Combustion method: direct fuel injection			X	X	X	X	X
Cooling system: conditioned water			X	X	X	X	X
Direction of rotation: c.c.w. (facing driving end)			X	X	X	X	X
Number of cylinders			12	12	16	16	18
Cylinder configuration: V angle		degrees	90	90	90	90	90
Bore		mm	130	130	130	130	130
Stroke		mm	150	150	150	150	150
Displacement, cylinder		liter	1.99	1.99	1.99	1.99	1.99
Displacement, total		liter	23.88	23.88	31.84	31.84	35.82
Compression ratio			14	14	14	14	14
Cylinder heads: single-cylinder			X	X	X	X	X
Cylinder liners: wet, replaceable			X	X	X	X	X
Number of inlet valves, per cylinder			2	2	2	2	2
Number of exhaust valves, per cylinder			2	2	2	2	2
Standard flywheel housing flange (engine main PTO)		SAE	0	0	0	0	0
Flywheel interface		DISC	18"	18"	18"	18"	18"

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Charge air pressure before cylinder FSP	R	bar ABS	3.1	3.4	3.2	3.3	3.3

COOLING SYSTEM (HT circuit)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Coolant temperature (at engine outlet to cooling equipment)	A	°C	95	95	95	95	95
Coolant temperature after engine, alarm	R	°C	97	97	97	97	97
Coolant temperature after engine, shutdown	L	°C	102	102	102	102	102
Coolant antifreeze content, max. permissible	L	%	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

COOLING SYSTEM (LT circuit)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Pressure loss in the external cooling system, max. permissible	L	bar	---	---	---	---	---

LUBE OIL SYSTEM

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Lube oil operating temperature before engine,from	R	°C	88	88	88	88	88
Lube oil operating temp. before engine, to	R	°C	98	98	98	98	98
Lube oil temperature before engine, alarm	R	°C	103	103	103	103	103
Lube oil temperature before engine, shutdown	L	°C	---	---	---	---	---
Lube oil operating press. bef. engine, from	R	bar	6.5	6.5	6.0	6.0	6.5
Lube oil operating press. bef. engine, to	R	bar	7.8	7.8	7.0	7.0	8.5
Lube oil pressure before engine, alarm	R	bar	5.5	5.5	5.5	5.5	5.5
Lube oil pressure before engine, shutdown	L	bar	5.0	5.0	5.0	5.0	5.0

FUEL SYSTEM

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Fuel pressure at supply connection to engine (when engine is starting), min. admissible	L	bar	-0.3	-0.3	-0.3	-0.3	-0.3
Fuel pressure at supply connection to engine (when engine is starting), max. admissible	L	bar	+0.5	+0.5	+0.5	+0.5	+0.5

GENERAL OPERATING DATA

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Cold start capability: air temperature (w/o start aid, w/o preheating) (case A)	R	°C	0**	0**	0**	0**	0**
Coolant preheating: preheating temperature (min.)	R	°C	32	32	32	32	32
Firing speed, from	R	rpm	100	100	100	100	100
Firing speed, to	R	rpm	200	120	120	120	120

CAPACITIES

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine coolant capacity (without cooling equipment)	R	liter	90	90	110	110	120
Intercooler coolant capacity	R	liter	---	---	---	---	---
Engine oil capacity , initial filling (standard-oil system) (Option: max. operating inclinations)	R	liter	77	77	102	102	130
Oil change quantity, max. (standard oil system)	R	liter	N	N	N	N	N
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	liter	74	74	99	99	114
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	50	50	69	69	87
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	67	67	92	92	110

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine weight, dry (basic engine configuration acc. to scope of supply specification)	R	kg	2490	2490	3100	3100	3500

ACOUSTICS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Exhaust noise, unsilenced FSP (sound power level LW, ISO 6798)	R	db(A)	129	129	128	N	130
Engine surface noise with attenuated FSP intake noise (filter) (sound power level LW, ISO 6798)	R	db(A)	N	N	N	N	123

2.4.3 12/16/18V 2000 Continuous operation with variable load: Application group 3B, Air-cooled charge air, Optimized fuel consumption

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			**12 V 2000G23**	**12 V 2000G63**	**16 V 2000G23**	**16 V 2000G63**	**18 V 2000G63**
Application group			3B	3B	3B	3B	3B
Intake air temperature		°C	25	25	25	25	25
Charge-air coolant temperature		°C	---	---	---	---	---
Raw-water inlet temperature		°C	---	---	---	---	---
Barometric pressure		mbar	1000	1000	1000	1000	1000
Site altitude above sea level		m	100	100	100	100	100

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

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine rated speed	A	rpm	1500	1500	1500	1500	1500
Continuous power ISO 3046 (10% overload CP cap., design power DIN 6280, ISO 8528)	A	kW	565	625	720	805	895

GENERAL CONDITIONS (for maximum power)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Intake air depression (new filter) (design)	A	mbar	15	15	15	15	15
Intake air depression (limit value)	L	mbar	30	30	30	30	30
Exhaust backpressure (design)	A	mbar	30	30	30	30	30
Exhaust backpressure (limit value)	L	mbar	50	50	50	50	50

MODEL-RELATED DATA (basic design)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine with exhaust turbocharging (ETC) and charge air cooling (CAC)			X	X	X	X	X
Exhaust piping, non-cooled			X	X	X	X	X
Working method: four-cycle, diesel, single-acting			X	X	X	X	X
Combustion method: direct fuel injection			X	X	X	X	X
Cooling system: conditioned water			X	X	X	X	X
Direction of rotation: c.c.w. (facing driving end)			X	X	X	X	X
Number of cylinders			12	12	16	16	18
Cylinder configuration: V angle		degrees	90	90	90	90	90
Bore		mm	130	130	130	130	130
Stroke		mm	150	150	150	150	150
Displacement, cylinder		liter	1.99	1.99	1.99	1.99	1.99
Displacement, total		liter	23.88	23.88	31.84	31.84	35.82
Compression ratio			16	16	16	16	16
Cylinder heads: single-cylinder			X	X	X	X	X
Cylinder liners: wet, replaceable			X	X	X	X	X
Number of inlet valves, per cylinder			2	2	2	2	2
Number of exhaust valves, per cylinder			2	2	2	2	2
Standard flywheel housing flange (engine main PTO)		SAE	0	0	0	0	0
Flywheel interface		DISC	18"	18"	18"	18"	18"

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Charge air pressure before CP cylinder (abs.)	R	bar ABS	2.5	2.7	2.5	2.7	2.8

COOLING SYSTEM (HT circuit)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Coolant temperature (at engine outlet to cooling equipment)	A	°C	95	95	95	95	95
Coolant temperature after engine, alarm	R	°C	97	97	97	97	97
Coolant temperature after engine, shutdown	L	°C	102	102	102	102	102
Coolant antifreeze content, max. permissible	L	%	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

COOLING SYSTEM (LT circuit)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Pressure loss in the external cooling system, max. permissible	L	bar	---	---	---	---	---

LUBE OIL SYSTEM

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Lube oil operating temperature before engine,from	R	°C	88	88	88	88	88
Lube oil operating temp. before engine, to	R	°C	98	98	98	98	98
Lube oil temperature before engine, alarm	R	°C	103	103	103	103	103
Lube oil temperature before engine, shutdown	L	°C	---	---	---	---	---
Lube oil operating press. bef. engine, from	R	bar	6.2	6.2	5.5	5.5	6.0
Lube oil operating press. bef. engine, to	R	bar	7.5	7.5	6.5	6.5	8.0
Lube oil pressure before engine, alarm	R	bar	4.4	4.4	4.5	4.5	4.4
Lube oil pressure before engine, shutdown	L	bar	3.9	3.9	4.0	4.0	3.9

FUEL SYSTEM

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Fuel pressure at supply connection to engine (when engine is starting), min. admissible	L	bar	-0.3	-0.3	-0.3	-0.3	-0.3
Fuel pressure at supply connection to engine (when engine is starting), max. admissible	L	bar	+0.5	+0.5	+0.5	+0.5	+0.5

GENERAL OPERATING DATA

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Cold start capability: air temperature (w/o start aid, w/o preheating) (case A)	R	°C	0**	0**	0**	0**	0**
Coolant preheating: preheating temperature (min.)	R	°C	32	32	32	32	32
Firing speed, from	R	rpm	100	100	100	100	100
Firing speed, to	R	rpm	120	120	120	120	120

CAPACITIES

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine coolant capacity (without cooling equipment)	R	liter	90	90	110	110	120
Intercooler coolant capacity	R	liter	---	---	---	---	---
Engine oil capacity , initial filling (standard-oil system) (Option: max. operating inclinations)	R	liter	77	77	102	102	130
Oil change quantity, max. (standard oil system)	R	liter	N	N	N	N	N
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	liter	74	74	99	99	114
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	50	50	69	69	87
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	67	67	92	92	110

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine weight, dry (basic engine configuration acc. to scope of supply specification)	R	kg	2490	2490	3100	3100	3500

ACOUSTICS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Exhaust noise, unsilenced CP (sound power level LW, ISO 6798)	R	db(A)	123	125	124	125	127
Engine surface noise with attenuated CP intake noise (filter) (sound power level LW, ISO 6798)	R	db(A)	119	119	120	121	122

2.4.4 12/16/18V Continuous operation with variable load: Application group 3B, Air-cooled charge air, Optimized exhaust emission (TA-Luft)

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			**12 V 2000G23**	**12 V 2000G63**	**16 V 2000G23**	**16 V 2000G63**	**18 V 2000G63**
Application group			3B	3B	3B	3B	3B
Intake air temperature		°C	25	25	25	25	25
Charge-air coolant temperature		°C	---	---	---	---	---
Raw-water inlet temperature		°C	---	---	---	---	---
Barometric pressure		mbar	1000	1000	1000	1000	1000
Site altitude above sea level		m	100	100	100	100	100

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

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine rated speed	A	rpm	1500	1500	1500	1500	1500
Continuous power ISO 3046 (10% overload CP cap., design power DIN 6280, ISO 8528)	A	kW	565	625	720	805	895

GENERAL CONDITIONS (for maximum power)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Intake air depression (new filter) (design)	A	mbar	15	15	15	15	15
Intake air depression (limit value)	L	mbar	30	30	30	30	30
Exhaust backpressure (design)	A	mbar	30	30	30	30	30
Exhaust backpressure (limit value)	L	mbar	50	50	50	50	50

MODEL-RELATED DATA (basic design)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine with exhaust turbocharging (ETC) and charge air cooling (CAC)			X	X	X	X	X
Exhaust piping, non-cooled			X	X	X	X	X
Working method: four-cycle, diesel, single-acting			X	X	X	X	X
Combustion method: direct fuel injection			X	X	X	X	X
Cooling system: conditioned water			X	X	X	X	X
Direction of rotation: c.c.w. (facing driving end)			X	X	X	X	X
Number of cylinders			12	12	16	16	18
Cylinder configuration: V angle		degrees	90	90	90	90	90
Bore		mm	130	130	130	130	130
Stroke		mm	150	150	150	150	150
Displacement, cylinder		liter	1.99	1.99	1.99	1.99	1.99
Displacement, total		liter	23.88	23.88	31.84	31.84	35.82
Compression ratio			16	16	16	16	16
Cylinder heads: single-cylinder			X	X	X	X	X
Cylinder liners: wet, replaceable			X	X	X	X	X
Number of inlet valves, per cylinder			2	2	2	2	2
Number of exhaust valves, per cylinder			2	2	2	2	2
Standard flywheel housing flange (engine main PTO)		SAE	0	0	0	0	0
Flywheel interface		DISC	18"	18"	18"	18"	18"

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Charge air pressure before CP cylinder (abs.)	R	bar ABS	2.8	3.1	2.8	3.1	3.2

COOLING SYSTEM (HT circuit)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Coolant temperature (at engine outlet to cooling equipment)	A	°C	95	95	95	95	95
Coolant temperature after engine, alarm	R	°C	97	97	97	97	97
Coolant temperature after engine, shutdown	L	°C	102	102	102	102	102
Coolant antifreeze content, max. permissible	L	%	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

COOLING SYSTEM (LT circuit)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Pressure loss in the external cooling system, max. permissible	L	bar	---	---	---	---	---

LUBE OIL SYSTEM

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Lube oil operating temperature before engine,from	R	°C	88	88	88	88	88
Lube oil operating temp. before engine, to	R	°C	98	98	98	98	98
Lube oil temperature before engine, alarm	R	°C	103	103	103	103	103
Lube oil temperature before engine, shutdown	L	°C	---	---	---	---	---
Lube oil operating press. bef. engine, from	R	bar	6.2	6.2	5.5	5.5	6.0
Lube oil operating press. bef. engine, to	R	bar	7.5	7.5	6.5	6.5	8.0
Lube oil pressure before engine, alarm	R	bar	4.4	4.4	4.5	4.5	4.4
Lube oil pressure before engine, shutdown	L	bar	3.9	3.9	4.0	4.0	3.9

FUEL SYSTEM

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Fuel pressure at supply connection to engine (when engine is starting), min. admissible	L	bar	-0.3	-0.3	-0.3	-0.3	-0.3
Fuel pressure at supply connection to engine (when engine is starting), max. admissible	L	bar	+0.5	+0.5	+0.5	+0.5	+0.5

GENERAL OPERATING DATA

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Cold start capability: air temperature (w/o start aid, w/o preheating) (case A)	R	°C	0**	0**	0**	0**	0**
Coolant preheating: preheating temperature (min.)	R	°C	32	32	32	32	32
Firing speed, from	R	rpm	100	100	100	100	100
Firing speed, to	R	rpm	120	120	120	120	120

CAPACITIES

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine coolant capacity (without cooling equipment)	R	liter	90	90	110	110	120
Intercooler coolant capacity	R	liter	---	---	---	---	---
Engine oil capacity , initial filling (standard-oil system) (Option: max. operating inclinations)	R	liter	77	77	102	102	130
Oil change quantity, max. (standard oil system)	R	liter	N	N	N	N	N
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	liter	74	74	99	99	114
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	50	50	69	69	87
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	67	67	92	92	110

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine weight, dry (basic engine configuration acc. to scope of supply specification)	R	kg	2490	2490	3100	3100	3500

ACOUSTICS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Exhaust noise, unsilenced CP (sound power level LW, ISO 6798)	R	db(A)	127	128	126	125	127
Engine surface noise with attenuated CP intake noise (filter) (sound power level LW, ISO 6798)	R	db(A)	120	121	121	121	122

2.4.5 12/16/18V Continuous operation with variable load: Application group 3B, Air-cooled charge air, Optimized exhaust emission (EPA 40 CFR89 / Tier 1)

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			**12 V 2000G83**	**16 V 2000G83**	**18 V 2000G83**
Application group			3B	3B	3B
Intake air temperature		°C	25	25	25
Charge-air coolant temperature		°C	---	---	---
Raw-water inlet temperature		°C	---	---	---
Barometric pressure		mbar	1000	1000	1000
Site altitude above sea level		m	100	100	100

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

Number of cylinders			**12**	**16**	**18**
Engine rated speed	A	rpm	1800	1800	1800
Continuous power ISO 3046 (10% overload CP cap., design power DIN 6280, ISO 8528)	A	kW	695	925	1040

GENERAL CONDITIONS (for maximum power)

Number of cylinders			**12**	**16**	**18**
Intake air depression (new filter) (design)	A	mbar	15	15	15
Intake air depression (limit value)	L	mbar	30	30	30
Exhaust backpressure (design)	A	mbar	30	30	30
Exhaust backpressure (limit value)	L	mbar	50	50	50

MODEL-RELATED DATA (basic design)

Number of cylinders			**12**	**16**	**18**
Engine with exhaust turbocharging (ETC) and charge air cooling (CAC)			X	X	X
Exhaust piping, non-cooled			X	X	X
Working method: four-cycle, diesel, single-acting			X	X	X
Combustion method: direct fuel injection			X	X	X
Cooling system: conditioned water			X	X	X
Direction of rotation: c.c.w. (facing driving end)			X	X	X
Number of cylinders			12	16	18
Cylinder configuration: V angle		degrees	90	90	90
Bore		mm	130	130	130
Stroke		mm	150	150	150
Displacement, cylinder		liter	1.99	1.99	1.99
Displacement, total		liter	23.88	31.84	35.82
Compression ratio			14	14	14
Cylinder heads: single-cylinder			X	X	X
Cylinder liners: wet, replaceable			X	X	X
Number of inlet valves, per cylinder			2	2	2
Number of exhaust valves, per cylinder			2	2	2
Standard flywheel housing flange (engine main PTO)		SAE	0	0	0
Flywheel interface		DISC	18"	18"	18"

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			**12**	**16**	**18**
Charge air pressure before CP cylinder (abs.)	R	bar ABS	3.0	3.1	3.0

COOLING SYSTEM (HT circuit)

Number of cylinders			**12**	**16**	**18**
Coolant temperature (at engine outlet to cooling equipment)	A	°C	95	95	95
Coolant temperature after engine, alarm	R	°C	97	97	97
Coolant temperature after engine, shutdown	L	°C	102	102	102
Coolant antifreeze content, max. permissible	L	%	50	50	50
Pressure loss in the external cooling system, max. permissible	L	bar	0.7	0.7	0.7

COOLING SYSTEM (LT circuit)

Number of cylinders			**12**	**16**	**18**
Pressure loss in the external cooling system, max. permissible	L	bar	---	---	---

LUBE OIL SYSTEM

Number of cylinders			**12**	**16**	**18**
Lube oil operating temperature before engine,from	R	°C	88	88	88
Lube oil operating temp. before engine, to	R	°C	98	98	98
Lube oil temperature before engine, alarm	R	°C	103	103	103
Lube oil temperature before engine, shutdown	L	°C	---	---	---
Lube oil operating press. bef. engine, from	R	bar	6.5	6.0	6.5
Lube oil operating press. bef. engine, to	R	bar	7.5	7.0	8.5
Lube oil pressure before engine, alarm	R	bar	5.5	5.5	5.5
Lube oil pressure before engine, shutdown	L	bar	5.0	5.0	5.0

FUEL SYSTEM

Number of cylinders			**12**	**16**	**18**
Fuel pressure at supply connection to engine (when engine is starting), min. admissible	L	bar	-0.3	-0.3	-0.3
Fuel pressure at supply connection to engine (when engine is starting), max. admissible	L	bar	+0.5	+0.5	+0.5

GENERAL OPERATING DATA

Number of cylinders			**12**	**16**	**18**
Cold start capability: air temperature (w/o start aid, w/o preheating) (case A)	R	°C	0**	0**	0**
Coolant preheating: preheating temperature (min.)	R	°C	32	32	32
Firing speed, from	R	rpm	100	100	100
Firing speed, to	R	rpm	120	120	120

CAPACITIES

Number of cylinders			**12**	**16**	**18**
Engine coolant capacity (without cooling equipment)	R	liter	90	110	120
Intercooler coolant capacity	R	liter	---	---	---
Engine oil capacity , initial filling (standard-oil system) (Option: max. operating inclinations)	R	liter	77	102	130
Oil change quantity, max. (standard oil system)	R	liter	N	N	N
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	liter	74	99	114
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	50	69	87
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	67	92	110

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			**12**	**16**	**18**
Engine weight, dry (basic engine configuration acc. to scope of supply specification)	R	kg	2490	3100	3500

ACOUSTICS

Number of cylinders			**12**	**16**	**18**
Exhaust noise, unsilenced CP (sound power level LW, ISO 6798)	R	db(A)	129	128	N
Engine surface noise with attenuated CP intake noise (filter) (sound power level LW, ISO 6798)	R	db(A)	N	N	N

2.4.6 12/16/18V 2000 Continuous operation, unrestricted: Application group 3B, Air-cooled charge air, Optimized fuel consumption, Optimized exhaust emission (EPA 40 CFR89 / Tier 1)

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			**12 V 2000G63**	**16 V 2000G63**	**18 V 2000G63**	**12 V 2000G83 ***	**16 V 2000G83 ***	**18 V 2000G83 ***
Application group			3A	3A	3A	3A	3A	3A
Intake air temperature		°C	25	25	25	25	25	25
Charge-air coolant temperature		°C	---	---	---	---	---	---
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			**12**	**16**	**18**	**12**	**16**	**18**
Engine rated speed	A	rpm	1500	1500	1500	1800	1800	1800
Continuous power ISO 3046 (10% overload CP cap., design power DIN 6280, ISO 8528)	A	kW	515	655	720	625	835	900

GENERAL CONDITIONS (for maximum power)

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
Intake air depression (new filter) (design)	A	mbar	15	15	15	30	30	30
Intake air depression (limit value)	L	mbar	30	30	30	50	50	50
Exhaust backpressure (design)	A	mbar	30	30	30	50	50	50
Exhaust backpressure (limit value)	L	mbar	50	50	50	100	100	100

MODEL-RELATED DATA (basic design)

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
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			12	16	18	12	16	18
Cylinder configuration: V angle		degrees	90	90	90	90	90	90
Bore		mm	130	130	130	130	130	130
Stroke		mm	150	150	150	150	150	150

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
Displacement, cylinder		liter	1.99	1.99	1.99	1.99	1.99	1.99
Displacement, total		liter	23.88	31.84	35.82	23.88	31.84	35.82
Compression ratio			16	16	16	14	14	14
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	0	0	0	0	0	0
Flywheel interface		DISC	18"	18"	18"	18"	18"	18"

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
Charge air pressure before CP cylinder (abs.)	R	bar ABS	2.4	2.3	2.4	2.8	2.9	2.9

COOLING SYSTEM (HT circuit)

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
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	102	102	102	102	102	102
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			**12**	**16**	**18**	**12**	**16**	**18**
Pressure loss in the external cooling system, max. permissible	L	bar	---	---	---	---	---	---

LUBE OIL SYSTEM

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
Lube oil operating temperature before engine,from	R	°C	88	88	88	88	88	88
Lube oil operating temp. before engine, to	R	°C	98	98	98	98	98	98
Lube oil temperature before engine, alarm	R	°C	103	103	103	103	103	103
Lube oil temperature before engine, shutdown	L	°C	---	N	---	---	---	---
Lube oil operating press. bef. engine, from	R	bar	6.2	5.5	6.0	6.5	6.0	6.5
Lube oil operating press. bef. engine, to	R	bar	7.5	6.5	8.0	7.8	7.0	8.5
Lube oil pressure before engine, alarm	R	bar	4.4	4.5	4.4	5.5	5.5	5.5
Lube oil pressure before engine, shutdown	L	bar	3.9	4.0	3.9	5.0	5.0	5.0

FUEL SYSTEM

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
Fuel pressure at supply connection to engine (when engine is starting), min. admissible	L	bar	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
Fuel pressure at supply connection to engine (when engine is starting), max. admissible	L	bar	+0.5	+0.5	+0.5	+0.5	+0.5	+0.5

GENERAL OPERATING DATA

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
Cold start capability: air temperature (w/o start aid, w/o preheating) (case A)	R	°C	0**	0**	0**	0**	0**	0**
Coolant preheating: preheating temperature (min.)	R	°C	32	32	32	32	32	32
Firing speed, from	R	rpm	100	100	100	100	100	100
Firing speed, to	R	rpm	120	120	120	120	120	120

CAPACITIES

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
Engine coolant capacity (without cooling equipment)	R	liter	90	110	120	90	110	120
Intercooler coolant capacity	R	liter	---	---	---	---	---	---
Engine oil capacity , initial filling (standard-oil system) (Option: max. operating inclinations)	R	liter	77	102	130	77	102	130
Oil change quantity, max. (standard oil system)	R	liter	N	N	N	N	N	N
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	liter	74	99	114	74	99	114
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	50	69	87	50	69	87
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	67	92	110	67	92	110

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
Engine weight, dry (basic engine configuration acc. to scope of supply specification)	R	kg	2490	3100	3500	2570	3150	3500

ACOUSTICS

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
Exhaust noise, unsilenced CP (sound power level LW, ISO 6798)	R	db(A)	123	123	125	126	126	126
Engine surface noise with attenuated CP intake noise (filter) (sound power level LW, ISO 6798)	R	db(A)	118	119	122	N	N	122

2.4.7 12/16/18V 2000 Standby operation: Application Group 3D, Water-cooled charge-air, Optimized fuel consumption

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			**12 V 2000G23**	**12 V 2000G63**	**16 V 2000G23**	**16 V 2000G63**	**18 V 2000G63**
Application group			3D	3D	3D	3D	3D
Intake air temperature		°C	25	25	25	25	25
Charge-air coolant temperature		°C	55	55	55	55	55
Raw-water inlet temperature		°C	---	---	---	---	---
Barometric pressure		mbar	1000	1000	1000	1000	1000
Site altitude above sea level		m	100	100	1000	100	100

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

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine rated speed	A	rpm	1500	1500	1500	1500	1500
Fuel stop power ISO 3046 FSP	A	kW	625	680	805	895	985

GENERAL CONDITIONS (for maximum power)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Intake air depression (new filter) (design)	A	mbar	15	15	15	15	15
Intake air depression (limit value)	L	mbar	30	30	30	30	30
Exhaust backpressure (design)	A	mbar	30	30	30	30	30
Exhaust backpressure (limit value)	L	mbar	50	50	50	50	50

MODEL-RELATED DATA (basic design)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine with exhaust turbocharging (ETC) and charge air cooling (CAC)			X	X	X	X	X
Exhaust piping, non-cooled			X	X	X	X	X
Working method: four-cycle, diesel, single-acting			X	X	X	X	X
Combustion method: direct fuel injection			X	X	X	X	X
Cooling system: conditioned water			X	X	X	X	X
Direction of rotation: c.c.w. (facing driving end)			X	X	X	X	X
Number of cylinders			12	12	16	16	18
Cylinder configuration: V angle		degrees	90	90	90	90	90
Bore		mm	130	130	130	130	130
Stroke		mm	150	150	150	150	150
Displacement, cylinder		liter	1.99	1.99	1.99	1.99	1.99
Displacement, total		liter	23.88	23.88	31.84	31.84	35.82
Compression ratio			16	16	16	16	16
Cylinder heads: single-cylinder			X	X	X	X	X
Cylinder liners: wet, replaceable			X	X	X	X	X
Number of inlet valves, per cylinder			2	2	2	2	2
Number of exhaust valves, per cylinder			2	2	2	2	2
Standard flywheel housing flange (engine main PTO)		SAE	0	0	0	0	0
Flywheel interface		DISC	18"	18"	18"	18"	18"

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Charge air pressure before cylinder FSP	R	bar ABS	2.7	2.9	2.7	3.0	3.0

COOLING SYSTEM (HT circuit)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Coolant temperature (at engine outlet to cooling equipment)	A	°C	95	95	95	95	95
Coolant temperature after engine, alarm	R	°C	97	97	97	97	97
Coolant temperature after engine, shutdown	L	°C	102	102	102	102	102
Coolant antifreeze content, max. permissible	L	%	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

COOLING SYSTEM (LT circuit)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Coolant temperature before intercooler (at engine inlet from cooling equipment)	A	°C	55	55	55	55	55
Coolant antifreeze content, max. permissible	L	%	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

LUBE OIL SYSTEM

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Lube oil operating temperature before engine,from	R	°C	88	88	88	88	88
Lube oil operating temp. before engine, to	R	°C	98	98	98	98	98
Lube oil temperature before engine, alarm	R	°C	103	103	103	103	103
Lube oil temperature before engine, shutdown	L	°C	---	---	---	---	---
Lube oil operating press. bef. engine, from	R	bar	6.2	6.2	5.5	5.5	6.0
Lube oil operating press. bef. engine, to	R	bar	7.5	7.5	6.5	6.5	8.0
Lube oil pressure before engine, alarm	R	bar	4.4	4.4	4.5	4.5	4.4
Lube oil pressure before engine, shutdown	L	bar	3.9	3.9	4.0	4.0	3.9

FUEL SYSTEM

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Fuel pressure at supply connection to engine (when engine is starting), min. admissible	L	bar	-0.3	-0.3	-0.3	-0.3	-0.3
Fuel pressure at supply connection to engine (when engine is starting), max. admissible	L	bar	+0.5	+0.5	+0.5	+0.5	+0.5

GENERAL OPERATING DATA

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Cold start capability: air temperature (w/o start aid, w/o preheating) (case A)	R	°C	0**	0**	0**	0**	0**
Coolant preheating: preheating temperature (min.)	R	°C	32	32	32	32	32
Firing speed, from	R	rpm	100	100	100	100	100
Firing speed, to	R	rpm	120	120	120	120	120

CAPACITIES

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine coolant capacity (without cooling equipment)	R	liter	110	110	130	130	140
Intercooler coolant capacity	R	liter	20	20	20	20	20
Engine oil capacity , initial filling (standard-oil system) (Option: max. operating inclinations)	R	liter	77	77	102	102	130
Oil change quantity, max. (standard oil system)	R	liter	N	N	N	N	N
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	liter	74	74	99	99	114
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	50	50	69	69	87
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	67	67	92	92	110

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine weight, dry (basic engine configuration acc. to scope of supply specification)	R	kg	2570	2570	3150	3150	3500

ACOUSTICS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Exhaust noise, unsilenced FSP (sound power level LW, ISO 6798)	R	db(A)	125	126	125	127	127
Engine surface noise with attenuated FSP intake noise (filter) (sound power level LW, ISO 6798)	R	db(A)	117	118	120	120	122

2.4.8 12/16/18V 2000 Standby operation: Application Group 3D, Water-cooled charge-air, Optimized exhaust emission (EPA 40 CFR89 / Tier 1)

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			**12 V 2000G43**	**12 V 2000G83**	**16 V 2000G43**	**16 V 2000G83**	**18 V 2000G83**
Application group			3D	3D	3D	3D	3D
Intake air temperature		°C	25	25	25	25	25
Charge-air coolant temperature		°C	55	55	55	55	55
Raw-water inlet temperature		°C	---	---	---	---	---
Barometric pressure		mbar	1000	1000	1000	1000	1000
Site altitude above sea level		m	100	100	100	100	100

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

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine rated speed	A	rpm	1800	1800	1800	1800	1800
Fuel stop power ISO 3046 FSP	A	kW	735	835	1007	1115	1250

GENERAL CONDITIONS (for maximum power)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Intake air depression (new filter) (design)	A	mbar	30	30	30	30	30
Intake air depression (limit value)	L	mbar	50	50	50	50	50
Exhaust backpressure (design)	A	mbar	50	50	50	50	50
Exhaust backpressure (limit value)	L	mbar	100	100	100	100	100

MODEL-RELATED DATA (basic design)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine with exhaust turbocharging (ETC) and charge air cooling (CAC)			X	X	X	X	X
Exhaust piping, non-cooled			X	X	X	X	X
Working method: four-cycle, diesel, single-acting			X	X	X	X	X
Combustion method: direct fuel injection			X	X	X	X	X
Cooling system: conditioned water			X	X	X	X	X
Direction of rotation: c.c.w. (facing driving end)			X	X	X	X	X
Number of cylinders			12	12	16	16	18
Cylinder configuration: V angle		degrees	90	90	90	90	90
Bore		mm	130	130	130	130	130
Stroke		mm	150	150	150	150	150
Displacement, cylinder		liter	1.99	1.99	1.99	1.99	1.99
Displacement, total		liter	23.88	23.88	31.84	31.84	35.82
Compression ratio			14	14	14	14	14
Cylinder heads: single-cylinder			X	X	X	X	X
Cylinder liners: wet, replaceable			X	X	X	X	X
Number of inlet valves, per cylinder			2	2	2	2	2
Number of exhaust valves, per cylinder			2	2	2	2	2
Standard flywheel housing flange (engine main PTO)		SAE	0	0	0	0	0
Flywheel interface		DISC	18"	18"	18"	18"	18"

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Charge air pressure before cylinder FSP	R	bar ABS	3.2	3.5	3.2	3.5	3.3

COOLING SYSTEM (HT circuit)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Coolant temperature (at engine outlet to cooling equipment)	A	°C	95	95	95	95	95
Coolant temperature after engine, alarm	R	°C	97	97	97	97	97
Coolant temperature after engine, shutdown	L	°C	102	102	102	102	102
Coolant antifreeze content, max. permissible	L	%	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

COOLING SYSTEM (LT circuit)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Coolant temperature before intercooler (at engine inlet from cooling equipment)	A	°C	55	55	55	55	55
Coolant antifreeze content, max. permissible	L	%	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

LUBE OIL SYSTEM

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Lube oil operating temperature before engine,from	R	°C	88	88	88	88	88
Lube oil operating temp. before engine, to	R	°C	98	98	98	98	98
Lube oil temperature before engine, alarm	R	°C	103	103	103	103	103
Lube oil temperature before engine, shutdown	L	°C	---	---	---	---	---
Lube oil operating press. bef. engine, from	R	bar	6.5	6.5	6.0	6.0	6.5
Lube oil operating press. bef. engine, to	R	bar	7.8	7.8	7.0	7.0	8.5
Lube oil pressure before engine, alarm	R	bar	5.5	5.5	5.5	5.5	5.5
Lube oil pressure before engine, shutdown	L	bar	5.0	5.0	5.0	5.0	5.0

FUEL SYSTEM

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Fuel pressure at supply connection to engine (when engine is starting), min. admissible	L	bar	-0.3	-0.3	-0.3	-0.3	-0.3
Fuel pressure at supply connection to engine (when engine is starting), max. admissible	L	bar	+0.5	+0.5	+0.5	+0.5	+0.5

GENERAL OPERATING DATA

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Cold start capability: air temperature (w/o start aid, w/o preheating) (case A)	R	°C	0**	0**	0**	0**	0**
Coolant preheating: preheating temperature (min.)	R	°C	32	32	32	32	32
Firing speed, from	R	rpm	100	100	100	100	100
Firing speed, to	R	rpm	120	120	120	120	120

CAPACITIES

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine coolant capacity (without cooling equipment)	R	liter	110	110	130	130	140
Intercooler coolant capacity	R	liter	20	20	20	20	20
Engine oil capacity , initial filling (standard-oil system) (Option: max. operating inclinations)	R	liter	77	77	102	102	130
Oil change quantity, max. (standard oil system)	R	liter	N	N	N	N	N
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	liter	74	74	99	99	114
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	50	50	69	69	87
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	67	67	92	92	110

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine weight, dry (basic engine configuration acc. to scope of supply specification)	R	kg	2570	2570	3150	3180	3500

ACOUSTICS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Exhaust noise, unsilenced FSP (sound power level LW, ISO 6798)	R	db(A)	129	129	128	N	N
Engine surface noise with attenuated FSP intake noise (filter) (sound power level LW, ISO 6798)	R	db(A)	119	119	121	N	N

2.4.9 12/16/18V 2000 Continuous operation with variable load: Application group 3B, Water-cooled charge-air, Optimized fuel consumption

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			**12 V 2000G23**	**12 V 2000G63**	**16 V 2000G23**	**16 V 2000G63**	**18 V 2000G63**
Application group			3B	3B	3B	3B	3B
Intake air temperature		°C	25	25	25	25	25
Charge-air coolant temperature		°C	55	55	55	55	55
Raw-water inlet temperature		°C	---	---	---	---	---
Barometric pressure		mbar	1000	1000	1000	1000	1000
Site altitude above sea level		m	100	100	100	100	100

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

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine rated speed	A	rpm	1500	1500	1500	1500	1500
Continuous power ISO 3046 (10% overload CP cap., design power DIN 6280, ISO 8528)	A	kW	565	625	720	805	895

GENERAL CONDITIONS (for maximum power)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Intake air depression (new filter) (design)	A	mbar	15	15	15	15	15
Intake air depression (limit value)	L	mbar	30	30	30	30	30
Exhaust backpressure (design)	A	mbar	30	30	30	30	30
Exhaust backpressure (limit value)	L	mbar	50	50	50	50	50

MODEL-RELATED DATA (basic design)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine with exhaust turbocharging (ETC) and charge air cooling (CAC)			X	X	X	X	X
Exhaust piping, non-cooled			X	X	X	X	X
Working method: four-cycle, diesel, single-acting			X	X	X	X	X
Combustion method: direct fuel injection			X	X	X	X	X
Cooling system: conditioned water			X	X	X	X	X
Direction of rotation: c.c.w. (facing driving end)			X	X	X	X	X
Number of cylinders			12	12	16	16	18
Cylinder configuration: V angle		degrees	90	90	90	90	90
Bore		mm	130	130	130	130	130
Stroke		mm	150	150	150	150	150
Displacement, cylinder		liter	1.99	1.99	1.99	1.99	1.99
Displacement, total		liter	23.88	23.88	31.84	31.84	35.82
Compression ratio			16	16	16	16	16
Cylinder heads: single-cylinder			X	X	X	X	X
Cylinder liners: wet, replaceable			X	X	X	X	X
Number of inlet valves, per cylinder			2	2	2	2	2
Number of exhaust valves, per cylinder			2	2	2	2	2
Standard flywheel housing flange (engine main PTO)		SAE	0	0	0	0	0
Flywheel interface		DISC	18"	18"	18"	18"	18"

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Charge air pressure before CP cylinder (abs.)	R	bar ABS	2.5	2.7	2.5	2.7	2.8

COOLING SYSTEM (HT circuit)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Coolant temperature (at engine outlet to cooling equipment)	A	°C	95	95	95	95	95
Coolant temperature after engine, alarm	R	°C	97	97	97	97	97
Coolant temperature after engine, shutdown	L	°C	102	102	102	102	102
Coolant antifreeze content, max. permissible	L	%	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

COOLING SYSTEM (LT circuit)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Coolant temperature before intercooler (at engine inlet from cooling equipment)	A	°C	55	55	55	55	55
Coolant antifreeze content, max. permissible	L	%	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

LUBE OIL SYSTEM

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Lube oil operating temperature before engine,from	R	°C	88	88	88	88	88
Lube oil operating temp. before engine, to	R	°C	98	98	98	98	98
Lube oil temperature before engine, alarm	R	°C	103	103	103	103	103
Lube oil temperature before engine, shutdown	L	°C	---	---	---	---	---
Lube oil operating press. bef. engine, from	R	bar	6.2	6.2	5.5	5.5	6.0
Lube oil operating press. bef. engine, to	R	bar	7.5	7.5	6.5	6.5	8.0
Lube oil pressure before engine, alarm	R	bar	4.4	4.4	4.5	4.5	4.4
Lube oil pressure before engine, shutdown	L	bar	3.9	3.9	4.0	4.0	3.9

FUEL SYSTEM

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Fuel pressure at supply connection to engine (when engine is starting), min. admissible	L	bar	-0.3	-0.3	-0.3	-0.3	-0.3
Fuel pressure at supply connection to engine (when engine is starting), max. admissible	L	bar	+0.5	+0.5	+0.5	+0.5	+0.5

GENERAL OPERATING DATA

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Cold start capability: air temperature (w/o start aid, w/o preheating) (case A)	R	°C	0**	0**	0**	0**	0**
Coolant preheating: preheating temperature (min.)	R	°C	32	32	32	32	32
Firing speed, from	R	rpm	100	100	100	100	100
Firing speed, to	R	rpm	120	120	120	120	120

CAPACITIES

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine coolant capacity (without cooling equipment)	R	liter	110	110	130	130	140
Intercooler coolant capacity	R	liter	---	20	20	20	20
Engine oil capacity , initial filling (standard-oil system) (Option: max. operating inclinations)	R	liter	77	77	102	102	130
Oil change quantity, max. (standard oil system)	R	liter	N	N	N	N	N
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	liter	74	74	99	99	114
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	50	50	69	69	87
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	67	67	92	92	110

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine weight, dry (basic engine configuration acc. to scope of supply specification)	R	kg	2570	2570	3150	3150	3500

ACOUSTICS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Exhaust noise, unsilenced CP (sound power level LW, ISO 6798)	R	db(A)	123	125	124	125	127
Engine surface noise with attenuated CP intake noise (filter) (sound power level LW, ISO 6798)	R	db(A)	116	117	118	120	124

2.4.10 12/16/18V Continuous operation with variable load: Application group 3B, Water-cooled charge-air, Optimized exhaust emission (TA-Luft)

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			**12 V 2000G23**	**12 V 2000G63**	**16 V 2000G23**	**16 V 2000G63**	**18 V 2000G63**
Application group			3B	3B	3B	3B	3B
Intake air temperature		°C	25	25	25	25	25
Charge-air coolant temperature		°C	55	55	55	55	55
Raw-water inlet temperature		°C	---	---	---	---	---
Barometric pressure		mbar	1000	1000	1000	1000	1000
Site altitude above sea level		m	100	100	100	100	100

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

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine rated speed	A	rpm	1500	1500	1500	1500	1500
Continuous power ISO 3046 (10% overload CP cap., design power DIN 6280, ISO 8528)	A	kW	565	625	720	805	895

GENERAL CONDITIONS (for maximum power)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Intake air depression (new filter) (design)	A	mbar	15	15	15	15	15
Intake air depression (limit value)	L	mbar	30	30	30	30	30
Exhaust backpressure (design)	A	mbar	30	30	30	30	30
Exhaust backpressure (limit value)	L	mbar	50	50	50	50	50

MODEL-RELATED DATA (basic design)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine with exhaust turbocharging (ETC) and charge air cooling (CAC)			X	X	X	X	X
Exhaust piping, non-cooled			X	X	X	X	X
Working method: four-cycle, diesel, single-acting			X	X	X	X	X
Combustion method: direct fuel injection			X	X	X	X	X
Cooling system: conditioned water			X	X	X	X	X
Direction of rotation: c.c.w. (facing driving end)			X	X	X	X	X
Number of cylinders			12	12	16	16	18
Cylinder configuration: V angle		degrees	90	90	90	90	90
Bore		mm	130	130	130	130	130
Stroke		mm	150	150	150	150	150
Displacement, cylinder		liter	1.99	1.99	1.99	1.99	1.99
Displacement, total		liter	23.88	23.88	31.84	31.84	35.82
Compression ratio			16	16	16	16	16
Cylinder heads: single-cylinder			X	X	X	X	X
Cylinder liners: wet, replaceable			X	X	X	X	X
Number of inlet valves, per cylinder			2	2	2	2	2
Number of exhaust valves, per cylinder			2	2	2	2	2
Standard flywheel housing flange (engine main PTO)		SAE	0	0	0	0	0
Flywheel interface		DISC	18"	18"	18"	18"	18"

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Charge air pressure before CP cylinder (abs.)	R	bar ABS	2.8	3.1	2.8	3.1	3.2

COOLING SYSTEM (HT circuit)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Coolant temperature (at engine outlet to cooling equipment)	A	°C	95	95	95	95	95
Coolant temperature after engine, alarm	R	°C	97	97	97	97	97
Coolant temperature after engine, shutdown	L	°C	102	102	102	102	102
Coolant antifreeze content, max. permissible	L	%	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

COOLING SYSTEM (LT circuit)

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Coolant temperature before intercooler (at engine inlet from cooling equipment)	A	°C	55	55	55	55	55
Coolant antifreeze content, max. permissible	L	%	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

LUBE OIL SYSTEM

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Lube oil operating temperature before engine,from	R	°C	88	88	88	88	88
Lube oil operating temp. before engine, to	R	°C	98	98	98	98	98
Lube oil temperature before engine, alarm	R	°C	103	103	103	103	103
Lube oil temperature before engine, shutdown	L	°C	---	---	---	---	---
Lube oil operating press. bef. engine, from	R	bar	6.2	6.2	5.5	5.5	6.0
Lube oil operating press. bef. engine, to	R	bar	7.5	7.5	6.5	6.5	8.0
Lube oil pressure before engine, alarm	R	bar	4.4	4.4	4.5	4.5	4.4
Lube oil pressure before engine, shutdown	L	bar	3.9	3.9	4.0	4.0	3.9

FUEL SYSTEM

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Fuel pressure at supply connection to engine (when engine is starting), min. admissible	L	bar	-0.3	-0.3	-0.3	-0.3	-0.3
Fuel pressure at supply connection to engine (when engine is starting), max. admissible	L	bar	+0.5	+0.5	+0.5	+0.5	+0.5

GENERAL OPERATING DATA

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Cold start capability: air temperature (w/o start aid, w/o preheating) (case A)	R	°C	0**	0**	0**	0**	0**
Coolant preheating: preheating temperature (min.)	R	°C	32	32	32	32	32
Firing speed, from	R	rpm	100	100	100	100	100
Firing speed, to	R	rpm	120	120	120	120	120

CAPACITIES

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine coolant capacity (without cooling equipment)	R	liter	110	110	130	130	140
Intercooler coolant capacity	R	liter	20	20	20	20	20
Engine oil capacity , initial filling (standard-oil system) (Option: max. operating inclinations)	R	liter	77	77	102	102	130
Oil change quantity, max. (standard oil system)	R	liter	N	N	N	N	N
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	liter	74	74	99	99	114
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	50	50	69	69	87
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	67	67	92	92	110

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Engine weight, dry (basic engine configuration acc. to scope of supply specification)	R	kg	2570	2570	3150	3150	3500

ACOUSTICS

Number of cylinders			**12**	**12**	**16**	**16**	**18**
Exhaust noise, unsilenced CP (sound power level LW, ISO 6798)	R	db(A)	127	126	126	128	127
Engine surface noise with attenuated CP intake noise (filter) (sound power level LW, ISO 6798)	R	db(A)	116	117	119	120	123

2.4.11 12/16/18V Continuous operation with variable load: Application group 3B, Water-cooled charge-air, Optimized exhaust emission (EPA 40 CFR89 / Tier 1)

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			**12 V 2000G83**	**16 V 2000G83**	**18 V 2000G83**
Application group			3B	3B	3B
Intake air temperature		°C	25	25	25
Charge-air coolant temperature		°C	55	55	55
Raw-water inlet temperature		°C	---	---	---
Barometric pressure		mbar	1000	1000	1000
Site altitude above sea level		m	100	100	100

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

Number of cylinders			**12**	**16**	**18**
Engine rated speed	A	rpm	1800	1800	1800
Continuous power ISO 3046 (10% overload CP cap., design power DIN 6280, ISO 8528)	A	kW	695	925	1040

GENERAL CONDITIONS (for maximum power)

Number of cylinders			**12**	**16**	**18**
Intake air depression (new filter) (design)	A	mbar	15	15	15
Intake air depression (limit value)	L	mbar	30	30	30
Exhaust backpressure (design)	A	mbar	30	30	30
Exhaust backpressure (limit value)	L	mbar	50	50	50

MODEL-RELATED DATA (basic design)

Number of cylinders			**12**	**16**	**18**
Engine with exhaust turbocharging (ETC) and charge air cooling (CAC)			X	X	X
Exhaust piping, non-cooled			X	X	X
Working method: four-cycle, diesel, single-acting			X	X	X
Combustion method: direct fuel injection			X	X	X
Cooling system: conditioned water			X	X	X
Direction of rotation: c.c.w. (facing driving end)			X	X	X
Number of cylinders			12	16	18
Cylinder configuration: V angle		degrees	90	90	90
Bore		mm	130	130	130
Stroke		mm	150	150	150
Displacement, cylinder		liter	1.99	1.99	1.99
Displacement, total		liter	23.88	31.84	35.82
Compression ratio			14	14	14
Cylinder heads: single-cylinder			X	X	X
Cylinder liners: wet, replaceable			X	X	X
Number of inlet valves, per cylinder			2	2	2
Number of exhaust valves, per cylinder			2	2	2
Standard flywheel housing flange (engine main PTO)		SAE	0	0	0
Flywheel interface		DISC	18"	18"	18"

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			**12**	**16**	**18**
Charge air pressure before CP cylinder (abs.)	R	bar ABS	3.0	3.0	3.0

COOLING SYSTEM (HT circuit)

Number of cylinders			**12**	**16**	**18**
Coolant temperature (at engine outlet to cooling equipment)	A	°C	95	95	95
Coolant temperature after engine, alarm	R	°C	97	97	97
Coolant temperature after engine, shutdown	L	°C	102	102	102
Coolant antifreeze content, max. permissible	L	%	50	50	50
Pressure loss in the external cooling system, max. permissible	L	bar	0.7	0.7	0.7

COOLING SYSTEM (LT circuit)

Number of cylinders			**12**	**16**	**18**
Coolant temperature before intercooler (at engine inlet from cooling equipment)	A	°C	55	55	55
Coolant antifreeze content, max. permissible	L	%	50	50	50
Pressure loss in the external cooling system, max. permissible	L	bar	0.7	0.7	0.7

LUBE OIL SYSTEM

Number of cylinders			**12**	**16**	**18**
Lube oil operating temperature before engine,from	R	°C	88	88	88
Lube oil operating temp. before engine, to	R	°C	98	98	98
Lube oil temperature before engine, alarm	R	°C	103	103	103
Lube oil temperature before engine, shutdown	L	°C	---	---	---
Lube oil operating press. bef. engine, from	R	bar	6.5	6.0	6.5
Lube oil operating press. bef. engine, to	R	bar	7.5	7.0	8.5
Lube oil pressure before engine, alarm	R	bar	5.5	5.5	5.5
Lube oil pressure before engine, shutdown	L	bar	5.0	5.0	5.0

FUEL SYSTEM

Number of cylinders			**12**	**16**	**18**
Fuel pressure at supply connection to engine (when engine is starting), min. admissible	L	bar	-0.3	-0.3	-0.3
Fuel pressure at supply connection to engine (when engine is starting), max. admissible	L	bar	+0.5	+0.5	+0.5

GENERAL OPERATING DATA

Number of cylinders			**12**	**16**	**18**
Cold start capability: air temperature (w/o start aid, w/o preheating) (case A)	R	°C	0**	0**	0**
Coolant preheating: preheating temperature (min.)	R	°C	32	32	32
Firing speed, from	R	rpm	100	100	100
Firing speed, to	R	rpm	120	120	120

CAPACITIES

Number of cylinders			**12**	**16**	**18**
Engine coolant capacity (without cooling equipment)	R	liter	110	130	140
Intercooler coolant capacity	R	liter	20	20	20
Engine oil capacity , initial filling (standard-oil system) (Option: max. operating inclinations)	R	liter	77	102	130
Oil change quantity, max. (standard oil system)	R	liter	N	N	N
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	liter	74	99	114
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	50	69	87
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	67	92	110

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			**12**	**16**	**18**
Engine weight, dry (basic engine configuration acc. to scope of supply specification)	R	kg	2570	3150	3500

ACOUSTICS

Number of cylinders			**12**	**16**	**18**
Exhaust noise, unsilenced CP (sound power level LW, ISO 6798)	R	db(A)	129	128	N
Engine surface noise with attenuated CP intake noise (filter) (sound power level LW, ISO 6798)	R	db(A)	119	121	N

2.4.12 12/16/18V 2000 Continuous operation, unrestricted: Application group 3B, Water-cooled charge-air, Optimized fuel consumption, Optimized exhaust emission (EPA 40 CFR89 / Tier 1)

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			**12 V 2000G63**	**16 V 2000G63**	**18 V 2000G63**	**12 V 2000G83 ***	**16 V 2000G83 ***	**18 V 2000G83 ***
Application group			3A	3A	3A	3A	3A	3A
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			**12**	**16**	**18**	**12**	**16**	**18**
Engine rated speed	A	rpm	1500	1500	1500	1800	1800	1800
Continuous power ISO 3046 (10% overload CP cap., design power DIN 6280, ISO 8528)	A	kW	515	655	720	625	835	900

GENERAL CONDITIONS (for maximum power)

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
Intake air depression (new filter) (design)	A	mbar	15	15	15	30	30	30
Intake air depression (limit value)	L	mbar	30	30	30	50	50	50
Exhaust backpressure (design)	A	mbar	30	30	30	50	50	50
Exhaust backpressure (limit value)	L	mbar	50	50	50	100	100	100

MODEL-RELATED DATA (basic design)

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
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			12	16	18	12	16	18
Cylinder configuration: V angle		degrees	90	90	90	90	90	90
Bore		mm	130	130	130	130	130	130
Stroke		mm	150	150	150	150	150	150

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
Displacement, cylinder		liter	1.99	1.99	1.99	1.99	1.99	1.99
Displacement, total		liter	23.88	31.84	35.82	23.88	31.84	35.82
Compression ratio			16	16	16	14	14	14
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	0	0	0	0	0	0
Flywheel interface		DISC	18"	18"	18"	18"	18"	18"

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
Charge air pressure before CP cylinder (abs.)	R	bar ABS	2.4	2.3	2.4	2.8	2.9	2.9

COOLING SYSTEM (HT circuit)

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
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	102	102	102	102	102	102
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			**12**	**16**	**18**	**12**	**16**	**18**
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			**12**	**16**	**18**	**12**	**16**	**18**
Lube oil operating temperature before engine,from	R	°C	88	88	88	88	88	88
Lube oil operating temp. before engine, to	R	°C	98	98	98	98	98	98
Lube oil temperature before engine, alarm	R	°C	103	103	103	103	103	103
Lube oil temperature before engine, shutdown	L	°C	---	N	---	---	---	---
Lube oil operating press. bef. engine, from	R	bar	6.2	5.5	6.0	6.5	6.0	6.5
Lube oil operating press. bef. engine, to	R	bar	7.5	6.5	8.0	7.8	7.0	8.5
Lube oil pressure before engine, alarm	R	bar	4.4	4.5	4.4	5.5	5.5	5.5
Lube oil pressure before engine, shutdown	L	bar	3.9	4.0	3.9	5.0	5.0	5.0

FUEL SYSTEM

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
Fuel pressure at supply connection to engine (when engine is starting), min. admissible	L	bar	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
Fuel pressure at supply connection to engine (when engine is starting), max. admissible	L	bar	+0.5	+0.5	+0.5	+0.5	+0.5	+0.5

GENERAL OPERATING DATA

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
Cold start capability: air temperature (w/o start aid, w/o preheating) (case A)	R	°C	0**	0**	0**	0**	0**	0**
Coolant preheating: preheating temperature (min.)	R	°C	32	32	32	32	32	32
Firing speed, from	R	rpm	100	100	100	100	100	100
Firing speed, to	R	rpm	120	120	120	120	120	120

CAPACITIES

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
Engine coolant capacity (without cooling equipment)	R	liter	110	130	140	110	130	140
Intercooler coolant capacity	R	liter	20	20	20	20	20	20
Engine oil capacity , initial filling (standard-oil system) (Option: max. operating inclinations)	R	liter	77	102	130	77	102	130
Oil change quantity, max. (standard oil system)	R	liter	N	N	N	N	N	N
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	liter	74	99	114	74	99	114
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	50	69	87	50	69	87
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	67	92	110	67	92	110

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
Engine weight, dry (basic engine configuration acc. to scope of supply specification)	R	kg	2570	3150	3500	2570	3180	3500

ACOUSTICS

Number of cylinders			**12**	**16**	**18**	**12**	**16**	**18**
Exhaust noise, unsilenced CP (sound power level LW, ISO 6798)	R	db(A)	123	123	125	126	126	126
Engine surface noise with attenuated CP intake noise (filter) (sound power level LW, ISO 6798)	R	db(A)	116	119	120	118	119	N

2.4.13 Firing order

Firing order

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

2.4.14 Final compression pressure

Final compression pressure

Final compression pressure at 120 rpm	30 bar to 36 bar

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/..).
Lube oil system	Check oil level (→ Page 6 – 41);
Fuel prefilter	Prime (→ Page 6 – 32).
Fuel prefilter, pressure gauge	Align adjustable pointer with position of pressure indicator (→ Page 6 – 27).
Fuel system	Vent (→ Page 6 – 23).
Cooling system	If engine is out of service for more than one year, change engine coolant (→ Page 6 – 45); Change charge-air coolant (→ Page 6 – 51).
Cooling system	Check engine coolant level (→ Page 6 – 46); Check charge-air coolant level (→ Page 6 – 52).
Cooling system	Preheat coolant with preheating unit.
ECU	Check plug-in connections (→ Page 6 – 65).
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 6 – 41);
Cooling system	Check engine coolant level (→ Page 6 – 46); Check charge-air coolant level (→ Page 6 – 52).
Cooling system	Preheat coolant with preheating unit.
Fuel prefilter	Drain (→ Page 6 – 28).
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/plant and all pipework visually for leaks, rectify any leaks with the engine stopped. Check for abnormal running noises and vibrations.
Fuel prefilter	Check if indicated differential pressure is within the limit (→ Page 6 – 27).
Exhaust system	Check exhaust color (→ Page 5 – 01).
Intercooler	Check condensate drain(s) for water discharge and obstruction (→ Page 6 – 34).
Air filter	Check signal ring position of service indicator (→ Page 6 – 37); Replace air filter (→ Page 6 – 35), if the signal ring is completely visible in the service indicator control window.
Coolant pump	Check relief bore (→ Page 6 – 47).
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 6 – 44); Drain charge-air coolant (→ Page 6 – 50) 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 Maintenance and Servicing

4.1.1 Maintenance and servicing

Preface

Low operating and maintenance costs as well as operational reliability and availability depend on maintenance and servicing being carried out in compliance with MTU's specifications and instructions.

The overall system, of which the engine is an integral part, must be maintained in such a way as to ensure trouble-free engine operation. For this purpose always:

- ensure that sufficient fuel of specified quality is available
- that the combustion air is dry and clean

Preventive maintenance instructions:

- Special care should be taken to keep the machinery plant in a clean and serviceable condition at all times to facilitate detection of possible leaks and prevent subsequent damage.
- Protect rubber and synthetic parts from oil and fuel, never treat with organic detergents, only wipe with dry cloth.
- Always replace all seals and gaskets. Our Service partner will always be available should assistance be required.

MTU maintenance concept

The MTU maintenance concept is a preventive maintenance concept.

Preventive maintenance permits advance operational planning and increases availability. The maintenance schedule refers to the specified load profile. 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. Specific operating conditions may require modifications to the Maintenance Schedule. Exchange parts (reliabilt®) are available for components to be replaced.

Note

The maintenance task matrix covers all tasks up to a major overhaul. After a major overhaul, the maintenance tasks must continue to be performed in accordance with the specified schedule.

The specification of fluids and lubricants, guidelines for maintenance and change intervals as well as a list of approved fluids and lubricants are provided in the MTU Fluids and Lubricants Specification A001061. Use only fluids and lubricants which comply with the MTU Fluids and Lubricants Specification.

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

- Fuel prefilter:

  Maintenance depends on fuel quality (purity). The filter elements of the fuel prefilter must be replaced every 2 years at the latest.
- Battery:

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

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 Specification, MTU Publication No. A001061.

4.2 Maintenance Schedule – Application Group 3D

4.2.1 Maintenance schedule

Application group

3D	Standby operation, load factor: < 85%

Load profile

Load factor	100%	85%
Corresponding operating time	5%	95%

Maintenance schedule matrix

	Engine oil filter	Belt drive	Coolant cooler	Fuel filter	Valve gear	Air filter	Fuel injectors	Fuel injection pumps	Combustion chambers
Maintenance level	W2	W2	W3	W3	W3	W4	W4	W4	W4
Time limit, years	2	2	1	2	-	3	-	-	4
Operating hours									
Daily									
500			X	X	X				
1000			X	X	X				
1500			X	X	X				
2000			X	X	X				
2500			X	X	X				
3000		X	X	X	X	X	X		X
3500			X	X	X				
4000			X	X	X				
4500			X	X	X				
5000			X	X	X				
5500			X	X	X				
6000		X	X	X	X	X	X	X	X

Maintenance tasks

Maintenance level	Interval (hours/years)	Item	Maintenance tasks
W2	0 / 2	Engine oil filter	Replace when changing the oil or when the interval/years is reached, at the latest (→ Page 6 – 42).
W2	3000 / 2	Belt drive	Check drive belt condition and tension, replace if necessary: • Battery-charging generator drive (→ Page 6 – 56) • Ventilator drive (→ Page 6 – 57).
W3	500 / -	Valve gear	Check valve clearance (→ Page 6 – 10).
W3	500 / 1	Coolant cooler	Check cooler elements for external contamination (see manufacturer's documentation).
W3	500 / 2	Fuel filter	Replace fuel filter or fuel filter element (→ Page 6 – 32).
W4	3000 / -	Fuel injectors	Replace injectors (→ Page 6 – 18).
W4	3000 / 3	Air filter	Replace air filter (→ Page 6 – 35).
W4	3000 / 4	Combustion chambers	Perform endoscopic examination (→ Page 6 – 04).
W4	6000 / -	Fuel injection pumps	Replace fuel injection pumps (→ Page 6 – 14).

4.3 Maintenance Schedule – Application Group 3B

4.3.1 Maintenance schedule

Application group

3B	Continuous operation with variable load, load factor: < 75%

Load profile

Load factor	110%	100%	70%
Corresponding operating time	1%	9%	90%

Maintenance schedule matrix

	Engine oil filter	Belt drive	Coolant cooler	Fuel filter	Valve gear	Air filter	Fuel injectors	Fuel injection pumps	Combustion chambers
Maintenance level	W2	W2	W3	W3	W3	W4	W4	W4	W4
Time limit, years	2	2	1	2	-	3	-	-	4
Operating hours									
Daily									
500			X	X	X				
1000			X	X	X				
1500			X	X	X				
2000			X	X	X				
2500			X	X	X				
3000		X	X	X	X	X	X		X
3500			X	X	X				
4000			X	X	X				
4500			X	X	X				
5000			X	X	X				
5500			X	X	X				
6000		X	X	X	X	X	X	X	X

Maintenance tasks

Maintenance level	Interval (hours/years)	Item	Maintenance tasks
W2	0 / 2	Engine oil filter	Replace when changing the oil or when the interval/years is reached, at the latest (→ Page 6 – 42).
W2	3000 / 2	Belt drive	Check drive belt condition and tension, replace if necessary: • Battery-charging generator drive (→ Page 6 – 56) • Ventilator drive (→ Page 6 – 57).
W3	500 / -	Valve gear	Check valve clearance (→ Page 6 – 10).
W3	500 / 1	Coolant cooler	Check cooler elements for external contamination (see manufacturer's documentation).
W3	500 / 2	Fuel filter	Replace fuel filter or fuel filter element (→ Page 6 – 32).
W4	3000 / -	Fuel injectors	Replace injectors (→ Page 6 – 18).
W4	3000 / 3	Air filter	Replace air filter (→ Page 6 – 35).
W4	3000 / 4	Combustion chambers	Perform endoscopic examination (→ Page 6 – 04).
W4	6000 / -	Fuel injection pumps	Replace fuel injection pumps (→ Page 6 – 14).

4.4 Maintenance Schedule – Application Group 3B TAL

4.4.1 Maintenance schedule

Application group

3B Continuous operation with variable load, load factor: < 75%

Load profile

Load factor	110%	100%	70%
Corresponding operating time	1%	9%	90%

Maintenance schedule matrix

	Engine oil filter	Engine oil	Belt drive	Coolant cooler	Fuel filter	Valve gear	Air filter	Fuel injectors	Fuel injection pumps	Combustion chambers
Maintenance level	W2	W2	W2	W3	W3	W3	W4	W4	W4	W4
Time limit, years	2	-	2	1	2	-	3	-	-	4
Operating hours										
Daily	X									
250		X								
500		X		X	X	X				
750		X								
1000		X		X	X	X				
1250		X								
1500		X		X	X	X				
1750		X								
2000		X		X	X	X				

	Engine oil filter	Engine oil	Belt drive	Coolant cooler	Fuel filter	Valve gear	Air filter	Fuel injectors	Fuel injection pumps	Combustion chambers
2250		X								
2500		X		X	X	X				
2750		X								
3000		X	X	X	X	X	X	X		X
3250		X								
3500		X		X	X	X				
3750		X								
4000		X		X	X	X				
4250		X								
4500		X		X	X	X				
4750		X								
5000		X		X	X	X				
5250		X								
5500		X		X	X	X				
5750		X								
6000		X	X	X	X	X	X	X	X	X

Maintenance tasks

Maintenance level	Interval (hours/years)	Item	Maintenance tasks
W2	1 / 2	Engine oil filter	Replace when changing the oil or when the interval/years is reached, at the latest (→ Page 6 – 42).
W2	250 / -	Engine oil	Change engine oil (→ Page 6 – 39).
W2	3000 / 2	Belt drive	Check drive belt condition and tension, replace if necessary: • Battery-charging generator drive (→ Page 6 – 56) • Ventilator drive (→ Page 6 – 57).
W3	500 / -	Valve gear	Check valve clearance (→ Page 6 – 10).
W3	500 / 1	Coolant cooler	Check cooler elements for external contamination (see manufacturer's documentation).
W3	500 / 2	Fuel filter	Replace fuel filter or fuel filter element (→ Page 6 – 32).
W4	3000 / -	Fuel injectors	Replace injectors (→ Page 6 – 18).
W4	3000 / 3	Air filter	Replace air filter (→ Page 6 – 14).
W4	3000 / 4	Combustion chambers	Perform endoscopic examination (→ Page 6 – 04).
W4	6000 / -	Fuel injection pumps	Replace fuel injection pumps (→ Page 6 – 14).

4.5 Maintenance Schedule – Application Group 3A

4.5.1 Maintenance schedule

Application group

3A	Continuous operation, unrestricted, load factor: 100%

Load profile

Load factor	110%	100%
Corresponding operating time	1%	99%

Maintenance schedule matrix

	Engine oil filter	Belt drive	Coolant cooler	Fuel filter	Valve gear	Air filter	Fuel injectors	Fuel injection pumps	Combustion chambers
Maintenance level	W2	W2	W3	W3	W3	W4	W4	W4	W4
Time limit, years	2	2	1	2	-	3	-	-	4
Operating hours									
Daily									
500				X					
1000			X	X	X				
1500				X					
2000			X	X	X				
2500				X					
3000		X	X	X	X	X	X		X
3500				X					
4000			X	X	X				
4500				X					
5000			X	X	X				
5500				X					
6000		X	X	X	X	X	X	X	X

Maintenance tasks

Maintenance level	Interval (hours/years)	Item	Maintenance tasks
W2	0 / 2	Engine oil filter	Replace when changing the oil or when the interval/years is reached, at the latest (→ Page 6 – 42).
W2	3000 / 2	Belt drive	Check drive belt condition and tension, replace if necessary: • Battery-charging generator drive (→ Page 6 – 56) • Ventilator drive (→ Page 6 – 57).
W3	500 / 2	Fuel filter	Replace fuel filter or fuel filter element (→ Page 6 – 32).
W3	1000 / -	Valve gear	Check valve clearance (→ Page 6 – 10).
W3	1000 / 1	Coolant cooler	Check cooler elements for external contamination (see manufacturer's documentation).
W4	3000 / -	Fuel injectors	Replace injectors (→ Page 6 – 18).
W4	3000 / 3	Air filter	Replace air filter (→ Page 6 – 35).
W4	3000 / 4	Combustion chambers	Perform endoscopic examination (→ Page 6 – 04).
W4	6000 / -	Fuel injection pumps	Replace fuel injection pumps (→ Page 6 – 14).

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 6 – 62).
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 6 – 65).
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 6 – 62).
Fuel system	Not vented	Vent fuel system (→ Page 6 – 23).
ECU	Defective	Contact Service.

Engine fires unevenly

Component	Probable Cause	Task
Fuel injection equipment	Injector defective	Replace (→ Page 6 – 18).
	Injection pump defective	Replace (→ Page 6 – 15).
Engine wiring	Defective	Check (→ Page 6 – 62).
Fuel system	Not vented	Vent fuel system (→ Page 6 – 23).
ECU	Defective	Contact Service.

Engine does not reach nominal speed

Component	Probable Cause	Task
Fuel supply	Fuel prefilter clogged	Replace (→ Page 6 – 32).
	Fuel filter clogged	Replace (→ Page 6 – 25).
Air supply	Air filter clogged	Check signal ring position of service indicator (→ Page 6 – 37).
Fuel injection equipment	Injector defective	Replace (→ Page 6 – 18).
	Injection pump defective	Replace (→ Page 6 – 15).
Engine wiring	Defective	Check (→ Page 6 – 62).
Engine	Overloaded	Contact Service.

Engine speed not steady

Component	Probable Cause	Task
Fuel injection equipment	Injector defective	Replace (→ Page 6 – 18).
	Injection pump defective	Replace (→ Page 6 – 15).
Speed sensor	Defective	Contact Service.
Fuel system	Not vented	Vent fuel system (→ Page 6 – 23).
ECU	Defective	Contact Service.

Charge-air temperature too high

Component	Probable Cause	Task
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 6 – 37).
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 6 – 37).
Fuel injection equipment	Injector defective	Replace (→ Page 6 – 18).
	Injection pump defective	Replace (→ Page 6 – 15).
Engine	Overloaded	Contact Service.

Exhaust gas blue

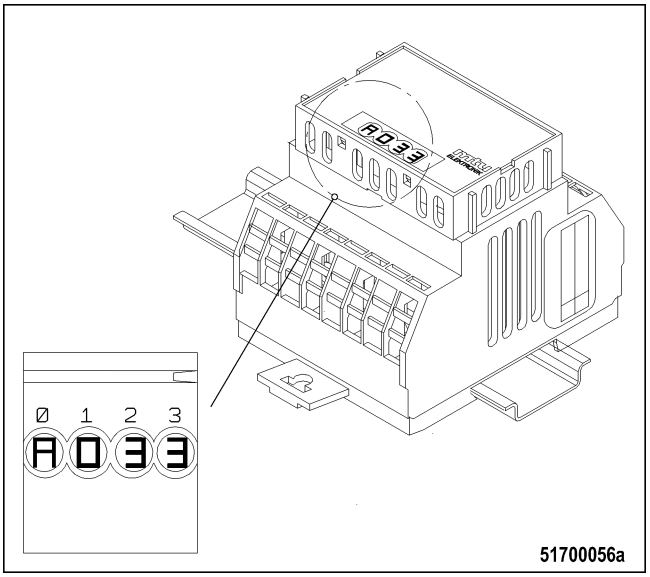
Component	Probable Cause	Task
Engine oil	Too much oil in engine	Drain engine oil (→ Page 6 – 39).
	Oil separator of crankcase breather contaminated	Replace (→ Page 6 – 08).
Exhaust turbocharger, cylinder head, piston rings, cylinder liner	Defective	Contact Service.

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 6 – 28).
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 6 – 41);
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 6 – 41); 2. Try to re-start the engine (→ Page 3 – 03). 3. Contact Service.

Fault code	Alarm text	Meaning	Task
023	L1 COOLANT LEVEL	Engine coolant level too low	Check coolant level and top up, if required (→ Page 6 – 46) .
024	L2 COOLANT LEVEL	Engine coolant level too low	Check coolant level and top up, if required (→ Page 6 – 46) .
030	ENGINE OVERSPEED	Engine overspeed; automatic engine shutdown	1. Acknowledge alarm. 2. Try to re-start the engine (→ Page 3 – 03). 3. Contact Service.
044	L1 LEVEL INTERCOOLER	Charge-air coolant level too low (1st limit)	Check coolant level and top up, if required (→ Page 6 – 52) .
045	L2 LEVEL INTERCOOLER	Charge-air coolant level too low (2nd limit)	1. Check coolant level and top up, if required (→ Page 6 – 52) . 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 6 – 26). 3. Flush fuel prefilter (→ Page 6 – 30). 4. Replace filter element of fuel prefilter (→ Page 6 – 32). 5. Replace filter element of fuel prefilter (→ Page 6 – 25). 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 6 – 26). 3. Flush fuel prefilter (→ Page 6 – 30). 4. Replace filter element of fuel prefilter (→ Page 6 – 32). 5. Replace filter element of fuel prefilter (→ Page 6 – 25). 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 3 – 03). 4. If fault occurs repeatedly: Contact Service.

Fault code	Alarm text	Meaning	Task
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)
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 3 – 03).
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 3 – 03).
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	1. Check wiring (CAN bus). 2. Contact Service.
181	CAN2 NODE LOST	At least one device not detected on Redundant CAN bus	1. Check wiring (CAN bus). 2. Contact 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)	1. Check wiring. 2. Contact Service.
202	SD T-FUEL	Sensor defect (Fuel temperature)	1. Check wiring. 2. Contact Service.
203	SD T-CHARGE AIR	Sensor defect (charge-air temperature)	1. Check wiring. 2. Contact Service.
205	SD T-COOLANT INTERC.	Sensor defect (charge-air coolant temperature)	1. Check wiring. 2. Contact Service.
208	SD P-CHARGE AIR	Sensor defect (charge-air pressure)	1. Check wiring. 2. Contact Service.
211	SD P-LUBE OIL	Sensor defect (lube oil pressure)	1. Check wiring. 2. Contact Service.
215	SD P-RAIL FUEL	Sensor defect (common rail pressure); HP controller in emergency mode	1. Check wiring. 2. Contact Service.
216	SD T-LUBE OIL	Sensor defect (lube oil temperature)	1. Check wiring. 2. Contact Service.
220	SD COOLANT LEVEL	Sensor defect (coolant level)	1. Check wiring. 2. Contact Service.
223	SD LEVEL INTERCOOLER	Sensor defect (charge-air coolant level)	1. Check wiring. 2. Contact Service.
229	SD ENG.SPEED SENSORS	Sensor defect (crankshaft speed) and sensor defect (camshaft speed)	1. Check wiring. 2. Contact Service.
230	SD CRANKSHAFT SPEED	Sensor defect (crankshaft speed)	1. Check wiring. 2. Contact Service.
231	SD CAMSHAFT SPEED	Sensor defect (camshaft speed)	1. Check wiring. 2. Contact Service.
240	SD P-FUEL	Sensor defect (fuel pressure)	1. Check wiring. 2. Contact 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)	1. Check speed transmitter. 2. Check wiring (CAN bus). 3. Contact Service.
266	SD SPEED DEMAND AN.	Sensor defect (analog nominal speed demand)	1. Check speed transmitter. 2. Check wiring. 3. Contact Service.
267	SD SP.DEM.TEST BENCH	Sensor defect (analog speed demand); NOTE: Only used in test-stand operation.	1. Check speed transmitter. 2. Check wiring. 3. Contact Service.
270	SD SPEED DEMAND FI1	Sensor defect (frequency input for speed demand);	1. Check speed transmitter. 2. Check wiring. 3. Contact 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	1. Check wiring. 2. Contact Service.
322	WIRING CYLINDER A2	Faulty wiring to solenoid valve cylinder A2; Misfiring	1. Check wiring. 2. Contact Service.
323	WIRING CYLINDER A3	Faulty wiring to solenoid valve cylinder A3; Misfiring	1. Check wiring. 2. Contact Service.
324	WIRING CYLINDER A4	Faulty wiring to solenoid valve cylinder A4; Misfiring	1. Check wiring. 2. Contact Service.
325	WIRING CYLINDER A5	Faulty wiring to solenoid valve cylinder A5; Misfiring	1. Check wiring. 2. Contact Service.

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

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

Fault code	Alarm text	Meaning	Task
354	OPEN_LOAD CYL. B4	Disconnection in wiring to solenoid valve cylinder B4; Misfiring	1. Check wiring. 2. Contact Service.
355	OPEN_LOAD CYL. B5	Disconnection in wiring to solenoid valve cylinder B5; Misfiring	1. Check wiring. 2. Contact Service.
356	OPEN_LOAD CYL. B6	Disconnection in wiring to solenoid valve cylinder B6; Misfiring	1. Check wiring. 2. Contact Service.
357	OPEN_LOAD CYL. B7	Disconnection in wiring to solenoid valve cylinder B7; Misfiring	1. Check wiring. 2. Contact Service.
358	OPEN_LOAD CYL. B8	Disconnection in wiring to solenoid valve cylinder B8; Misfiring	1. Check wiring. 2. Contact Service.
359	OPEN_LOAD CYL. B9	Disconnection in wiring to solenoid valve cylinder B9; Misfiring	1. Check wiring. 2. Contact Service.
360	OPEN_LOAD CYL. B10	Disconnection in wiring to solenoid valve cylinder B10; Misfiring	1. Check wiring. 2. Contact 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	1. Check wiring. 2. Try to re-start the engine (→ Page 3 – 03). 3. Contact Service.
364	STOP POWER STAGE 2	Solenoid valve or wiring or ECU defective automatic engine shutdown	1. Check wiring. 2. Try to re-start the engine (→ Page 3 – 03). 3. Contact Service.
365	STOP MV-WIRING	Solenoid-valve wiring faulty; automatic engine shutdown	1. Check wiring. 2. Try to re-start the engine (→ Page 3 – 03). 3. Contact 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.
384	TRAN.OUT4 PLANT DEF	Binary transistor output plant 4 defective	Contact Service.

Fault code	Alarm text	Meaning	Task
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 Description

6.1 Engine

6.1.1 Engine – Barring manually

Preconditions

- Engine is stopped and starting disabled.

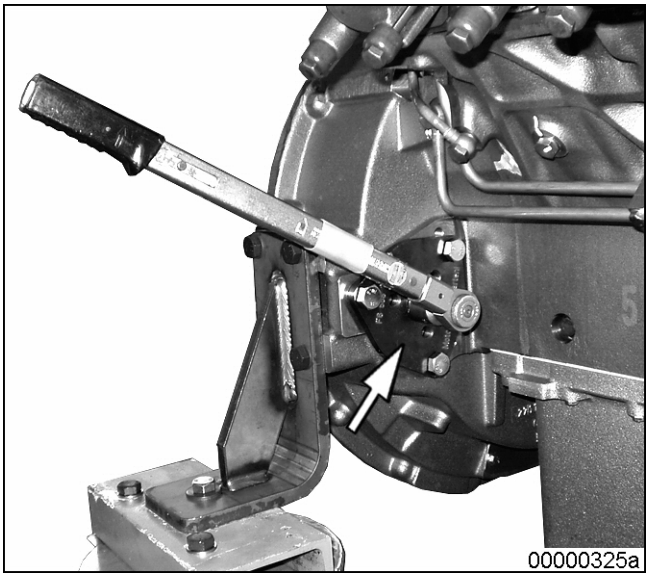
Special tools

Designation / Use	Part No.	Qty.
Barring tool for 12V engines		
Barring tool for 16/18V engines		

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 manually

1. Remove cover from flywheel housing.
2. Install barring tool (arrow) on flywheel housing.
3. Rotate crankshaft in engine direction of rotation. Apart from the normal compression resistance, there should be no abnormal resistance.

   Result: If the resistance exceeds the normal compression resistance, contact Service.
4. For barring-tool removal follow reverse sequence of working steps.

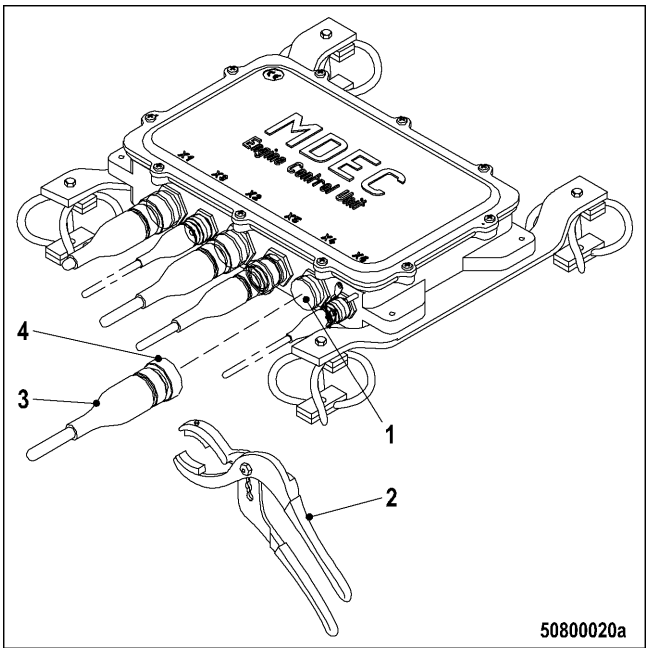
6.1.2 Engine – barring with starting system

Special tools

Designation / Use	Part No.	Qty.
Connector pliers		

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.



Barring engine 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 3 – 03).
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 3 – 05).
4. Stop engine (→ Page 3 – 06).

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, max. diameter: 7 mm		

Preparatory steps

1. Remove cylinder-head cover (→ Page 6 – 13).
2. Remove injector (→ Page 6 – 19).

Bringing the piston to BDC position

1. Use the barring tool to rotate the crankshaft until the crank pin of the cylinder to be inspected is at BDC position.
2. Insert the endoscope through the cylinder-head injector bore into the combustion chamber.

Findings	Task
• Thin carbon deposits around the carbon-residue control ring • Light, localized additive deposits on upper surface • Polished spots on lower edge • Ring of oil deposits in the area between the positions of the upper piston-ring and the lower edge of the carbon-residue control ring • Start of traces left by upper piston ring • Bright surface round circumference • Even honing pattern without complaint • Start of traces left by lower cooling-oil bores • Wear pattern appears to be darker	No measures necessary.
• Oxidation discoloration of even or uneven intensity. • Start and end of discolored areas have no clear edges and do not extend over the whole stroke length • Discolored areas become lighter in upper part of cooling bore; rest of circumference without complaint • Piston-ring set without complaint	Further endoscope check necessary during maintenance work.
• In addition to bright discolorations (which are not critical for engine operation), evidently darker "black zones" all over the running surface, beginning at upper-piston-ring TDC position • Overheating discoloration in piston stroke direction with damaged honing pattern • Piston rings show overheating discoloration	Cylinder liner must be replaced. Contact Service.

Cylinder-liner endoscopic examination

1. Assess findings of endoscopic examination using the above table.
2. For description of findindings on cylinder liner surface use the specified terms (→ Page 6 – 06).
3. Depending on the findings:
   - Do not take any measures, or
   - Conduct endoscopic examination of another liner in the course of maintenance work; or
   - Contact Service: Cylinder liner must be replaced.

Final steps

1. Install injector (→ Page 6 – 19).
2. Install cylinder-head cover (→ Page 6 – 13).

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

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 stroke direction. Findings not critical.
Scored area	These areas consist of scorings next to one another of different length and depth. 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 to 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 towards the second TDC-ring . The honing pattern is usually not visible any more and has 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.
Corrosion	Corrosion traces have irregular circumferential length and depth. They can be caused by either the piston skirt or crown. The material deposit on the liner (smear) shows heavy discoloration and heavy scoring. Replace liner.

Evaluation of findings and further measures

The findings in the start phase of oxidation discoloration and heat discoloration are similar. A definite opinion can first be made after a careful inspection and reference to the above criteria. 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 and diaphragm check

Preconditions

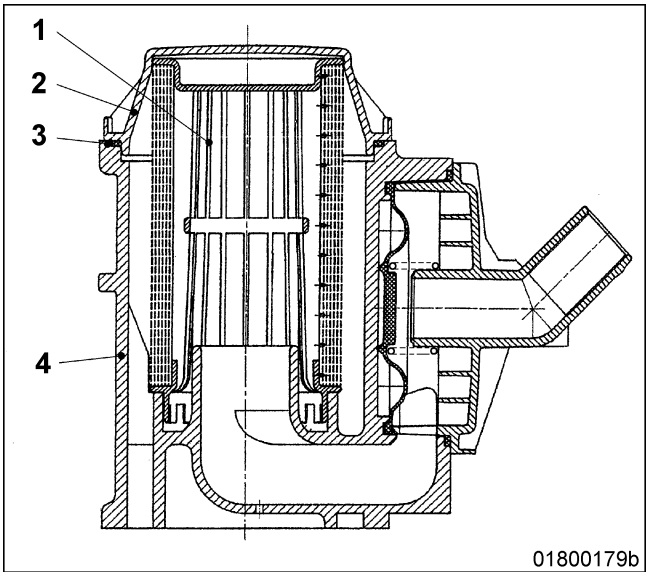
- Engine is stopped and starting disabled.

Special tools

Designation / Use	Part No.	Qty.
Torque wrench		

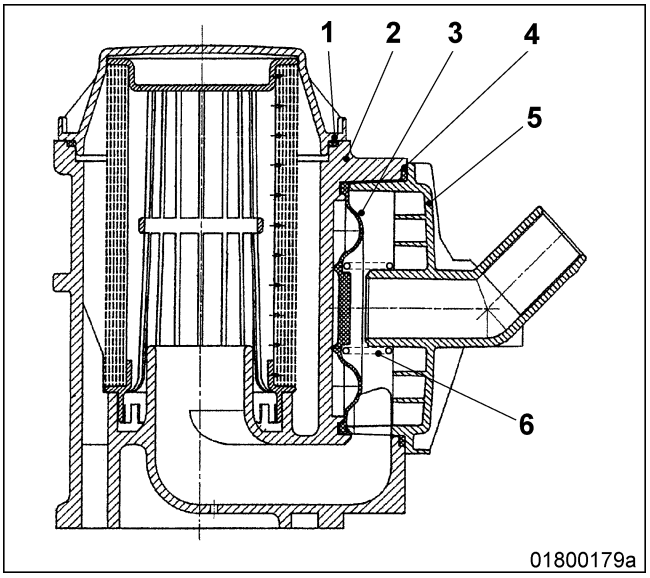
Spare parts

Designation / Use	Part No.	Qty.
Filter element		
Diaphragm		
O-ring		



Oil separator replacement

1. Remove cover (2) with O-ring (3).
2. Remove filter element (1) from housing (4).
3. Insert new filter element into housing (4) observing correct installation position, and fit cover (2) with new sealing ring.
4. Tighten screws of cover (2) to 6 Nm + 2 Nm.
5. Replace filter elements of further oil separators in the same way.



Diaphragm check

1. Remove cover (5).
2. Take off spring (6), seal (4) and diaphragm (3).
3. Check diaphragm (3) for damage.
4. Replace diaphragm if damaged.
5. Mount diaphragm (3) on housing (2).
6. Install new seal (4) and spring (6) together with cover (5).
7. Tighten screws of cover (5) to 6 Nm + 2 Nm.
8. Check diaphragms in further oil separators in the same way.

6.4 Valve Gear

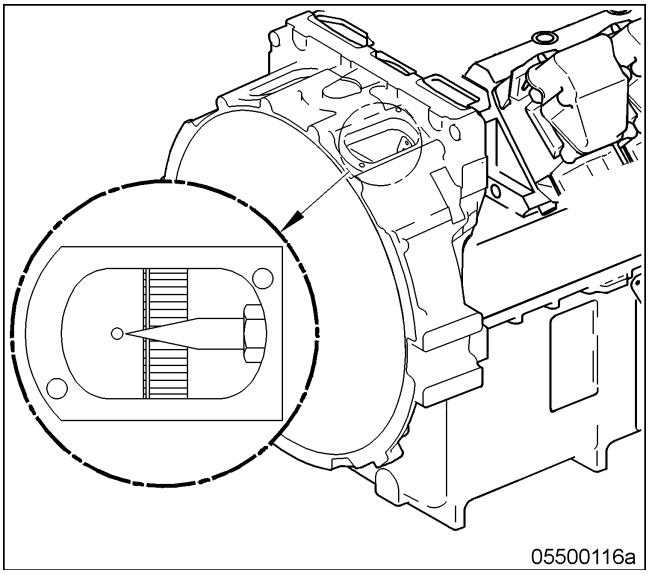
6.4.1 Valve clearance – Check and adjustment

Preconditions

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

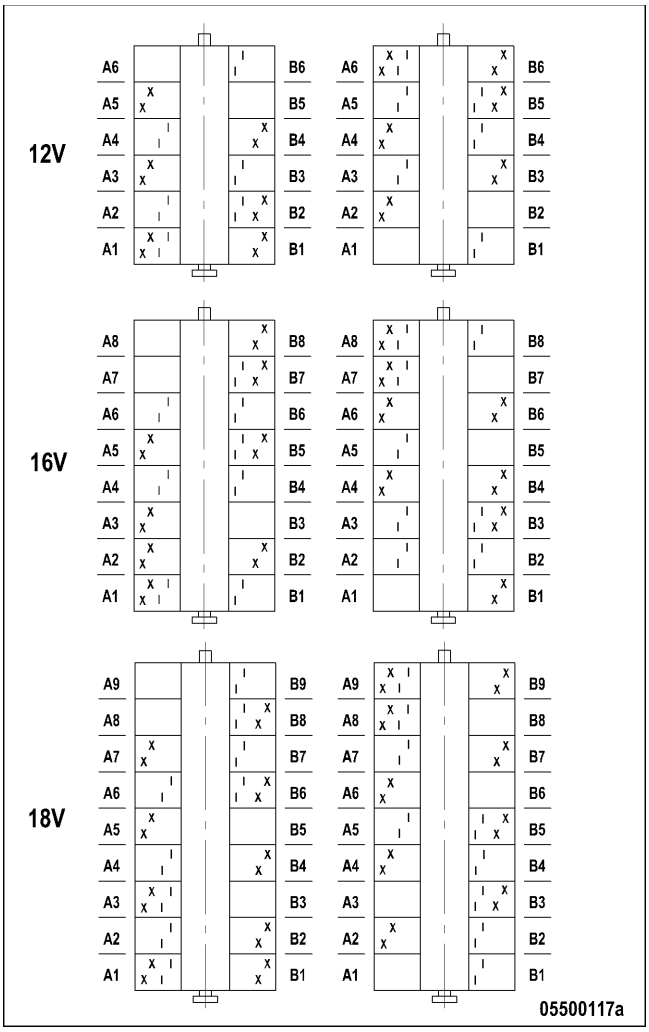
Special tools

Designation / Use	Part No.	Qty.
Feeler gauge		

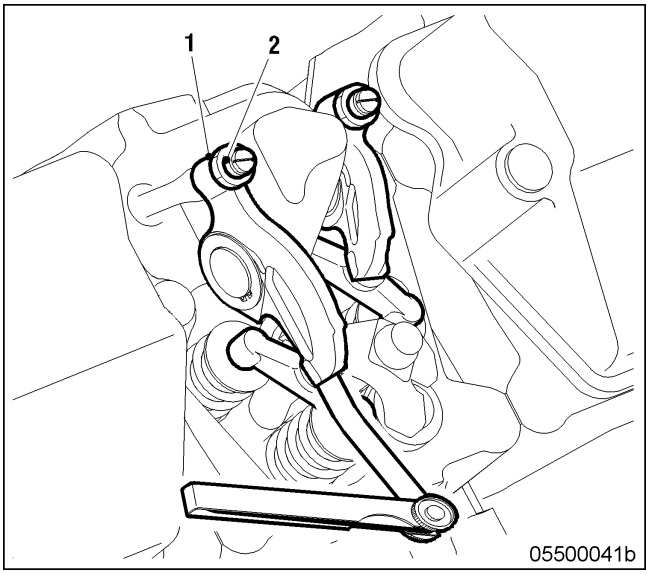


Preparatory steps

1. Remove cylinder-head cover (→ Page 6 – 13).
2. Use barring tool to bar engine manually in engine direction of rotation (→ Page 6 – 01), until the markings are aligned.



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



Adjusting valve clearance in two crankshaft positions

1. Check TDC position of piston in cylinder A1:
   - If the rocker arms are not under load on cylinder A, the piston is in firing TDC.
   - If the rocker arms are under load on cylinder A, the piston is in overlap TDC.
2. Check valve clearance with cold engine:
   - Inlet = 0.4 mm;
   - Exhaust = 0.6 mm;
3. Check all valve clearances in 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.

Valve clearance adjustment

1. Loosen locknut (1) and unscrew adjusting screw (2) by a few threads.
2. Insert feeler gauge between valve bridge and rocker arm.
3. Readjust adjusting screw (2) so that the feeler gauge just passes through the gap.
4. Tighten locknut (1) to 50 Nm, holding adjusting screw (2) firmly.
5. Check if the feeler gauge just passes through between valve bridge and rocker arm.

   Result: If not, adjust valve clearance.

Final steps

1. Remove barring tool.
2. Install cylinder-head cover (→ Page 6 – 13).
3. Install cover.

6.4.2 Cylinder-head cover – Removal and installation

Preconditions

- Engine is stopped and starting disabled.

Special tools

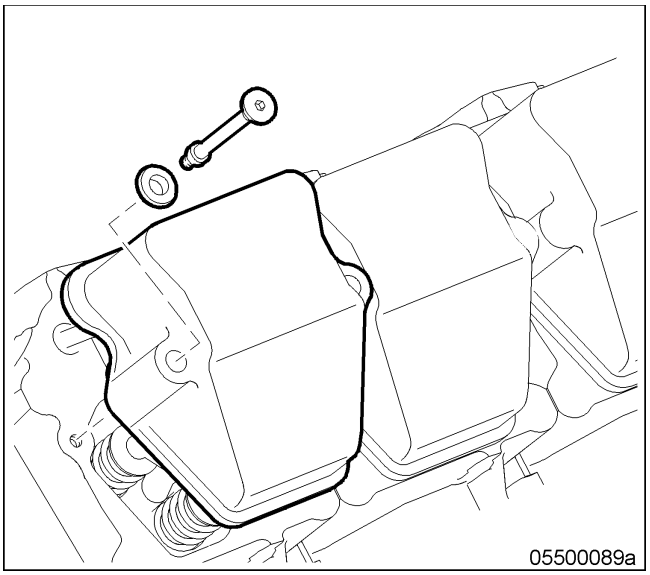
Designation / Use	Part No.	Qty.
Torque wrench		

Spare parts

Designation / Use	Part No.	Qty.
Gasket		

Preparatory steps

1. On cylinder-head covers with crankcase breather: Loosen clamps.
2. Slide rubber sleeves onto the pipe.



Cylinder-head cover – Removal and installation

1. Remove screws.
2. Remove cylinder-head cover with gasket from cylinder head.
3. Clean mating faces.
4. Check condition of gasket in cylinder-head cover.
5. Replace damaged gasket(s).
6. Place cylinder-head covers onto crankcase and tighten screws to 20 Nm.

Final steps

1. Slide rubber sleeves onto the relevant pipe connection.
2. Tighten all clamps.

6.5 Injection Pump / HP Pump

6.5.1 Injection pump replacement

Spare parts

Designation / Use	Part No.	Qty.
Injection pump		

Remove injection pump and install new one (→ Page 6 – 15)**.**

6.5.2 Injection pump removal and installation

Preconditions

- Engine is stopped and starting disabled.

Special tools

Designation / Use	Part No.	Qty.
Barring tool		

Material

Designation / Use	Part No.	Qty.
Petroleum jelly		

Spare parts

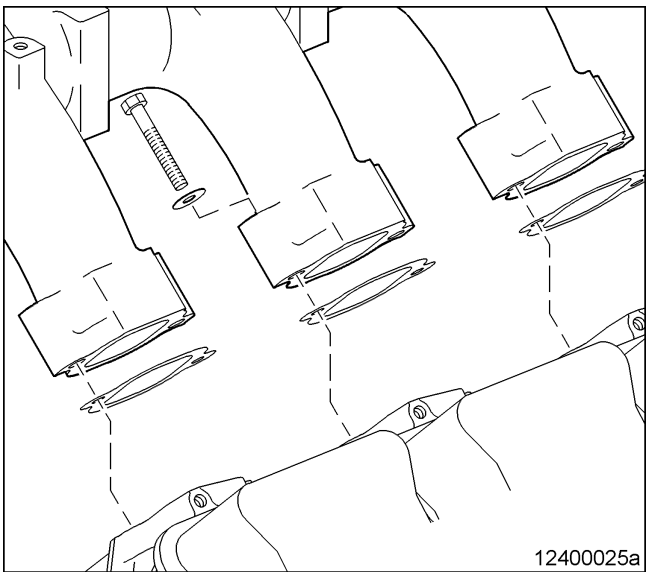
Designation / Use	Part No.	Qty.
Sealing ring		
Sealing ring		

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.

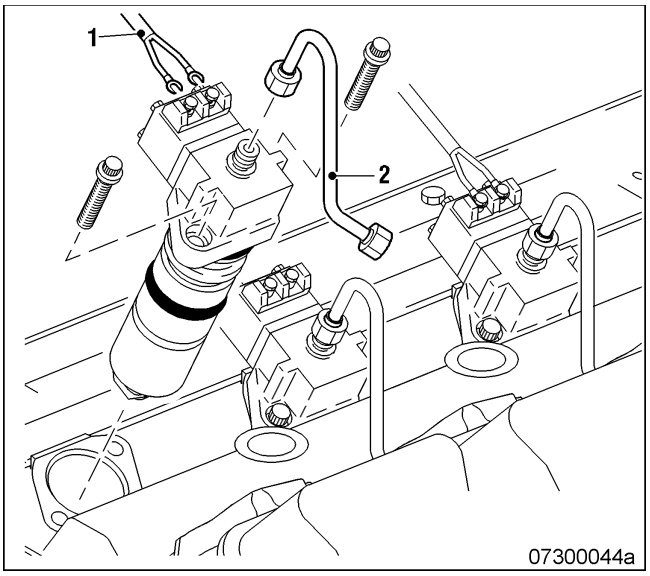
WARNING

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 line before fuel filter.
2. Remove engine control system (→ Page 6 – 63).
3. Drain fuel (→ Page 6 – 22).
4. Remove charge-air manifold and all seals.

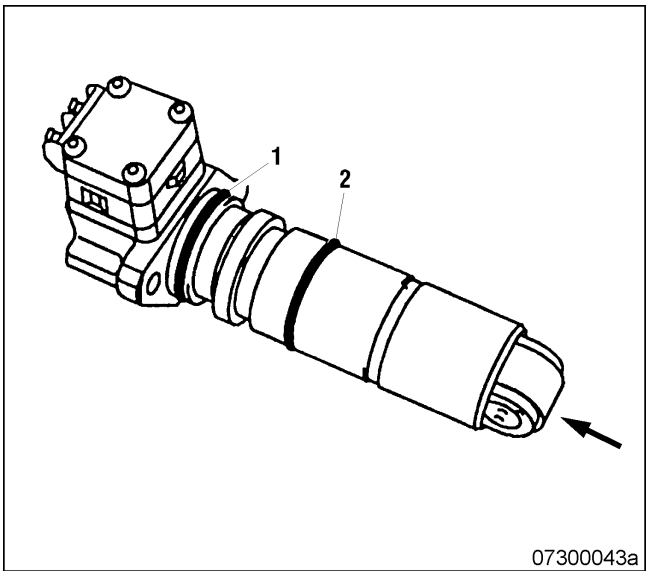


Injection pump removal

1. Mark installation position of injection pump.
2. Disconnect wiring (1) from injection pump.
3. Remove fuel line (2).
4. Remove injection pump securing screws.

   Note: Never try to prise loose a jammed injection pump at the solenoid valve or the intermediate plate.

5. Pull out injection pump, if required, press out carefully at the recess of the injection pump head.
6. Remove sealing rigs from injection pump.
7. Cover installation bore.

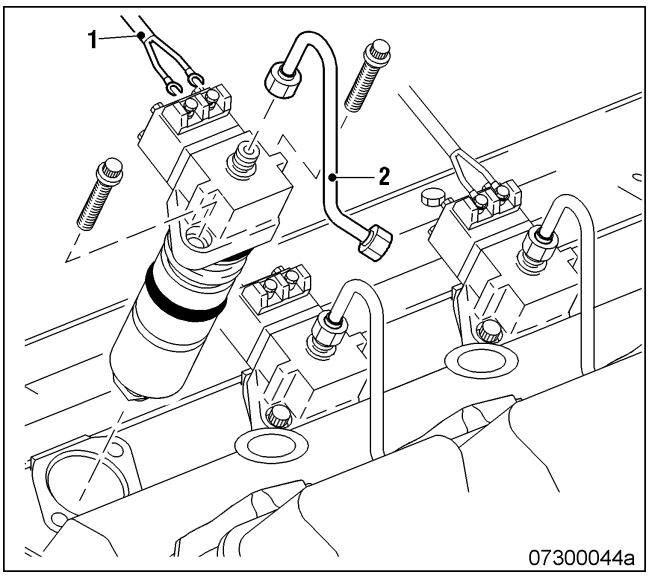


Injection pump installation

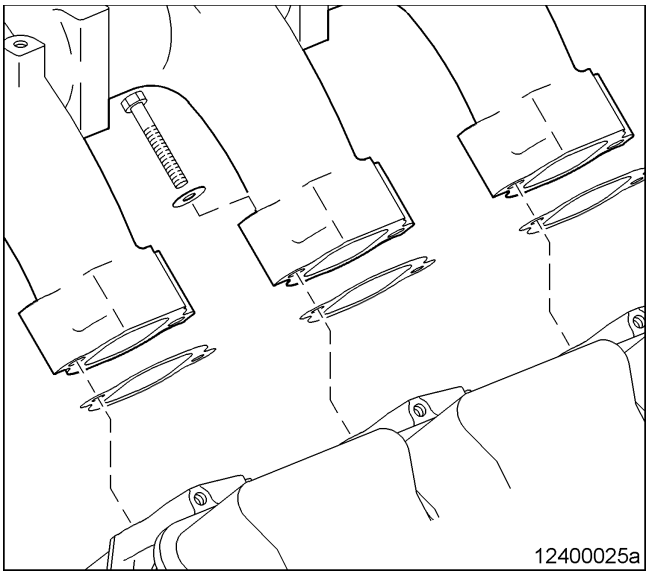
1. Remove all blanking plugs and covers.
2. Clean mating face of injection pump and roller.

   Note: Sealing rings are identified by different item numbers, pay attention to correct installation position!

3. Coat new sealing rings (1) and (2) with petroleum jelly and set them onto injection pump.
4. Coat roller (arrow) with engine oil.
5. Clean sealing face and installation bore on crankcase.
6. Use barring tool (→ Page 6 – 01) to align camshaft pump cams with base circle.



7. Install injection pump, observing marked installation position.
8. Tighten injection pump to 60 Nm + 12 Nm.
9. Install fuel line (2).
10. Tighten locknuts of the fuel line (2) to 20 Nm + 5 Nm.
11. Install injection pump wiring (1).
12. Tighten screws to 1.0 Nm +/- 0.2 Nm.



Final steps

1. Remove barring tool (→ Page 6 – 01).
2. Clean mating faces on cylinder head and charge-air manifold.
3. Check gaskets for damage and replace them, if required.
4. Set gasket onto cylinder head.
5. Install charge-air manifold.
6. Install engine control system (→ Page 6 – 63).
7. Open fuel supply line before fuel filter.
8. Vent fuel system (→ Page 6 – 23).

6.6 Fuel Injector

6.6.1 Injector replacement

Spare parts

Designation / Use	Part No.	Qty.
Injector		

Remove injector and install new one (→ Page 6 – 19)**.**

6.6.2 Injector removal and installation

Preconditions

- Engine is stopped and starting disabled.

Special tools

Designation / Use	Part No.	Qty.
Impact extractor		
Fuel suction device		
Torque wrench		

Material

Designation / Use	Part No.	Qty.
Petroleum jelly		

Spare parts

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

WARNING

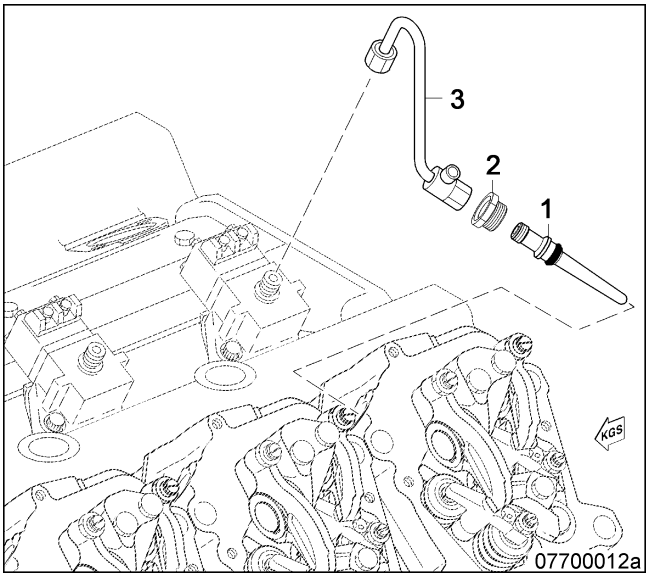
Fuels are combustible.
Risk of fire and explosion!
- Avoid naked flames, electrical sparks and ignition sources.
- Do not smoke.

WARNING

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

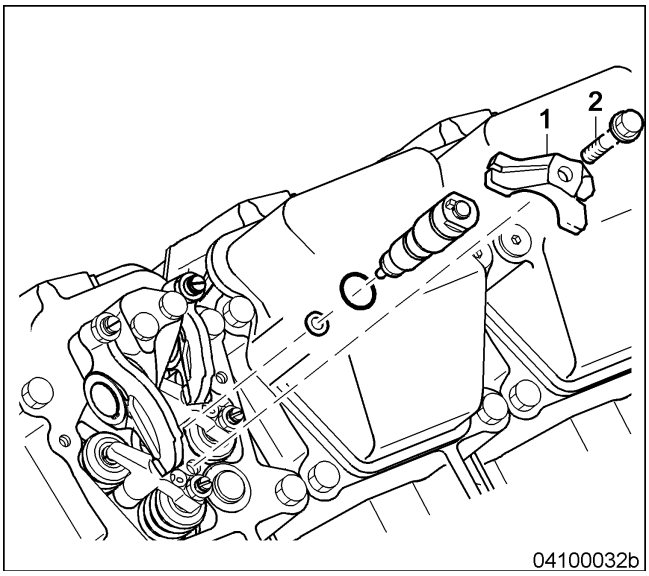
Preparatory steps

1. Remove cylinder head cover (→ Page 6 – 13).
2. Drain fuel (→ Page 6 – 22).

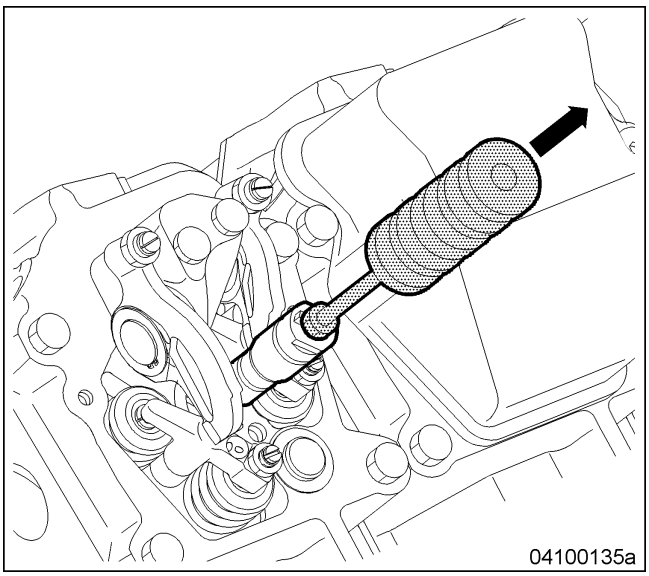


Injector removal

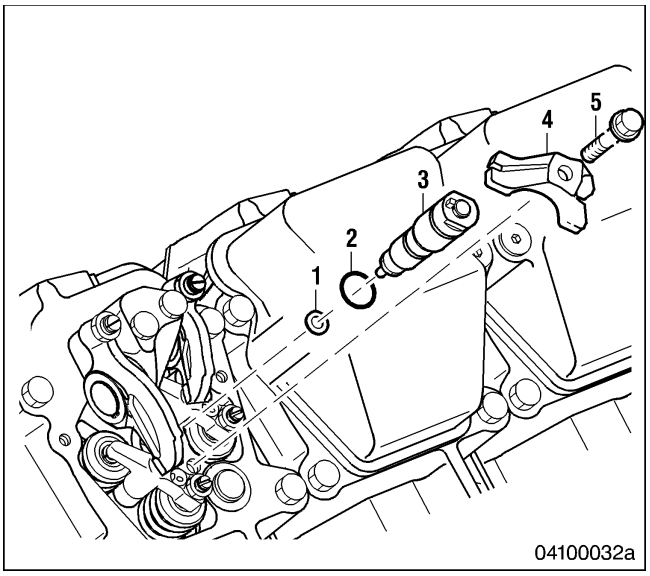
1. Remove leak-off-fuel lines.
2. Remove fuel line (3).
3. Remove thrust screw (2).
4. Pull off pressure pipe neck (1).
5. Extract fuel from the exposed bores using the suction device.
6. Seal all connections with appropriate plugs.

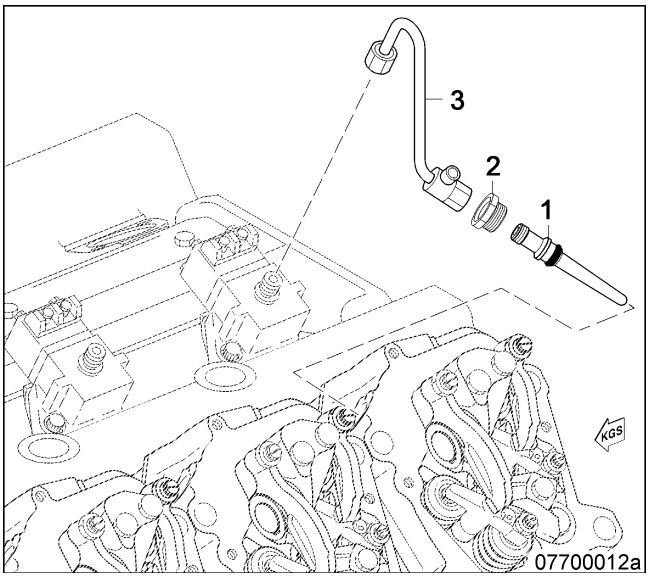


7. Remove screw (2).
8. Take off clamp (1).



9. Screw extractor into injector.
10. Remove injector using the impact extractor.
11. Remove sealing ring using a self-made hook.





Injector installation

1. Prior to installation, remove all plugs.
2. Clean sealing surface on cylinder head and protective sleeve.
3. Coat new sealing ring (1) with petroleum jelly and fit onto injector.
4. Coat new sealing ring (2) with petroleum jelly and fit onto injector.
5. Press injector into cylinder head by hand.

   Result:
   - The pin must be at 11-o'clock position to the longitudinal axis of the engine.
   - The pin must be engaged in the groove of the clamp (4).
6. Install clamp (4) with screw (5), positioning it correctly.

   Result: Forked clamp end must engage in the cover recess.
7. Check injector for correct seating.
8. Tighten clamp screw (5) to 50 Nm.
9. Blow out fuel line (3) and pressure pipe neck (1) with compressed air.
10. Coat new O-ring with petroleum jelly and fit on pressure pipe neck (1).
11. Coat sealing cone of pressure pipe neck with engine oil.
12. Insert pressure pipe neck into cylinder head until the sealing ring is in contact with cylinder head, do not press in yet!
13. Press pressure pipe neck (1) into cylinder head by hand.
14. Screw thrust screw (2) into cylinder head by a few threads.
15. Tighten thrust screw (2) to 40 Nm + 5 Nm.
16. Install fuel line (3).
17. Tighten union nut on injection pump to 30 Nm + 5 Nm.
18. Tighten union nut on pressure pipe neck to 20 Nm + 5 Nm.
19. Install leak-off-fuel lines.

Final steps

1. Install cylinder head cover (→ Page 6 – 13).
2. Vent fuel system (→ Page 6 – 23).

6.7 Fuel System (Low Pressure)

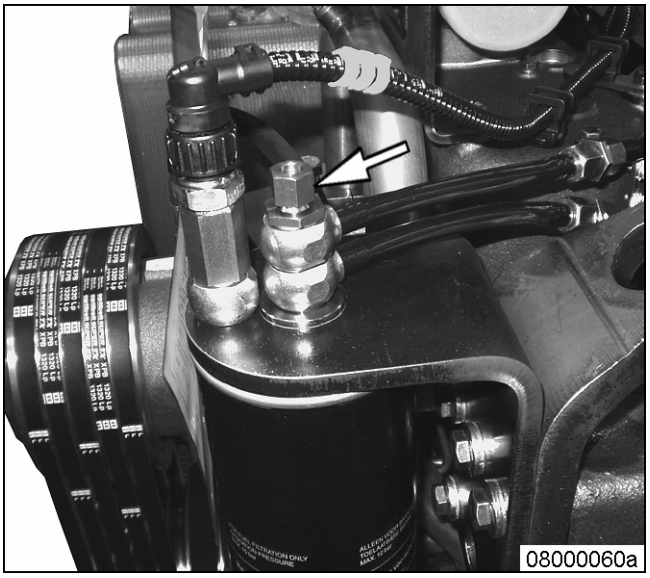
6.7.1 Fuel – Draining

Preconditions

- Engine is stopped and starting disabled.

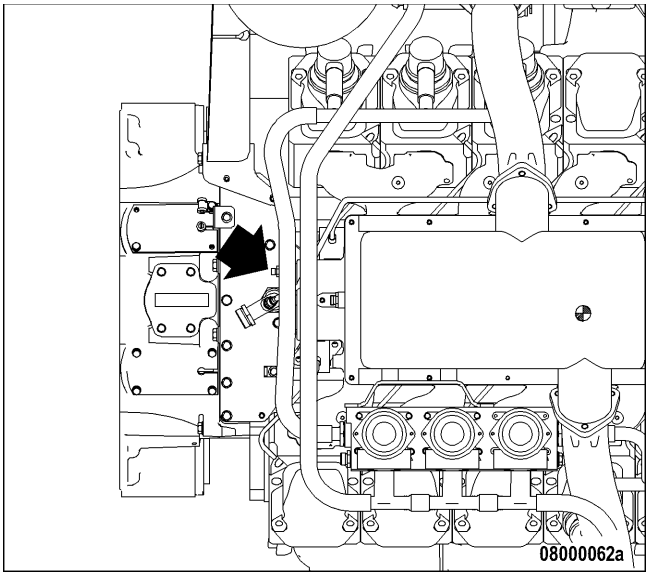
WARNING

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



Fuel – Draining

1. Loosen nut (arrow) on banjo union.



2. Remove fuel line from non-return valve.
3. Unscrew non-return valve on end piece (arrow) and drain fuel into a suitable container.
4. When the fuel flow has stopped, install non-return valve with new sealing ring and tighten.
5. Install fuel line.
6. Tighten nut on banjo union.

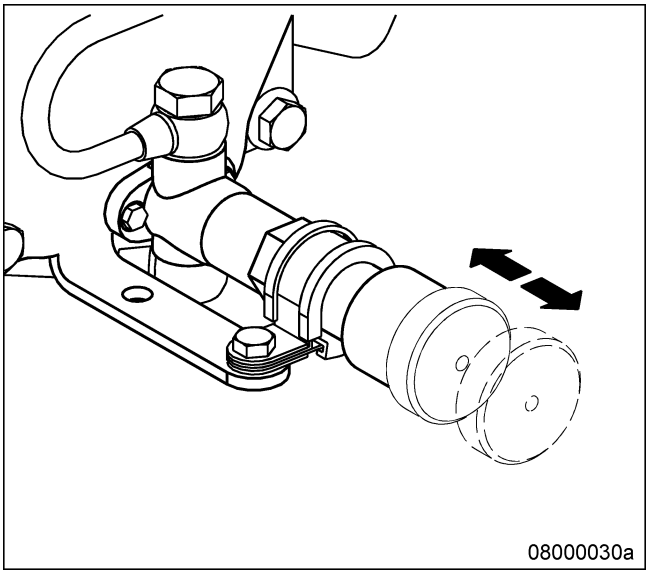
6.7.2 Fuel system – Venting

Preconditions

- Engine is stopped and starting disabled.

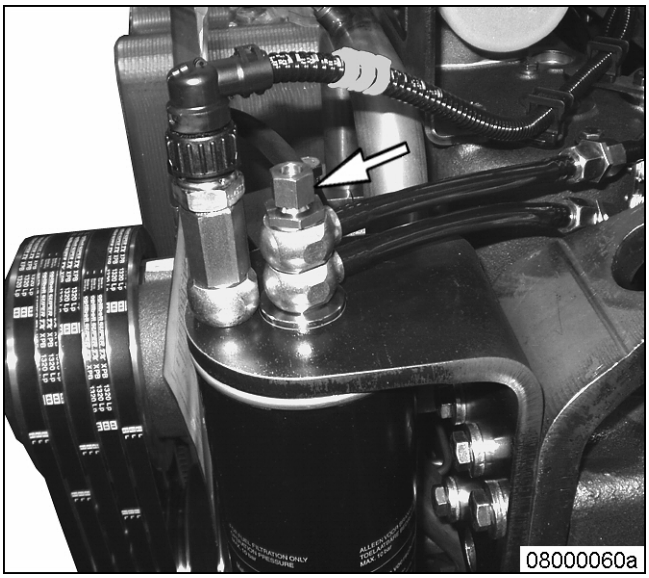
WARNING

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

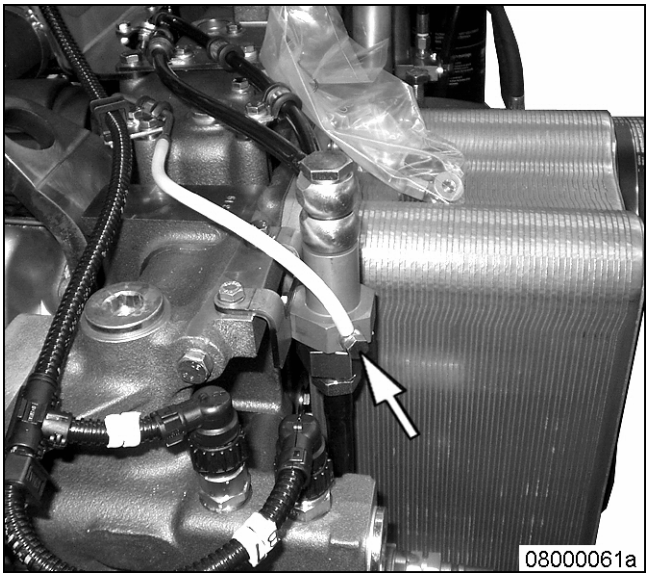


Fuel system – Venting

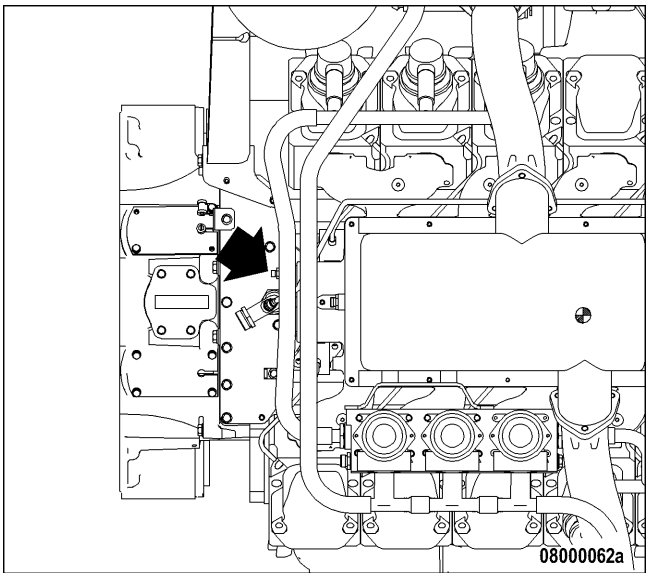
1. Unlock fuel priming pump, unscrew handle.



2. Loosen nut (arrow) on banjo union.
3. Operate the pump with the handle until fuel without bubbles comes out of the vent plugs.
4. Tighten nut on banjo union.



5. Loosen banjo screw (arrow).
6. Operate the pump with the handle until fuel without bubbles comes out of the nipple.
7. Tighten banjo screw.



8. Loosen union nut of fuel return line.
9. Loosen non-return valve (arrow).
10. Operate the pump with the handle until fuel without bubbles comes out of the nipple.
11. Tighten non-return valve.
12. Tighten union nut of fuel return line.
13. Lock fuel priming pump, screw in handle.

6.8 Fuel Filter

6.8.1 Fuel filter – Replacement

Preconditions

- Engine is stopped and starting disabled.

Special tools

Designation / Use	Part No.	Qty.
Strap wrench		

Material

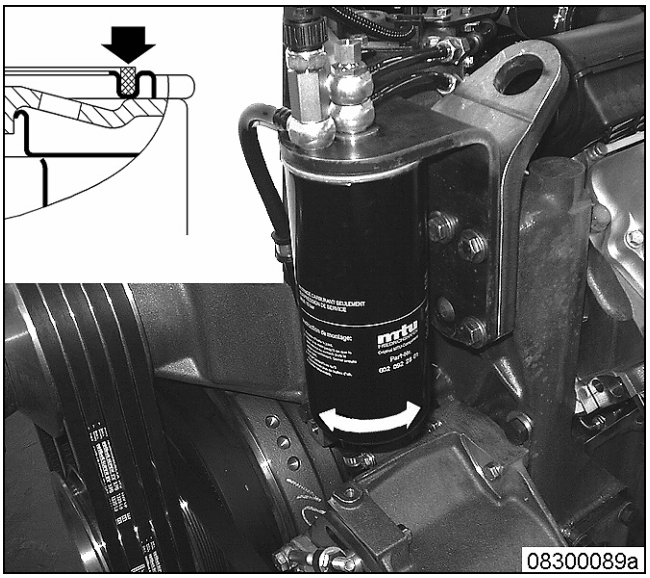
Designation / Use	Part No.	Qty.
Diesel fuel		

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 the strap wrench.
2. Clean the sealing surface on the bracket.
3. Fill the new easy-change filter with clean fuel.
4. Install and tighten new filter by hand.
5. Vent fuel system (→ Page 6 – 23).

6.8.2 Fuel prefilter cleaning

Preconditions

- Engine is stopped and starting disabled.

Material

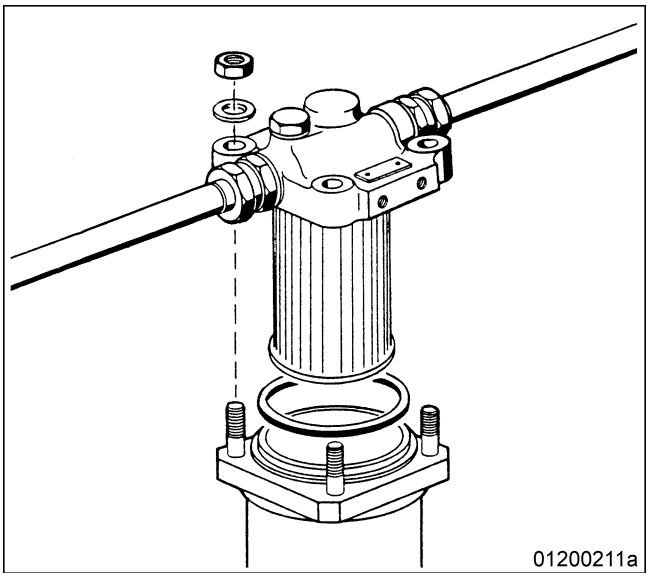
Designation / Use	Part No.	Qty.
Diesel fuel		

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.



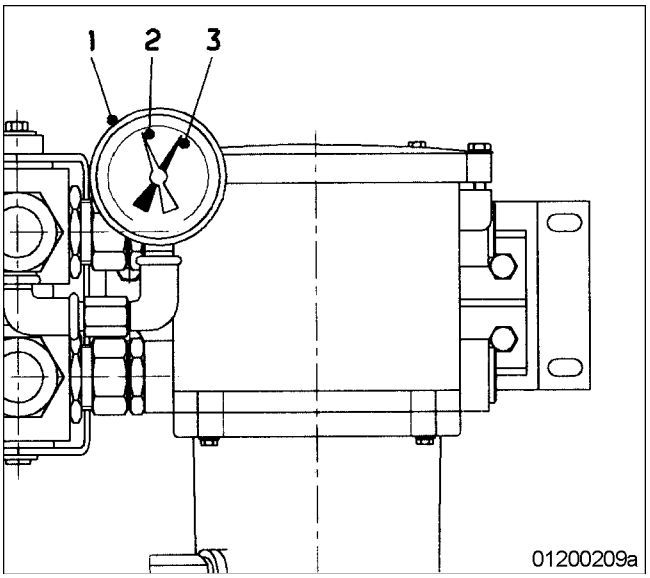
Fuel prefilter cleaning

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 6 – 30).

6.8.4 Fuel prefilter – draining

Preconditions

- Engine is stopped and starting disabled.

Material

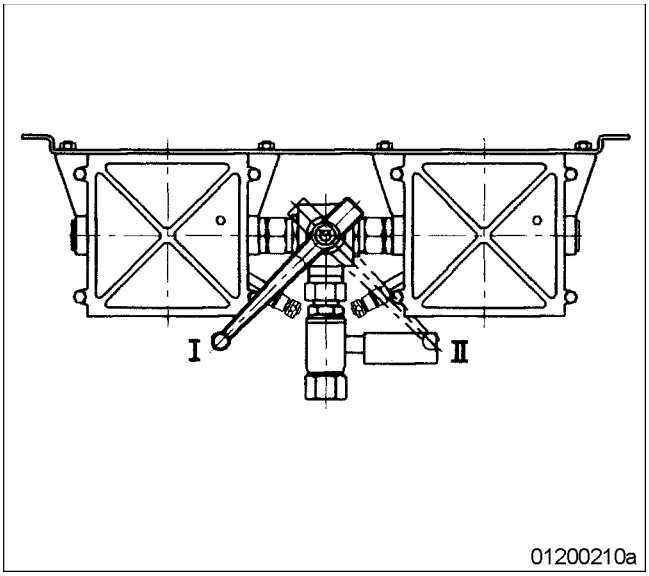
Designation / Use	Part No.	Qty.
Diesel fuel		

Spare parts

Designation / Use	Part No.	Qty.
Gasket		

WARNING

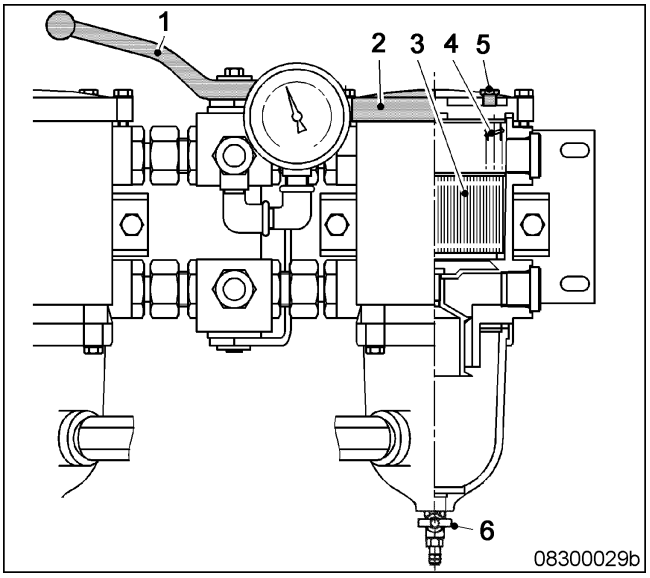
Fuels are combustible.
Risk of fire and explosion!
- Avoid naked flames, electrical sparks and ignition sources.
- Do not smoke.



I Left filter cut in
II Right filter cut in

Fuel prefilter – draining

1. Cut out the filter to be drained.



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

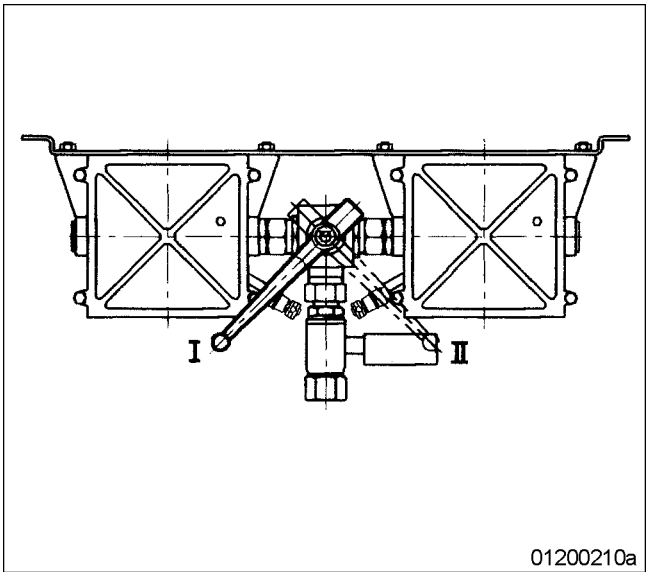
Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!
- Take special care when working on a running engine.

WARNING

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

WARNING

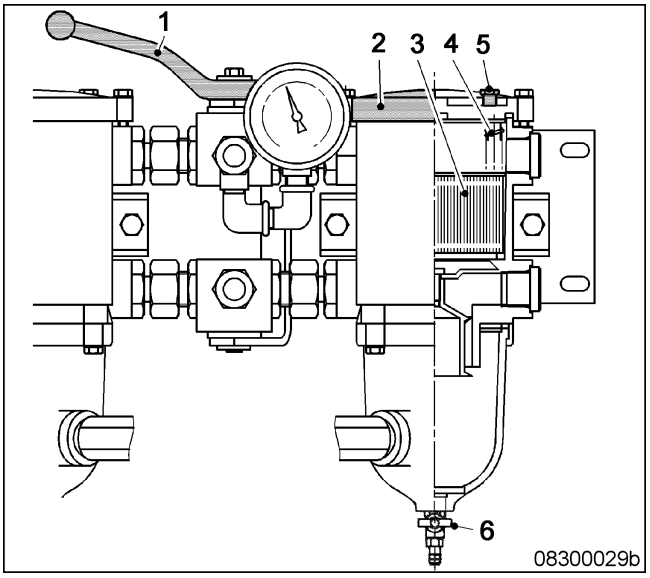
Engine noise above 85 dB (A).
Risk of damage to hearing!
- Wear ear protectors.



I Left filter cut in
II Right filter cut in

Fuel prefilter – flushing

1. Cut out the contaminated filter.



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 3 – 06)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 6 – 27).
   Result: If flushing did not lead to an improvement of the differential pressure, replace filter element (→ Page 6 – 32).

6.8.6 Fuel prefilter – filter element replacement

Preconditions

- Engine is stopped and starting disabled.

Material

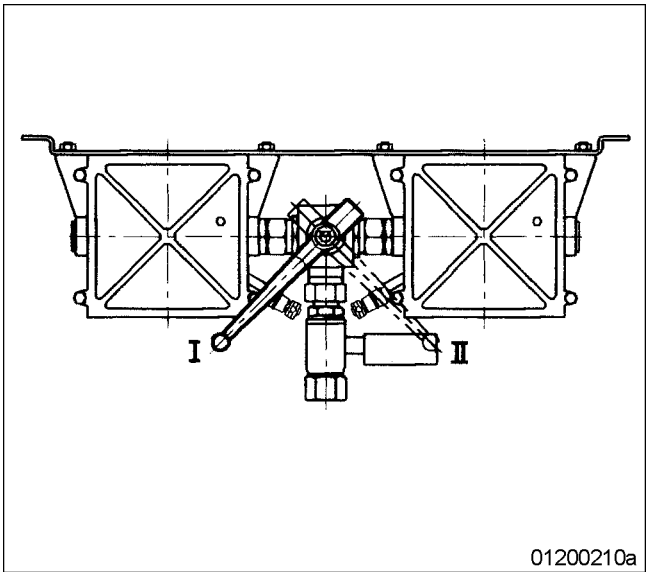
Designation / Use	Part No.	Qty.
Diesel fuel		

Spare parts

Designation / Use	Part No.	Qty.
Filter element		
Gasket		

WARNING

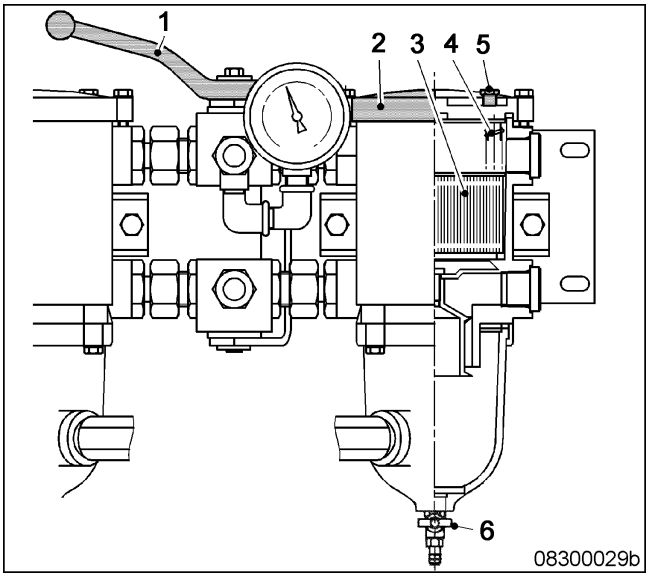
Fuels are combustible.
Risk of fire and explosion!
- Avoid naked flames, electrical sparks and ignition sources.
- Do not smoke.



I Left filter cut in
II Right filter cut in

Fuel prefilter – filter element replacement

1. Cut out the contaminated filter.



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 6 – 27).

6.9 Charge-Air Cooling, General, Left Side

6.9.1 Intercooler – Checking condensate drains for coolant discharge and obstructions

Preconditions

- Engine is stopped and starting disabled.

Spare parts

Designation / Use	Part No.	Qty.
Sealing ring		

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. Remove plug screw(s) from charge-air manifold.
2. Check drain bore(s) for air discharge. If no air emerges:
3. Clean drain bore(s) and blow out with compressed air.
4. If a large amount of coolant is continuously discharged, the intercooler is leaking. Contact Service.
5. Install plug screw(s) with new sealing ring and tighten.

Emergency measures prior to engine start with a leaking intercooler

1. Remove injectors (→ Page 6 – 19).
2. Bar engine manually (→ Page 6 – 01).
3. Bar engine with starting system to blow out combustion chambers (→ Page 6 – 02).
4. Install injectors (→ Page 6 – 19).

6.10 Air Filter

6.10.1 Air filter replacement

Spare parts

Designation / Use	Part No.	Qty.
Air filter		

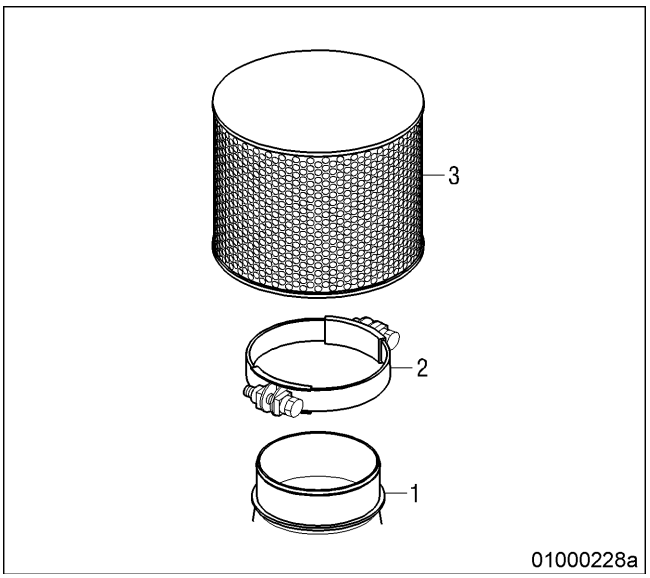
Remove air filter and install new one (→ Page 6 – 36)**.**

Reset signal ring of service indicator (→ Page 6 – 37)**.**

6.10.2 Air filter removal and installation

Preconditions

- Engine is stopped and starting disabled.



Air filter removal and installation

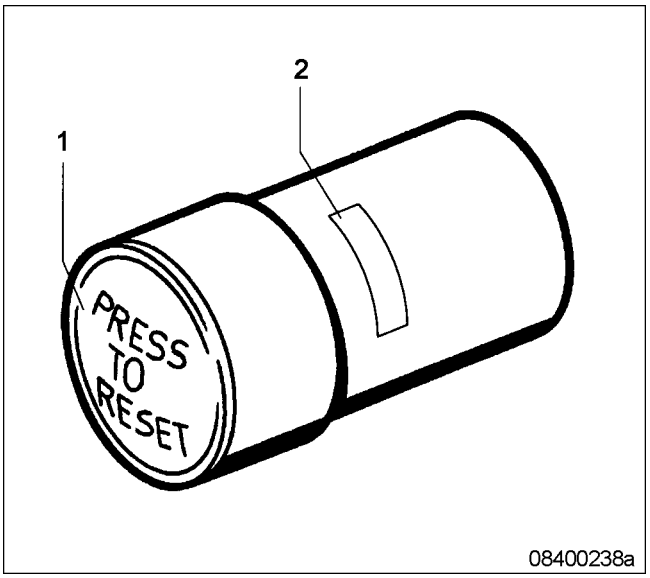
1. Loosen clamp (2).
2. Remove air filter (3) and clamp (2) from flange of intake housing (1).
3. Verify that there are no objects in the flange of the intake housing (1) and clean it.
4. Place new air filter (3) with clamp (2) onto intake housing (1).
5. Tighten clamp (2).

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 6 – 35).
2. After installation of new filter, press reset button (1).

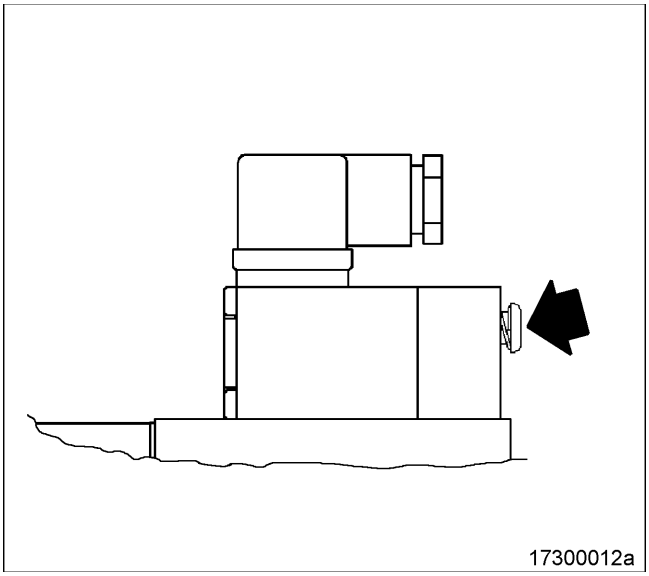
   Result: Engaged piston with signal ring moves back to initial position.

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

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 engine oil.
Engine oil can contain combustion residues which are harmful to health.
Risk of injury and scalding!

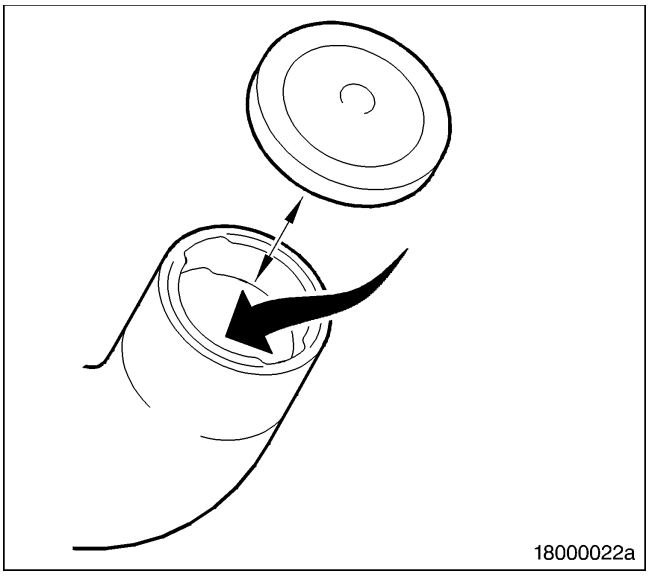
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

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 6 – 42).

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 6 – 42).



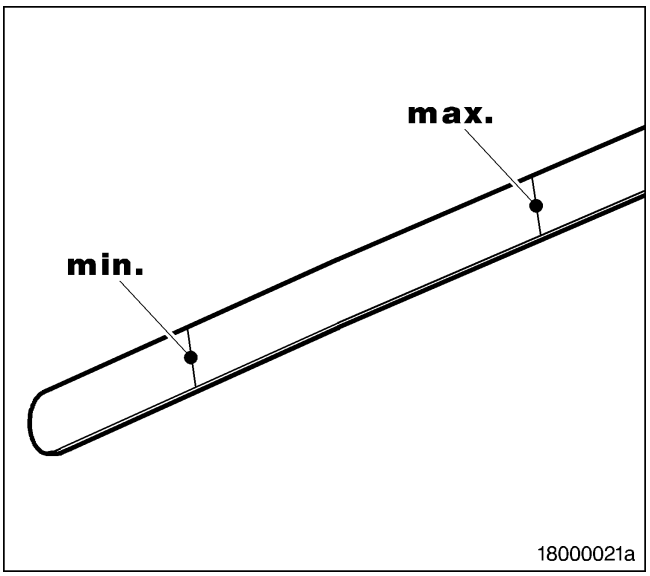
Engine oil system filling

1. Determine amount of engine oil required for oil change (→ Product Summary - Technical Data).
2. Open cover of filler neck.
3. Pour oil in at filler neck up to "max." mark at oil dipstick.
4. Close cover of filler neck.
5. Check oil level (→ Page 6 – 41).
6. After oil change and oil filter replacement, bar engine with starting system (→ Page 6 – 02).

6.13.2 Engine oil level check

Preconditions

- Engine is stopped and starting disabled.



Oil level check prior to engine start

1. Withdraw dipstick from guide tube and wipe it.
2. Insert dipstick into guide tube to stop, withdraw after approx. 10 seconds and check oil level.
3. Oil level must be between "min." and "max." marks.
4. If necessary, top up to "max." mark (→ Page 6 – 39).
5. Insert dipstick into guide tube to stop.

Oil level check 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 to stop, withdraw after approx. 10 seconds and check oil level.
3. Oil level must be between "min." and "max." marks.
4. If necessary, top up to "max." mark (→ Page 6 – 39).
5. Insert dipstick into guide tube to 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.
Strap wrench		

Material

Designation / Use	Part No.	Qty.
Engine oil		

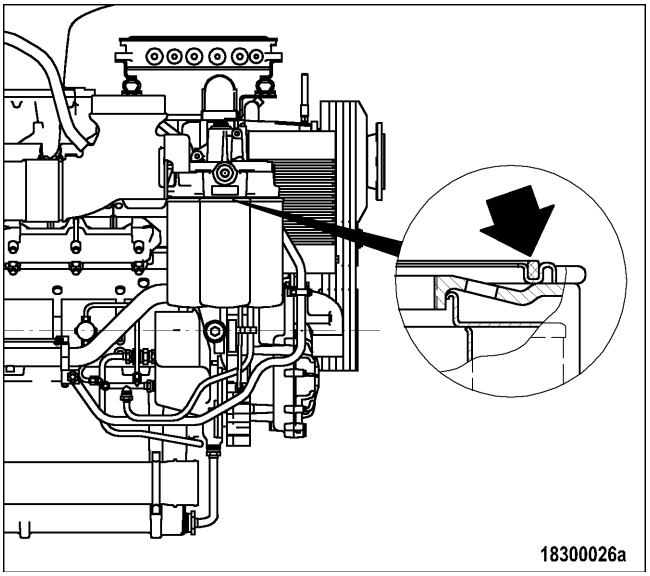
Spare parts

Designation / Use	Part No.	Qty.
Oil filter		

WARNING

Hot engine oil.
Engine oil can contain combustion residues which are harmful to health.
Risk of injury and scalding!

- 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 the strap wrench.
2. Clean the sealing surface of the filter head.
3. Check condition of the new sealing ring and coat it with oil.
4. Install and tighten new oil filter by hand.
5. Replace further oil filters in the same way.
6. After each oil change and filter replacement, bar the engine using the starting device (→ Page 6 – 02).
7. Check oil level (→ Page 6 – 41).

6.15 Cooling System, General, HT Circuit

6.15.1 Engine coolant filling

Preconditions

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

Material

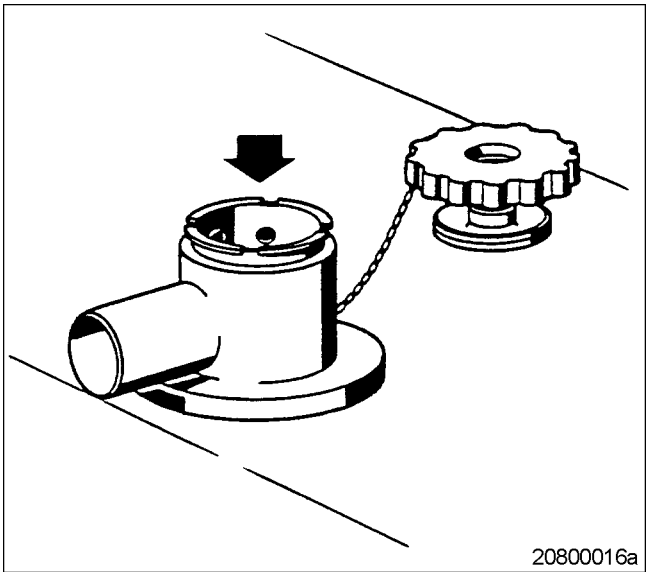
Designation / Use	Part No.	Qty.
Engine coolant		

WARNING

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

CAUTION

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



Preparatory steps

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

Engine coolant filling

1. Fill coolant through filler neck on expansion tank or through filling line until coolant level reaches lower edge of cast-in eye or marking plate.
2. Check proper condition of breather valve and clean sealing faces, if required.
3. Set 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 6 – 46) and top up, if required.

6.15.2 Engine coolant – Draining

Preconditions

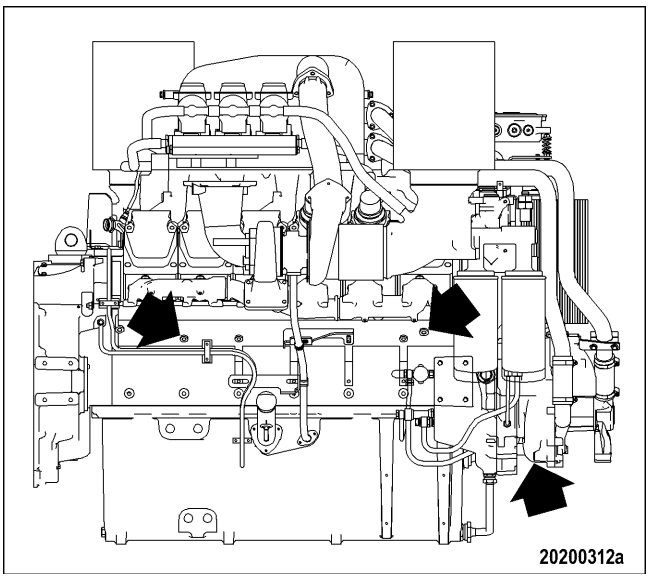
- Engine is stopped and starting disabled.

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.

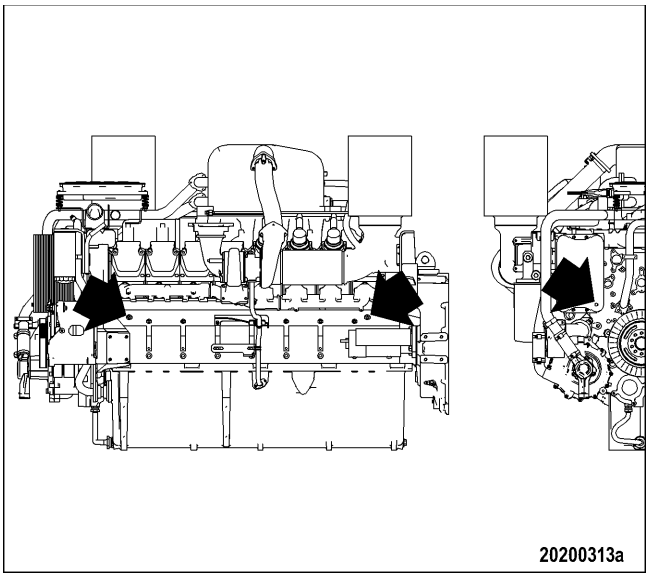
Preparatory steps

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 cocks or drain plugs and drain coolant at the following points:
   - At the preheating unit;
   - At the HT coolant pump;
   - On the crankcase, right side.



5. Draining of residual coolant:
   - On crankcase, left side;
     On oil heat exchanger.
6. Seal all open drain points.
7. Set breather valve onto filler neck and close it.

6.15.3 Engine coolant change

Material

Designation / Use	Part No.	Qty.
Coolant		

Drain engine coolant (→ Page 6 – 44)**.**

Fill engine coolant system (→ Page 6 – 43)**.**

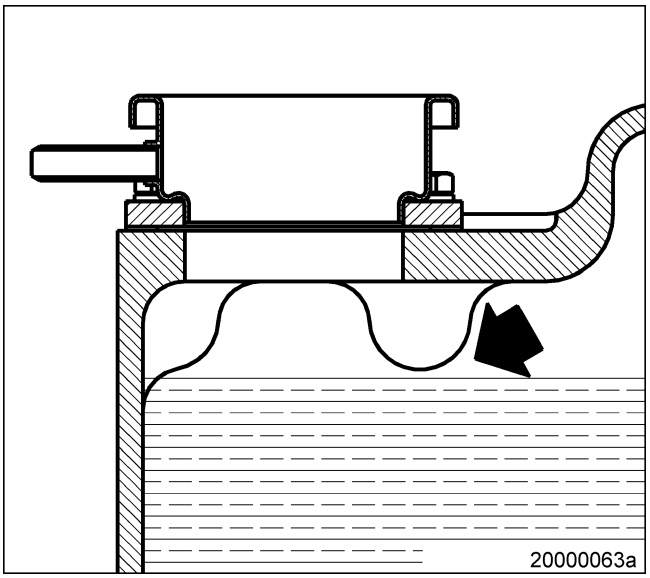
6.15.4 Engine coolant-level check

Preconditions

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

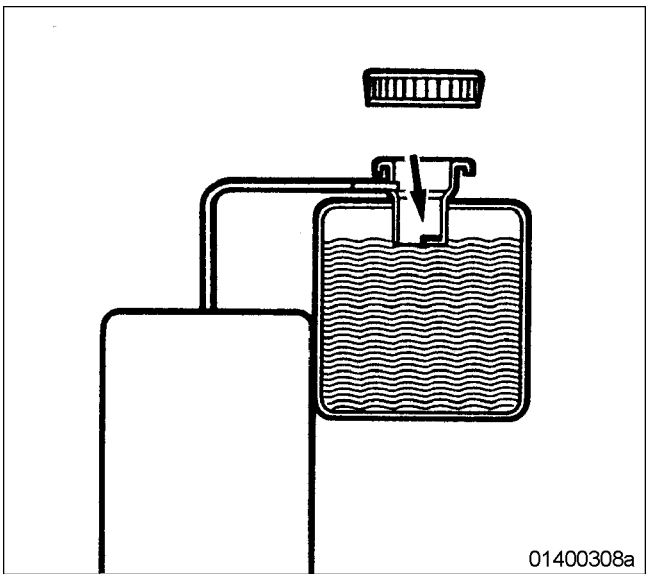
WARNING

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 engine coolant (→ Page 6 – 43).
3. Check proper condition of breather valve, clean sealing faces if required.
4. Fit breather valve onto filler neck and close it.

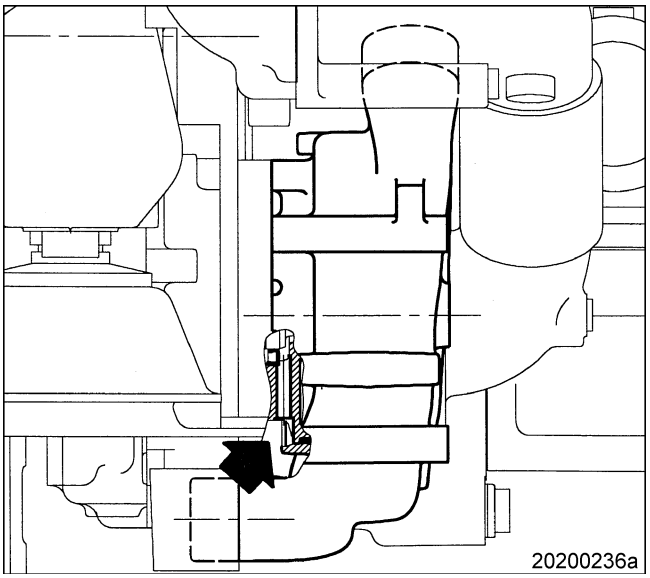
Coolant-level check by means of level sensor:

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 engine coolant (→ Page 6 – 43).

6.15.5 Cooling 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.



Cooling pump - Relief bore check

1. Check relief bore for oil and water discharge.
2. Stop engine (→ Page 3 – 06) and disable engine start.
3. Clean the relief bore with a wire if it is dirty.
   - Permissible coolant discharge: up to 10 drops/hour;
   - Permissible coolant discharge: up to 5 drops/hour;
4. If coolant discharge exceeds the specified limits, contact Service.

6.16 Cooling System, 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

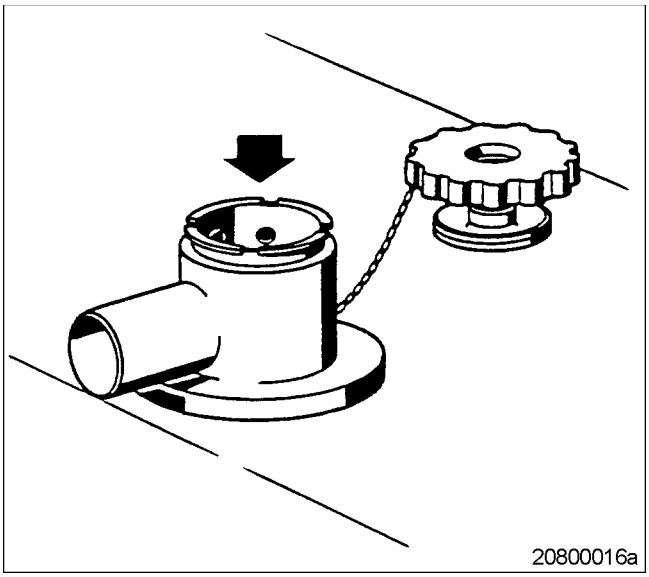
Designation / Use	Part No.	Qty.
Sealing ring		

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 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 screw from filling point on coolant line to intercooler.

Charge-air coolant filling

1. Fill treated coolant through filling line or through filler neck of coolant expansion tank until coolant level reaches marking plate.
2. Install plug screws of filling points with new sealing rings.
3. Check proper condition of breather valve and clean sealing faces, if required.
4. Set 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 6 – 52).

6.16.2 Charge-air coolant – Draining

Preconditions

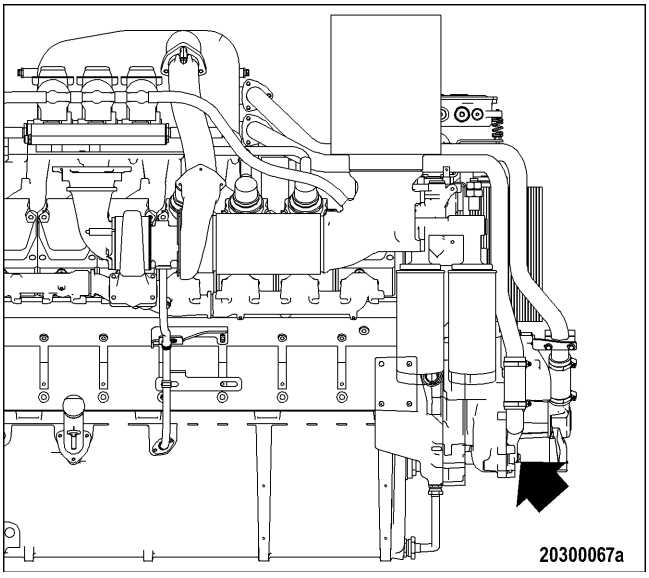
- Engine is stopped and starting disabled.

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 plugs and drain coolant at the following points:
   - at the LT cooling pump;
   - at the coolant line (customer's equipment).
6. Draining of residual coolant:
   - at charge-air cooler.
7. Screw in 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 6 – 50).

Fill charge-air coolant system (→ Page 6 – 48).

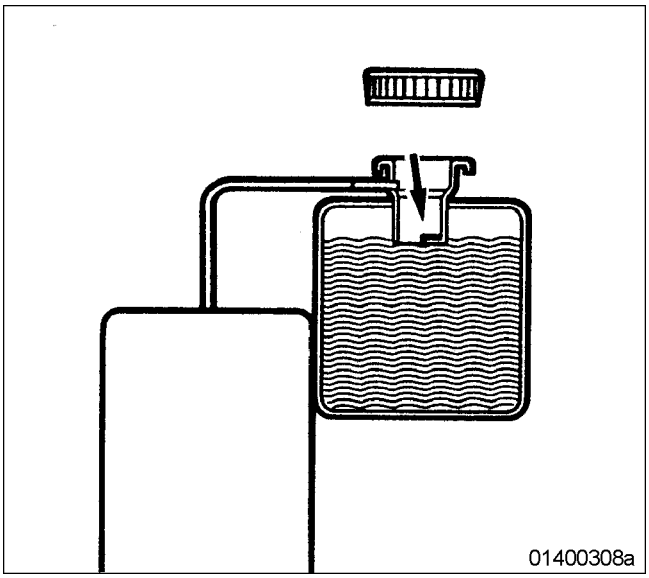
6.16.4 Charge-air coolant level check

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 6 – 48).
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 6 – 48).

6.17 Battery-Charging Generator

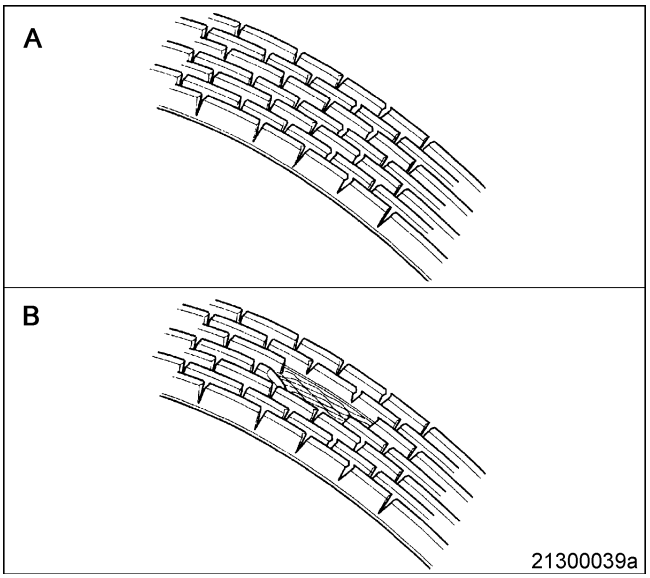
6.17.1 Battery-charging generator drive – Drive-belt check and adjustment

Preconditions

- Engine is stopped and starting disabled.

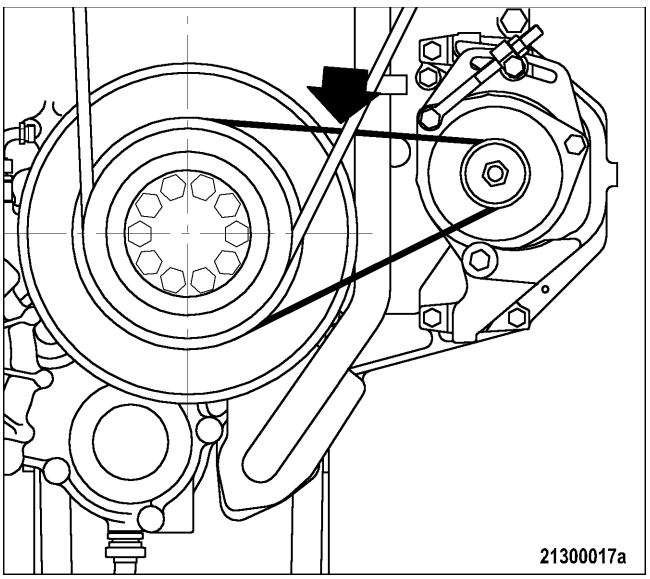
Special tools

Designation / Use	Part No.	Qty.
Belt-tension tester		



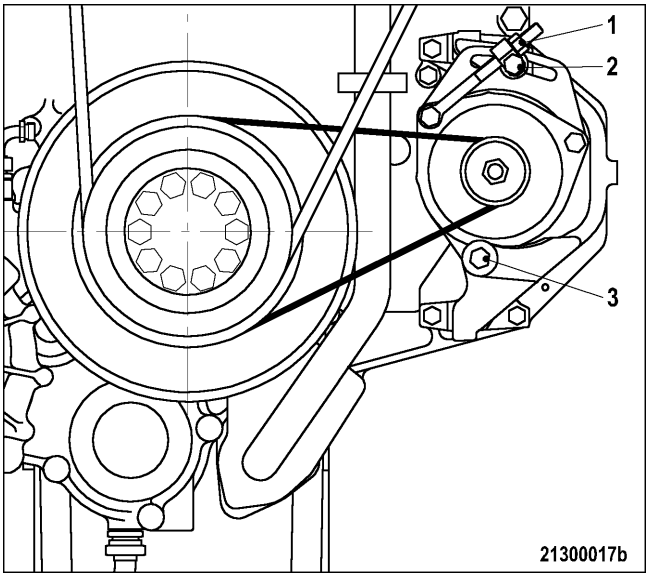
Belt condition check

1. Remove guard cover.
2. Check belt for contamination by oil, cracks, wear, and signs of overheating.
3. Replace drive belt:
   - If belt is oily;
   - If belt shows signs of overheating;
   - If ribs are broken around the entire circumference (A);
   - If ribs are broken around the entire circumference and material is broken off in some places (B). (→ Page 6 – 56)
4. Install guard cover.



Belt tension check

1. Remove guard cover.
2. Place belt-tension tester onto drive belt midway between the belt pulleys.
3. Press button uniformly down on drive-belt surface until spring disengagement can be heard and felt.
4. Do not press any further, otherwise the reading is not exact.
5. Take off belt-tension tester without changing the position of the indication arm.
6. Read off measuring value at the intersection of indication arm and "KG" scale.
   - Specified belt tension for new drive belt: 450 N –50 N
   - Specified belt tension for used drive belt: 350 N –50 N
7. If the measured value deviates from the specified belt tension, readjust belt tension.
8. Install guard cover.



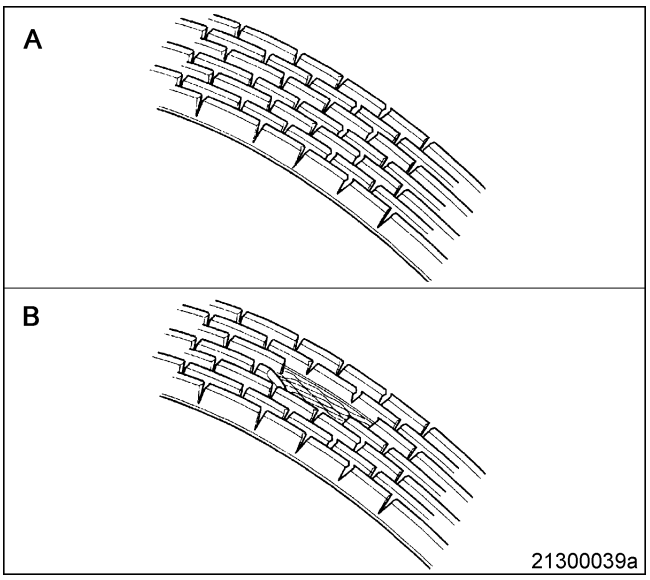
Belt tension adjustment

1. Loosen securing screws (2 and 3).
2. Tension ribbed drive belt with tensioning nut (1) and check belt tension
3. Tighten securing screw (2).
   - Tightening torque: 40 Nm +4 Nm
4. Tighten securing screw (3).
5. Check drive belt tension.
6. Install guard cover.

6.17.2 Battery-charging generator drive – drive belt condition check

Preconditions

- Engine is stopped and starting disabled.



Belt condition check

1. Remove guard cover.
2. Check belt for contamination by oil, cracks, wear, and signs of overheating.
3. Replace drive belt:
   - If belt is oily;
   - If belt shows signs of overheating;
   - If ribs are broken around the entire circumference (A);
   - If ribs are broken around the entire circumference and material is broken off in some places (B) (→ Page 6 – 56).
4. Install guard cover.

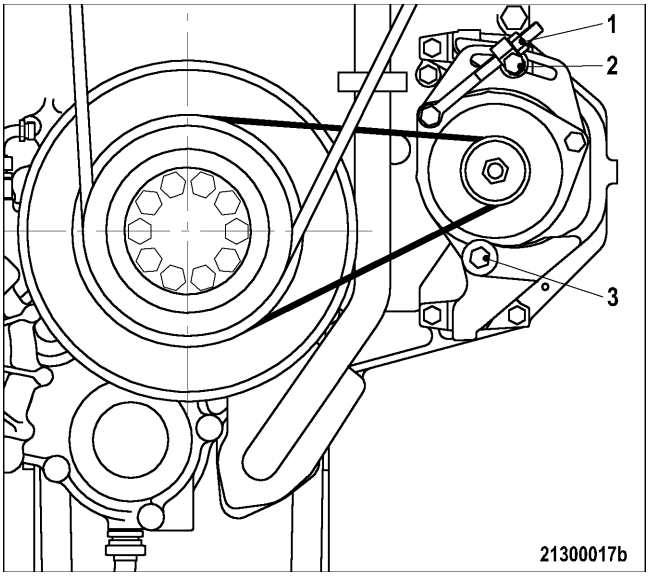
6.17.3 Battery-charging generator drive – Drive belt replacement

Preconditions

- Engine is stopped and starting disabled.

Spare parts

Designation / Use	Part No.	Qty.
Ribbed belt		



Battery-charging generator drive – Drive belt replacement

1. Remove guard cover.
2. Remove ventilator drive belt (applicable only to TD cooling). (→ Page 6 – 60)
3. Loosen securing screws (2 and 3).
4. Release tensioning screw (1) until the ribbed belt can be removed.
5. Check belt pulleys for cleanliness, remove dirt, if any.
6. Fit new drive belt.
7. Tension drive belt with tensioning nut (1) and check belt tension (→ Page 6 – 53).
8. Tighten securing screw (2).
   - Tightening torque: 40 Nm +4 Nm
9. Tighten securing screw (3).
10. Install ventilator drive belt (→ Page 6 – 60)
11. Install guard cover.

6.18 Ventilator Drive

6.18.1 Ventilator drive – Drive-belt check and adjustment

Preconditions

- Engine is stopped and starting disabled.

Special tools

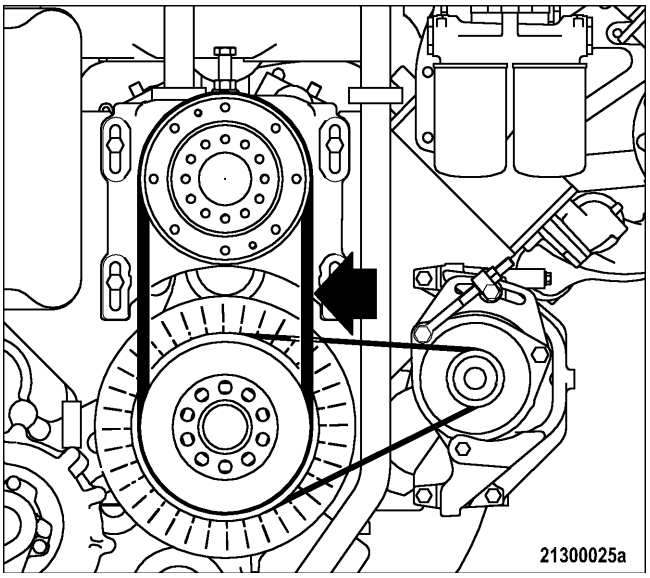
Designation / Use	Part No.	Qty.
Belt-tension tester		

Preparatory steps

1. Remove screws from guard cover.
2. Remove guard cover.

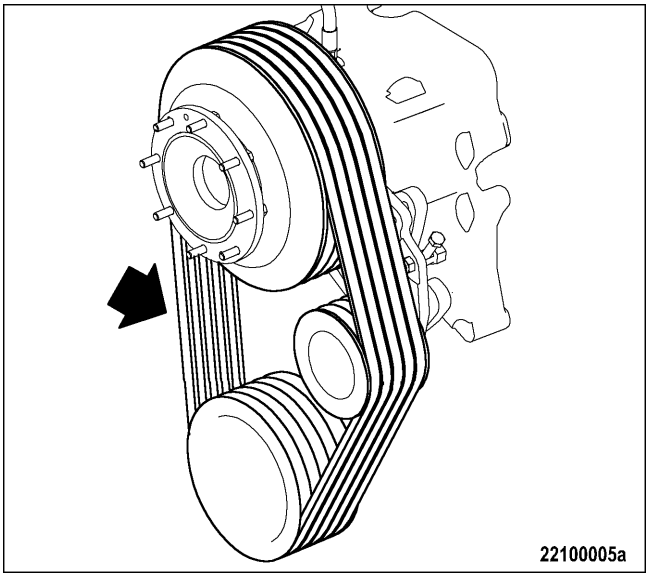
Belt condition check

1. Remove guard cover.
2. Check V-belt for contamination by oil, cracks, wear, chunking and signs of overheating.
3. Replace V-belt:
   - If belt is oily;
   - If belt shows signs of overheating;
   - If belt shows cracks;
   - If belt is worn;
   - If belt is chunked (→ Page 6 – 60).



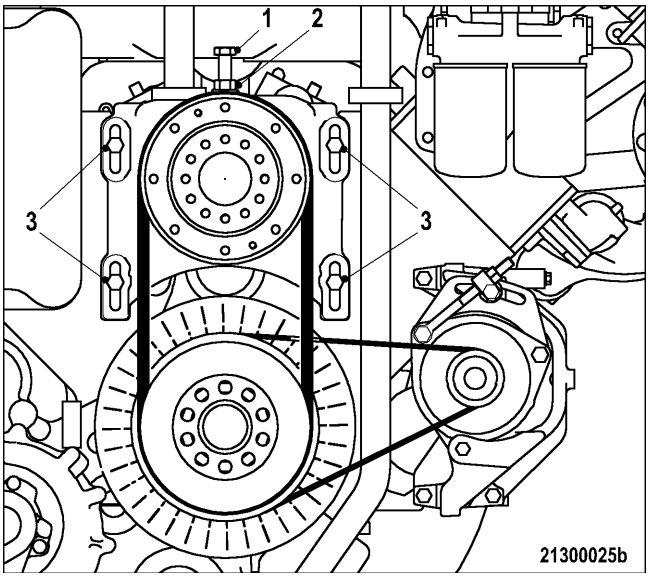
Belt-tension check on 12/16V engines:

1. Place belt-tension tester onto V-belt midway between the belt pulleys (arrow).
2. Press button uniformly against V-belt surface until spring disengagement can be heard and felt.
3. Take off belt-tension tester without changing the position of the indication arm.
4. Read off measured value at the intersection of indication arm and "KG" scale.
   - Specified belt tension for new V-belt: 660 N
   - Specified belt tension for used V-belt: 510 N
5. If the measured value deviates from the specified belt tension, readjust belt tension.



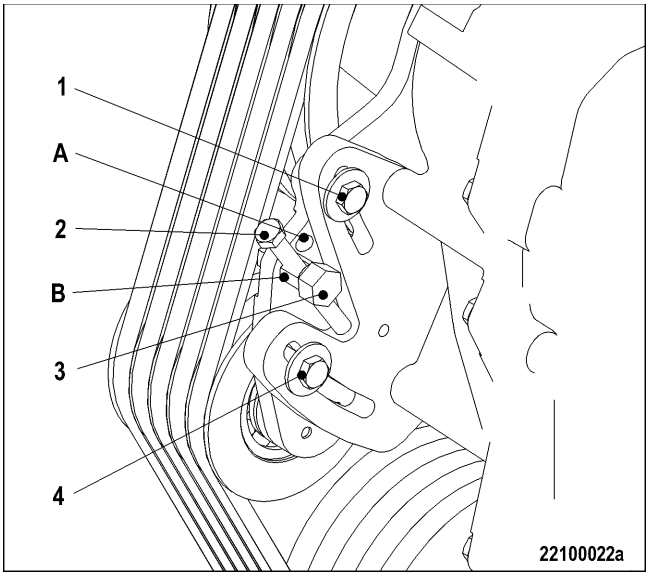
Belt-tension check on 18V engines:

1. Place belt-tension tester onto V-belt midway between the belt pulleys (arrow).
2. Press button uniformly against V-belt surface until spring disengagement can be heard and felt.
3. Take off belt-tension tester without changing the position of the indication arm.
4. Read off measured value at the intersection of indication arm and "KG" scale.
   - Specified belt tension for new drive belt: 670 N –-50 N
   - Specified belt tension for used drive belt: 570 N –-50 N
5. If the measured value deviates from the specified belt tension, readjust belt tension.



Belt-tension adjustment on 12/16V engines:

1. Loosen securing screws (3).
2. Release locknut (2).
3. Screw in tensioning screw (1) to set specified belt tension.
4. Tighten locknut.
5. Check V-belt tension.
6. Tighten securing screws with torque wrench.
   - Tightening torque: 100 Nm



Belt-tension adjustment on 18V engines:

1. Loosen securing screws (1 and 4).

   Note: On engines for 50 Hz generators, bolt (3) must be in position (A). On all other engines, it must be in position (B).

2. Screw in tensioning screw (2) to tension V-belt.
3. Check V-belt tension.
4. Tighten securing screws (1 and 4) with torque wrench.
   - Tightening torque: 69 Nm
5. Check V-belt tension.

Final steps

1. Install guard cover.
2. Fit screws and tighten.

6.18.2 Ventilator drive – Drive belt replacement

Preconditions

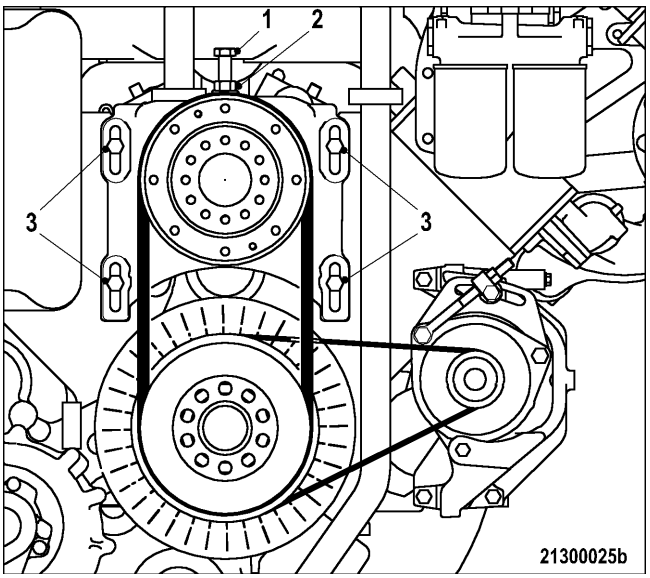
- Engine is stopped and starting disabled.

Spare parts

Designation / Use	Part No.	Qty.
V-belt		

Preparatory steps

1. Remove guard cover from cooler.
2. Remove ventilator.

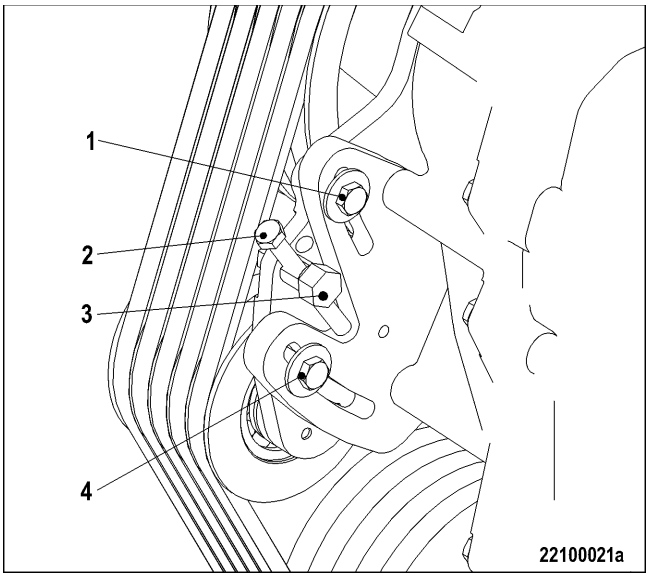


Drive belt replacement on 12V/16V engines:

1. Loosen securing screws (3).
2. Release locknut (2).
3. Screw out tensioning screw (1) until V-belts can be removed.
4. Check belt pulley on ventilator bearing pedestal and crankshaft for contamination, clean if necessary.

   Note: V-belts must only be fitted in the grooves as a set and without applying any force.

5. Fit new set of drive belts.
6. To check V-belt tension, the ventilator bearing pedestal must rest against the gearcase.
7. Adjust and check V-belt tension (→ Page 6 – 57).



Drive belt replacement on 18V engines:

1. Loosen securing screws (1 and 4).
2. Unscrew tensioning screw (2) with bolt (3) until the V-belts can be removed.
3. Check belt pulley on ventilator bearing pedestal and crankshaft for contamination, clean if necessary.

   Note: V-belts must only be fitted in the grooves as a set and without applying any force.

4. Fit new set of drive belts.
5. To check V-belt tension, the ventilator bearing pedestal must rest against the gearcase.
6. Adjust and check V-belt tension (→ Page 6 – 57).

Final steps

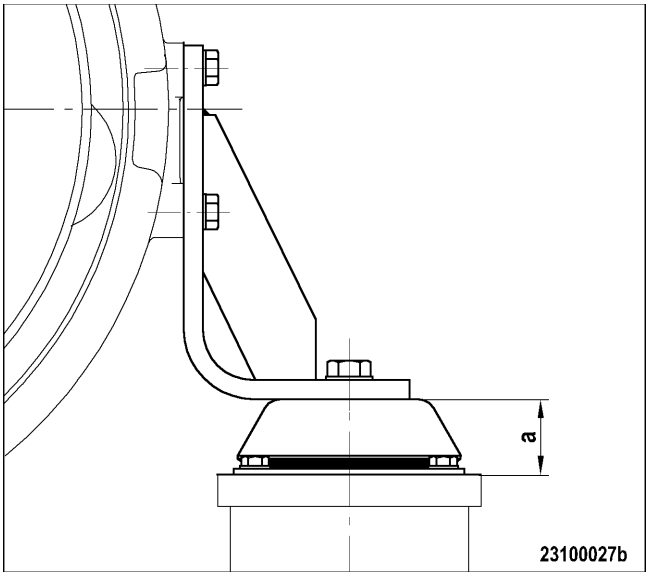
1. Install ventilator.
2. Install guard cover.

6.19 Engine Mounts

6.19.1 Engine mounts – Resilient elements check

Preconditions

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



Engine mounts – Resilient elements 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 setting dimension:
   - Dimension (a) = 55 mm.
2. If dimension (a) is less than 55 mm, resilient elements must be replaced. Contact Service.

6.20 General Wiring, 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 Engine Governor (Electronic) Control System

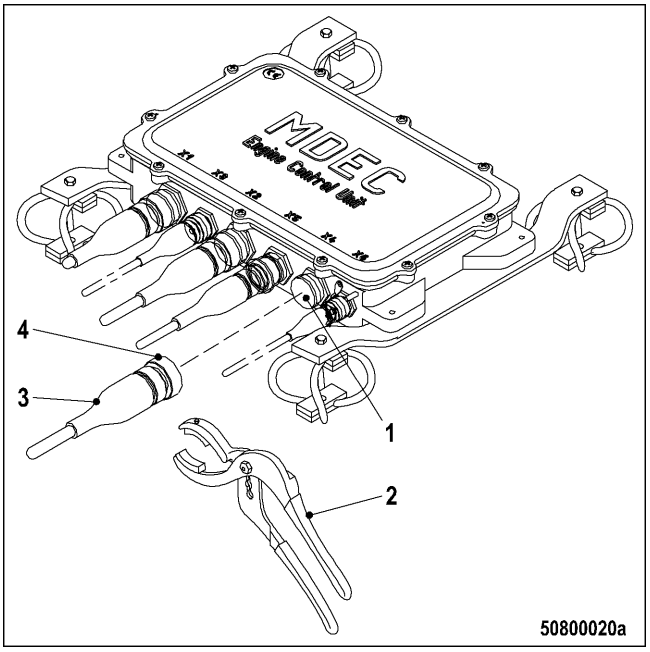
6.21.1 ECU – Removal and installation

Preconditions

- Engine is stopped and starting disabled.

Special tools

Designation / Use	Part No.	Qty.
Connector pliers		
Covering caps for Cannon sockets		



ECU – Removal

1. Note or mark assignment of cables to connector sockets.
2. Use connector pliers (2) to disengage the bayonet union nuts (4) of the connectors (3) by turning them counterclockwise.
3. Withdraw all connectors.
4. Close connector sockets with appropriate covering caps (1).
5. Disconnect grounding strip from ECU grounding pin .
6. Unscrew corresponding screws and remove ECU.

ECU – Installation

1. Follow reverse sequence of operations as described for removal. Ensure correct assignment of connectors to sockets.
2. Use connector pliers to turn the bayonet union nuts of the connectors clockwise until they lock into place.

6.21.2 ECU and connectors cleaning

Preconditions

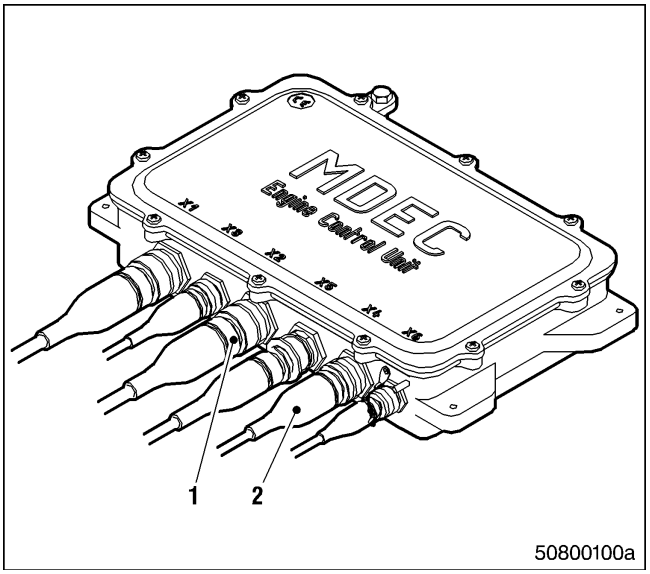
- Engine is stopped and starting disabled.

Special tools

Designation / Use	Part No.	Qty.
Connector pliers		

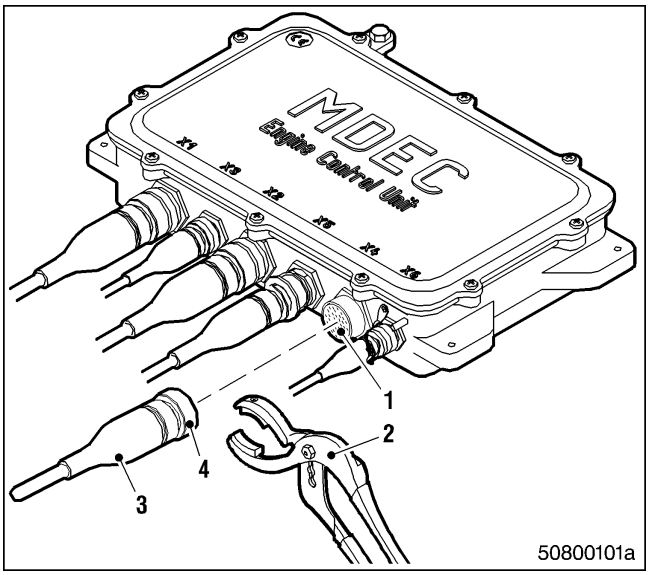
Material

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 6 – 65).

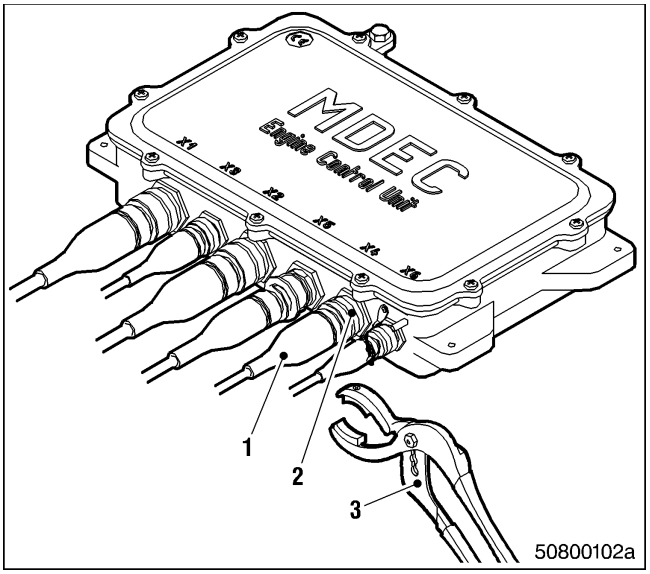
6.21.3 ECU – checking plug-in connections

Preconditions

- Engine is stopped and starting disabled.

Special tools

Designation / Use	Part No.	Qty.
Connector pliers		



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.

7 Annex

7.1 Abbreviations

Abbreviation	Meaning	Explanation
ANSI	American National Standards Institute	
ATL	Abgasturbolader	Turbocharger
BR	Baureihe	Engine Series
CAN	Controller Area Network	
DIN	Deutsches Institut für Normung e. V.	German Standardization Organization, at the same time identifier of German standards (DIN = "Deutsche Industrie-Norm")
DL	Default Lost	Alarm: Default CAN bus failure
ECU	Engine Control Unit	
EDM	Engine Data Module	
EEPROM	Electrically Erasable and Programmable Read-Only Memory	
EMU	Engine Monitoring Unit	
FLS	Fluids and Lubricants Specification	MTU Publication No. A01061/..
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	
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
OT	Oberer Totpunkt	Top dead center (TDC)
P-xyz	Pressure-xyz	Pressure measuring point xyz
PAN	Panel	
PIM	Peripheral Interface Module	
RL	Redundancy Lost	Alarm: Redundant CAN bus failure
SAE	Society of Automotive Engineers	U.S. standardization organization
SD	Sensor Defect	Alarm: Sensor failure
SS	Safety System	Alarm initiated by safety system

Abbreviation	Meaning	Explanation
SPC	Spare Parts Catalog	
T-xyz	Temperature-xyz	Temperature measuring point xyz
TC	Tools Catalog	
TD	Transmitter Deviation	
UT	Unterer Totpunkt	Bottom dead center (BDC)

7.2 Index

A

B

C

E

F

G

I

L

M

O

P

S

T

V