Engine Number:

Please enter your engine number here. This will help us to serve you better in questions of repairs, spare parts and after-sales service generally.

We reserve the right to make technical alterations to the drawings and particulars in this documentation package, if this should become necessary to improve the engines. Reprints and duplication of any kind, either in whole or in part, require our written permission.
This documentation is intended for the following engine:

- Engine type: 
- Type of application: 
- System name: 
- Power: \( kW \)
- Speed: \( \text{min}^{-1} \)
- Commissioned on: 

Please enter data. This will make it a lot easier for us to process after-sales support, repair work and spare parts orders.

The documentation should be presented to the responsible service partner for every service assignment.
Introduction

Please read and keep in mind...

- Read and keep to the information in this documentation. You will avoid accidents, retain the manufacturer’s warranty and have a fully functional, ready-to-use engine at your disposal.

- This engine is built exclusively for the purpose intended according to the scope of delivery as defined by the equipment manufacturer (use for the intended purpose). Any use above and beyond this is considered improper use. The manufacturer will not be liable for damages resulting from this. The user will bear the sole risk in this case.

- Use for the intended purpose also includes observance of the operating, maintenance and repair instructions specified by the manufacturer. The engine may only be used, maintained and repaired by persons who are familiar with it and instructed in the dangers.

- Make sure that this documentation is available to everyone involved in the operation, maintenance and repair and that they have understood the contents.

- Non-compliance with this documentation package may lead to malfunctions and damage to your engine, or even injury to persons, for which the manufacturer will not accept any liability.

- A prerequisite for proper maintenance and repair is the availability of all necessary equipment, hand tools and special tools. All equipment and tools must be in perfect working condition.

- Engine parts such as springs, clamps, elastic retaining rings etc. constitute an increased risk of injury when not used properly.

- The relevant rules for the prevention of accidents and other generally recognised safety and industrial medicine rules must be followed.

- Maximum cost-effectiveness, reliability and long life is only guaranteed when DEUTZ Power Systems original parts are used.

- Repair of the engine must comply with use for the intended purpose. Only parts released for the purpose by the manufacturer may be used for conversion work. Unauthorised modifications to the engine exclude manufacturer liability for resulting damages.
Take care when the engine is running

Carry out maintenance or repair work only when the engine is at a standstill. If you remove any protective features, fit them back in place on completion of the work concerned. When working on the running engine, work clothing must be close-fitting.

Safety

You will find this symbol next to all safety instructions. Follow these meticulously. The attention of operating personnel should be drawn to these safety instructions. In addition, general statutory safety and accident prevention regulations applying in your country must be complied with.

Note

You will find this symbol next to instructions of a general nature.

Follow these meticulously.

Asbestos

Gaskets used in this engine are asbestos-free. Please use appropriate spare parts for maintenance and repair work.
Dear Customer,

Deutz Power Systems engines are designed for a large number of applications. A wide range of variants ensures that the special requirements of each customer are met.

Your engine is appropriately equipped for your requirements, which means that not all of the components described in this manual are necessarily fitted to your engine.

We have endeavoured to highlight any differences so that you will be able to locate the operating and maintenance instructions relevant to your engine quickly and easily.

Please read this documentation before starting your engine, and always follow the operating and maintenance instructions.

We are at your service for any questions you may have.

Your
DEUTZ Power Systems Service

The engines of DEUTZ Power Systems

DEUTZ Power Systems engines are the product of many years of research and development. The profound know-how gained in connection with high-quality requirements is our guarantee for the manufacture of engines with a long life, high reliability and low fuel consumption. Naturally the high requirements for environmental protection are also met.

Maintenance and care

Good service and maintenance will ensure that the engine continues to satisfy your requirements. Recommended service intervals must be observed and maintenance work carried out conscientiously. If the engine becomes difficult to operate, or if operating conditions deviate from normal, it is particularly important to take steps to find out the cause.

DEUTZ Power Systems Service

Please consult one of our service representatives responsible for operating faults and questions on spare parts. Our trained specialist personnel ensures fast, professional repairs using original parts in the event of damage.

Original parts from DEUTZ Power Systems are always manufactured according to the latest standards in technology.

Information about our service can be found at the end of this manual.
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Service
User notes

General

The maintenance and service work prescribed in the operation manual and the workshop manual must be performed on schedule and in full.

The maintenance and service personnel must have the necessary technical knowledge to perform the work. Safety and protection devices which may have to be removed during maintenance and service work must be replaced afterwards.

The rules for the prevention of accidents and the safety regulations must be observed at all times during maintenance and service work.
Please also observe the special safety regulations for the various service groups which are listed in detail as work cards in the Job Cards chapter (cf. also chapter 1 Safety Regulations / Rules for Accident Prevention).

The maintenance intervals can be taken from the maintenance schedules. These also provide information about the work to be performed.

The job cards provide technical hints for performing the work.

Regulations

Safety Regulations / Rules for Accident Prevention

Detailed safety instructions have been compiled for various service groups in the form of job cards, these precede the job cards of the respective service groups.

The legally prescribed rules for accident prevention (available from the appropriate associations or technical publishers) must be observed. These will depend on the location, the operating mode and the supplies and expendables used.

Special safety measures dependent on the respective work are specified and highlighted in the work description.

It generally applies among other things:

- for personnel:
  - Only instructed personnel may operate or maintain the engine. Unauthorized persons must not enter the engine room.
  - Wear tight fitting clothing and ear protectors in the engine room when engines are running.
  - Only employ qualified personnel for repairs or service work.

- for the engine room:
  - Make sure it is properly ventilated (do not cover the ventilation shafts).
  - Provide a first aid kit and suitable fire extinguishers. Check filling and operational readiness at regular intervals.
  - Only store inflammable materials in the engine room which are necessary for operating the system.
  - Smoking and naked lights are prohibited in the engine room.

- for operation and maintenance of the engine:
  - Only start the engine when all safety devices have been fitted and the turning gear has been removed. Make sure there is no-one in the danger zone.
- Only perform cleaning, maintenance and repair work when the engine is switched off and secured against starting up.

Rules for disposal

The work described in the operation manual and workshop manual necessitate the renewal of parts and operating media among other things. These renewed parts / operating media must be properly stored, transported and disposed of. The owner is responsible for this.

Disposal includes recycling and disposal of parts / operating media whereby recycling has priority.

The details of disposal and its supervision are governed by regional, national and international laws and decrees which the plant owner is responsible for observing.
Operating manual and workshop manual

To structure the information to suit the user, the service documentation is divided into operating manual and workshop manual.

Operating Manual

The Operating Manual contains a general description of the engine as well as instructions for the necessary maintenance measures and so on. The maintenance measures described in the Operation Manual can be performed by technically skilled personnel.

The chapters of the operating manual are as follows:

0 Introduction
   Contents
1 User notes
2 Description (description of the engine and components)
3 Operation (operating the engine)
4 Operating media (operating media, auxiliary materials and operating media specifications under "Technical Bulletin")
5 Maintenance (maintenance schedules and special tools up to Deutz maintenance and service schedule E40)
6 Troubleshooting
7 Preservation ("Technical Bulletin")
8 Technical data (technical data on the engine, tightening specifications and test and setting values up to Deutz maintenance and service schedule E40)
9 Job cards (job card list, job cards for maintenance work up to Deutz maintenance and service schedule E40 in numerical order)
10 Miscellaneous (this is an optional chapter only enclosed if needed, containing supplementary documentation)
   Service
   General safety regulations
Workshop Manual

The workshop manual contains all the same chapters as the operating manual, with the addition of the instructions required for maintenance work from Deutz maintenance and service schedule E40 onwards. The maintenance measures from schedule E40 onwards, as described in the workshop manual, may only be performed by authorised personnel.

The chapters of the workshop manual are as follows:

0 Introduction
   Contents
1 User notes
2 Description (description of the engine and components)
3 Operation (operating the engine)
4 Operating media (operating media, auxiliary materials and operating media specifications under "Technical Bulletin")
5 Maintenance (maintenance schedules, special tools as required by all Deutz maintenance and service schedules)
6 Troubleshooting
7 Preservation ("Technical Bulletin")
8 Technical data (technical data of the engine, tightening specifications and test and setting values as required by all Deutz maintenance and service schedules)
9 Job cards (job card list, job cards for maintenance work from all Deutz maintenance and service schedules in numerical order)
10 Miscellaneous (this is an optional chapter only enclosed if needed, containing supplementary documentation)
   Service
   General safety regulations
Job cards

All job cards have a job card number which is associated with a defined work procedure. An overview of the numbering system follows: The structure of the job card is shown in the illustration on the next page.

<table>
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<th>Differentiation of the job cards</th>
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<tr>
<td>The first letter stands for the competence required to perform the maintenance work.</td>
</tr>
<tr>
<td>B Operating manual: to be carried out by technically skilled personnel only</td>
</tr>
<tr>
<td>W Workshop manual: to be carried out by authorised personnel only</td>
</tr>
<tr>
<td>I Repair: to be carried out by authorised Service Centres only.</td>
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</table>

<table>
<thead>
<tr>
<th>Maintenance group</th>
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<tr>
<td>1 Cylinder head</td>
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<td>2 Drive system</td>
</tr>
<tr>
<td>3 Crankcase</td>
</tr>
<tr>
<td>4 Engine control</td>
</tr>
<tr>
<td>5 Speed governing</td>
</tr>
<tr>
<td>6 Exhaust system / Charging</td>
</tr>
<tr>
<td>7 Fuel system</td>
</tr>
<tr>
<td>8 Lube oil system</td>
</tr>
<tr>
<td>9 Coolant system</td>
</tr>
<tr>
<td>10 Compressed air system</td>
</tr>
<tr>
<td>11 Monitoring system</td>
</tr>
<tr>
<td>12 Other components</td>
</tr>
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<td>13 Electrical system</td>
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</table>

<table>
<thead>
<tr>
<th>Subsystem (component)</th>
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<tr>
<td>The subsystem differs depending on the maintenance group.</td>
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<table>
<thead>
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<th>Consecutive number</th>
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</thead>
<tbody>
<tr>
<td>- Counting per subsystem (component)</td>
</tr>
<tr>
<td>- Different activities in the subsystem (component)</td>
</tr>
<tr>
<td>- Version differences</td>
</tr>
</tbody>
</table>

T 1-1 Numbering of job cards
For inquiries about job cards please always give the engine type or system 1, the number of the job card 2 and the date of issue 7.

1  Engine type or system  
2  Number of the job card  
3  Title of the job card  
4  Tools, aids, spare parts and references  
5  Safety instructions  
6  General notes  
7  Date of issue of the job card

**Spare parts**

Spares are available from DEUTZ Service. You will find a list of spares in the spare parts list of the engine or the system. You will find further information in the Service chapter at the end of the Operation Manual or Workshop Manual.
Description

Type and designations

The engines in this series are water-cooled four-stroke, high-performance Otto gas engines which can be used in a wide range of drive applications with easy usability of the coolant and exhaust heat in force-heat coupling processes. A special low exhaust emission combustion process has been developed for environmental protection.

Type designation

<table>
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<th>T</th>
<th>B</th>
<th>G</th>
<th>620</th>
<th>V</th>
<th>-</th>
<th>K</th>
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<tr>
<td>Mixture charge cooling</td>
<td>B</td>
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<tr>
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<tr>
<td>No. of cylinders</td>
<td>12, 16 or 20</td>
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<td></td>
</tr>
<tr>
<td>Two circuit cooling</td>
<td>K</td>
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</table>
Name plate

Position on the engine

The rating plate is fixed to the engine. The engine number is punched additionally.

A 2-1  Position of the rating plate on the engine

A 2-2  Position of the engine number on the engine
Figure, rating plate

1. Engine type designation
2. Year
3. Engine number
4, 5, 6. Performance abbreviation according to DIN ISO 3046 Part 7 and abbreviation for the gas type\(^1\). A * or ** in front of the performance abbreviation refers to the corresponding NOx emission, see 13, 14.
7, 8, 9. Numeric value of the performance in kW
10, 11, 12. Engine speed in rpm
13, 14. NOx emission in mg
15. Height above sea level (conditions at installation site)
16. Air pressure px in mbar (conditions at installation site)
17. Charge air coolant temperature tcx in °C (conditions at installation site)
18. Relative humidity Φx in % (conditions at installation site)
19. Mixture coolant temperature tcx in °C (conditions at installation site)
20. Numeric value of performance of the oil pump in kW (F)

\(^1\) Abbreviation for gas type
n natural gas
s sewage gas
l methane gas
m pit gas
p propane gas
Designation of the engines sides, cylinder numbering and direction of rotation

The designation used in this operating manual is highlighted respectively in bold print and corresponds with DIN ISO 1204.

The four sides of the engine normally carry the following designations in practice:

Engine sides

1) Drive side: Flywheel, clutch side
2) Left side: Cylinder side A
3) Free side: End, damper, fluid pump, opposite to clutch side
4) Right side: Cylinder side B

Cylinder numbering

Counted and labelled from the drive side.

Direction of rotation:

Looking towards the drive side: In anticlockwise direction "left-hand rotation"
Engine and unit illustrations

V12 engine

A 2-5 80397-1 V12 engine

V16 engine

A 2-6 81043-1 V16 engine
V20 engine

A 2-7 833831-1 V20 engine
V16 engine, left side

1 Exhaust pipe after TC  
2 Crankcase bleed valve  
3 Oil separator  
4 Oil filler neck  
5 Gas mixing pipe  
6 Mixer valve  
7 Gas inlet gas mixer valve  
8 Oil dipstick  
9 Speed governor  
10 Air filter  
11 Ignition system  
12 Flywheel  
13 Engine mounting  
14 Starter  
15 Engine centre of gravity  
16 Oil pan
V16 engine, drive side

1. Ignition system
2. Intercooler
V16 engine, right side

1. Feed to intercooler (low temperature circuit)
2. Flow from intercooler (low temperature circuit)
3. Lube oil filter
4. Lube oil cooler
V16 engine, free side

1  Coolant drain
2  Lube oil filter
3  Coolant feed
4  Pressure pipe from pre-lube pump
5  Pre-lube pump electric
V16 engine, top

1 Gas throttle
2 Speed governor
3 Exhaust manifold (A-side)
4 Turbocharger
5 Exhaust pipe after TC
6 Feed to intercooler (low temperature circuit)
7 Flow from intercooler (low temperature circuit)
Design and function

Cylinder head

The cylinder heads are made from a special alloyed casting like the crankcase. One single cylinder head is installed per cylinder. Thanks to the excellent access and optimized design, the single cylinder head can be replaced in a very short time.

The cylinder heads are liquid-cooled and integrated into the engine cooling system.

The cylinder heads are multi-valve heads, i.e. two inlet valves per cylinder ensure optimum filling and two outlet valves for fast exhaust discharge. The high heat-proof valves are located in the pressed-in and therefore easily replaceable valve seat rings. The valves are controlled by a proven valve bridge technique. The valve bridge control operates with particularly low wear and is very maintenance-friendly.

A 2-11 Cylinder head

1   Rocker arm (inlet)
2   Rocker arm (outlet)
3   Stop rod
4   Valve bridge
5   Spark-plug shaft
6   Valve
7   Valve spring
8   Valve head
Channel guide

The channel guide is based on the cross current principle. The cylinder heads are supplied with the combustion gas through the charge mixture pipe from the one side. The two inlet channels 2 and 3 have different manifolds in the cylinder heads. They are divided into a filling channel 2 and a twist channel 3. These ensure, by their shape, a combustion gas flow into the combustion chamber which greatly improves the filing. The outlet channels 1 end in the exhaust system in which the exhaust gas energy is not lost but recycled.

Drive system

The machined crankshaft with bolted on counterweights is suspended in the crankcase. The bearing covers are held vertically by two studs and are fastened horizontally by two additional screws for cross bracing. The engine has forged light metal pistons which are cooled by lube-oil injection nozzles and double T-shank con-rods. The lube oil supply to the main bearing and con-rod bearing is provided by a lube oil pump which sucks the lube oil from the oil pan.

Crankcase

The crankcase is made of a specially alloyed casting. Torsional strength, breaking strain and casting tightness which enables a low weight and compactness distinguish this manufacturing method. The side walls of the crankcase are pulled down to below the center of the crankshaft and therefore guarantee additional torsional strength. The small cylinder enable a narrow design which is required in many applications.
Engine control and wheel drive

A 2-13 Wheel drive

1 Toothed wheel crankshaft (59 teeth)
2 Intermediate wheel (59 teeth)
3 Intermediate wheel (33 teeth)
4 Camshaft toothed wheel, B-side (66 teeth)
5 Camshaft toothed wheel, A-side (66 teeth)
6 Intermediate wheel to the lube oil pump (52 teeth)
7 Toothed wheel lube oil pump drive (40 teeth)

Speed control

The speed controller controls the performance of the engine by adjusting the throttle valve position. This control takes place electronically via the TEM system. During electronic speed control the actual speed is picked up by a magnetic pulse sensor (pickup). The pickup signal is transferred to the TEM system and compared with the reference speed. In case of deviations, the actuator is controlled by the TEM system. The actuator is connected with the throttle valve and can adjust it.

In the V12 and V16 engines the actuator is connected to the throttle by the regulating lever and a linkage.

The V20 engine is equipped with two actuators whose output shafts act directly on the rotary disk valves.
Actuator

The V12 and V16 engines are equipped with the actuator StG 30, two actuators StG 2080 are fitted to the V20 engine.

The actuators are distinguished by:

- high adjustment forces acting in both directions
- low power consumption
- Insensitivity at slow voltage change in the power supply, sudden changes lead to controller faults.

V12 and V16 engine with StG 30

A DC motor transfers the torque to the controller output shaft via intermediate gearing. Setting of the controller output shaft is achieved by the return probe, which carries out non-contact sampling of the return cams and passes the information to the TEM system.

On reaching the stop, current limitation is implemented after approx. 20 seconds, which reduces the actuator current to such an extent that no damage is suffered by the actuator.

A 2-14 Actuator, Heinzmann StG 30

1 DC motor
2 Gearbox
3 Output shaft
4 Probe
5 Return cams
V20 engine with StG 2080

On the shaft of the actuator is a multi-pole permanent magnet. Opposite the permanent magnet is a coil body on which a working coil is mounted. If the working coils conduct, torque occurs in one direction, the reversal of the current provides torque in the opposite direction.

A return spring is attached to the controller output shaft, the force of which is normally sufficient to pull the actuator to the stop position in the event of a power failure. Setting of the controller output shaft is achieved by the return probe, which carries out non-contact sampling of the return cams and passes the information to the TEM system.

On reaching the stop, current limitation is implemented after approx. 20 seconds, which reduces the actuator current to such an extent that no damage is suffered by the actuator.

A 2-15 Actuator, Heinzmann StG 2080

1 Working coil
2 Output shaft
3 Permanent magnet
4 Probe
5 Return cams
6 Return spring
Installation location

A 2-16 Actuator StG 30; V12 and V16 engine

A 2-17 Actuator StG 2080; V20 engine
Charging

The engine is equipped with a turbocharger and a liquid-cooled mixture cooler. The engine achieves a higher performance with simultaneous reduction of the pollutant emissions due to the mixture charging.

Schematic diagram of turbocharging

1. Intake air
2. Air filter
3. Filtered air
4. Gas / air carburettor
5. Gas
6. Mixture to the compressor
7. Compressor wheel
8. From compressor to mixture cooler
9. Mixture cooler
10. Cooled mixture
11. Inlet valve
12. Outlet valve
13. To the exhaust gas turbine
14. Turbine wheel
15. To the silencer
Compressor bypass

When adapting the turbocharger, the combustion behaviour of the gas (energy content, combustion speed etc.) must be taken into account. Methane or sewage gas may vary greatly in composition. This results in great changes in the combustion behaviour. At decreasing heat value and high inert gas content the combustion speed is reduced which leads to a higher exhaust gas temperature. This on the other hand leads to a higher charging pressure at the same performance and the compressor of the turbocharger begins "pumping". An adjustable compressor bypass on the turbocharger avoids the need for another turbocharger specification according to the gas composition. An optimum adaptation to the existing gas quality is possible at any time without conversions. For two-gas operation, i.e. alternative operation with natural gas or dump/sewage gas, the compressor bypass with solenoid valve is provided. The turbocharger is optimized for the natural gas operation (solenoid valve closed). For operation with methane/sewage gas the bypass is released by opening the solenoid valve. Additionally a setting option for adapting to the dump gas quality is available. The bypass is set in commissioning and when required (e.g. very great variation in the gas quality at dumps) by DEUTZ service personnel.

1 Bypass pipe
2 Setting screw
3 Mixture pipe before turbocharger
4 Mixture pipe after turbocharger
A 2-19 Compressor bypass (two-gas operation)

1. Bypass pipe
2. Setting screw
3. Mixture pipe before turbocharger
4. Mixture pipe after turbocharger
5. Solenoid valve
   - closed: Natural gas operation
   - open: Sewage/methane gas operation
Gas system

Gas control line

Structure and function (DIN EN 676; DIN 33831, Part 2)

The control and safety systems incorporated in the gas regulator line ensure that the gas engine can be operated safely and reliably. The gas pressure regulator adapts the mains side gas pressure to the requirements of the gas engine.

Improper installation, adjustment, modification, operation or maintenance can cause injury or damage.

Installation, wiring, adjustment and maintenance may only be performed by authorized and qualified personnel.

Read the instructions for installation and use.

The equipment must be installed according to applicable regulations.

The local regulations of electricity and gas boards must be observed.

A 2-20 80321-2 Figure Gas regulator line
Components of the gas control system- all DVGW tested!

1. Flange
2. Shut-off device (ballcock) - hand-operated shut-off of the gas supply for repair work within the gas regulator line and with the unit shut down. When the whole gas control system is disconnected the closed pressure gauge with pushbutton tap stays at the control system output for checking the gas pressure
3. Gas filter
4. Gas pressure gauge (electr. pulse transmitter) - Automatic monitoring of the minimum admissible gas pressure upstream of the gas pressure regulator
5. Solenoid valves - with measurement connection
6. Flame flashover protection (gas group 2 only)
7. Reducer
8. Gas pressure regulator - The pressure regulator reduces the gas pressure at the input of the gas regulator line to the gas pressure required in the engine.
9. Outlet pipe
10. Flange

Automatic shutoff process

To purge the engine when shutting off, the gas supply line must be closed before the ignition is interrupted. This is part of the automatic process carried out by the TEM system.

Assembly and testing

G 600 (DVGW-TRGI), G 490 and G 495 installation regulations apply for the intake up to the customer’s on site shut-off device.

The components of the gas regulator line are tested by the manufacturer for strength and leaks. The fully assembled plant must be subjected to a final leak test with air or inert gas with 1.2 times the maximum permissible operating pressure (set output pressure at the regulator) but at least 150 mbar.

- The pressure in the input chamber (mains side) must always be equal to or greater than the pressure in the outlet chamber (engine side).
- Pressure build-up always before the input side, pressure release always before the output side (change pressure slowly!).
- The gas regulator line may only be attached horizontally.
- The gas regulator line must be protected against careless damage, especially if situated low down.
- No vibrations may be transmitted from the engine to the gas pipe.
- The ballcock and pushbutton tap must be operable by hand (max. attachment height 2,100 mm!).
- The pressure gauges must be easy to read.

Instructions for installation

Depending on the gas type, the engine requires the appropriate gas control line.

Nonferrous metals (brass) may not be used for gas-carrying parts when using aggressive gases.
The gas control line must be installed in the same room as the gas engine. This ensures that the gas control line is subjected to the same air pressure conditions as the engine.

Exhaust gas lines must be directed into atmosphere with sufficient cross-section.

Pressure regulators, monitoring devices and pipes must be installed without bracings. Pressure regulators and monitoring devices are always to be fitted according to the manufacturer’s instructions. The direction of flow must be followed.

The gas control line must be installed as close to the engine as possible. The distance between the gas control line outlet and the gas mixer inlet must be max. 3 m in length and with max. three 90° curves.

Flame flashovers can occur with fuel gas mixtures whose components may also contain oxygen. The gas control lines contain endurance burning flame flashover protection devices with temperature monitoring to prevent flashovers in the gas-carrying line. For this, a distance of maximum 40 times the pipe diameter of the gas line is permitted between the engine and gas control line. For larger distances, an endurance burning detonation arrester must be provided instead of the flame flashover protection.

Example:

<table>
<thead>
<tr>
<th>Pipe diameter</th>
<th>= 100 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 x 100 cm</td>
<td>= 4000 cm</td>
</tr>
<tr>
<td>max. permissible distance</td>
<td>= 4 m</td>
</tr>
</tbody>
</table>
Gas / air mixer, mixture formation

The gas and air are blended to form a combustible mixture in the carburettor immediately upstream of the turbocharger.

The carburettor is in the form of a Venturi tube, i.e. a pipe with a converging section to channel flow which gradually diverges again. The design means that the flow has only a minimum pressure drop and therefore only minimum filling losses in the cylinders. The highest flow rate occurs at the most constricted section. The gas is mixed with the core flow radially from outside at this location via an annular gap using the resulting vacuum. This mixing mode has the advantage that the volume ratio of gas to air remains almost constant even in the case of great fluctuations in the sucked mixture and deviates only slightly from the so-called lambda window in which the safe and cost-effective operating range of the engine is contained.

The adjustable gas gap is used to set the gas-air mixture. The mixture volume is regulated by means of the throttle.

A 2-21 Schematic multi-gas mixer

1  Servomotor
2  Coupling
3  Adjustment spindle
4  Adjustable gas gap
5  Gas inlet
6  Fuel-air mixture
7  Venturi nozzle
8  Air line
9  Air from filter
A 2-22 Servomotor

A 2-23 Proximity switch, lean mixture
Lube oil system

The lube oil reduces friction of the components which rub against each other and dissipates heat from the rubbing positions, the piston head and the turbocharger. A film of lube oil on the cylinder surfaces reduces the gliding friction of the piston and piston rings. The lube oil also captures impurities within a suspension and transports them to the lube oil filter. The lube oil pump sucks the lube oil from the oil tray, feeds it through the lube oil cooler and the lube oil filter into the lube oil circuit of the engine. The lube oil pressure in the engine circuit is set by a lube oil pressure regulating valve. The bypass valve is installed to avoid the flow of lube oil being interrupted when the lube oil filter is dirty. If the lube oil pressure gets so high that the lube oil pump is at risk, the safety valve opens and allows the excess lube oil to flow back into the oil tray.

Lube oil level switch

The engine is equipped with a lube oil level switch. It transfers various information about the lube oil level in the engine to the TEM system.

The lube oil refilling process therefore runs fully automatically through the TEM system. If there should still be a lack of oil, the engine is shut down by the TEM system.

The lube oil change is also automated by the lube oil level switch in connection with the TEM system. The lube oil level switch reports the different oil levels (oil tray empty or full) to the TEM system which then switches the pre-lube pump on or off accordingly.

A 2-24 Lube oil level switch

1. Connecting line to the oil pan
2. Vent line
3. Connector
4. Oil pan
Crankcase bleed valve

Model AS 500 - Dynapure

The crankcase bleed valve is equipped with an oil mist trap. The sucked in air/oil mixture is spun and accelerated in the oil mist trap by a rotating drum so strongly that the micro-fine oil mist particles form small droplets and are separated from the air in the rotating filter drum by the sieving and inertia effect. The oil gained in this way flows back into the oil pan through the drain.

A 2-25 Crankcase bleed valve

1. Intake pipe
2. Air return line to the air filter
3. Oil mist trap
4. Drain line

A 2-26 Schematic oil mist trap

1. Air outlet, the cleaned air is returned
2. Rotating filter drum with turbo wheel
3. Intake elbow
4. Drain for trapped oil
Cooling system

The chemical energy in the gas is converted into heat energy during combustion. The engine can only partly convert this into mechanical energy. The remaining heat is dissipated mainly with the exhaust gas and the coolant.

The engine has a two circuit cooling system. The lube oil cooler, mixture cooler, water-cooled exhaust pipe and cylinder cooler are integrated in the engine cooling circuit. The low temperature mixture cooler is cooled by a separate cooling circuit. In this way it is possible to reduce the mixture temperature and increase the engine performance. The coolant temperature is controlled and monitored automatically. The engine is switched off by the TEM system at temperatures above the set maximum values.
Compressed air system

Compressed air starter

The V20 engine is equipped with a compressed air starter or an electric starter depending on the version.

The compressed air starter generates a sufficiently high starting speed for ignition through the flywheel.

Triggered by the TEM system control air presses the starter pinion into the flywheel ring gear, the operating air then rotates the engine up to starting speed. When the engine has fired, the TEM system tracks out the starter and blocks further starts when the machine is running.

A 2-27 83843-0 Schematic diagram compressed air starter with air control system

A 2-28 83843-1 Compressed air starter with air control system

1 Compressed air starter
2 Pressure reducing starter valve - Input pressure: max. 30 bar - backpressure: 1...10 bar
3 Solenoid valve 24V
4 Safety valve - Pressure setting: 12 bar
5 Pressure gauge
6 Dirt trap
7 High-pressure hose (air supply)
Electrical system

Ignition system

The engine is equipped with a TEM-ZS3 microprocessor-controlled ignition system which is supplied by the TEM system with a voltage of 24 V. A toothed gear on the flywheel is scanned by an electronic sensor and enables the exact crank angle time to be determined. The right process phase for the ignition spark in the four-stroke technique is selected by an additional sensor on the camshaft. The electronic control device sends medium voltage pulses to the ignition coils assigned to every cylinder. From there a high voltage cable leads to each spark plug. An extremely fast voltage rise guarantees a powerful and short ignition spark with a gentle effect on the spark plug electrodes. Settings on the ignition device are made exclusively by DEUTZ service personnel. Some examples are adjustment of the ignition time to adapt to the gas quality, or the selection of two different ignition times in two-gas operation. For work on the ignition system such as changing parts, e.g. spark plugs, ignition cables and ignition coils, the ignition no longer needs to be switched off because the TEM system has switched off the ignition safely when at a standstill.
Electrical starter

The engine is equipped with an electrical starter. The starter accelerates the engine crankshaft to ignition speed.

An electric motor is fitted to the flywheel housing which drives the flywheel via the starter pinion.

A 2-30 Electrical starter
Terminal assignment plans TEM Evolution

A 2-31 Terminal assignment plan TEM Evolution (V12 engine)

A 2-32 Terminal assignment plan TEM Evolution (V16 engine)
<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Direction of rotation of camshaft</td>
</tr>
<tr>
<td>2</td>
<td>Pickup index camshaft toothed wheel</td>
</tr>
<tr>
<td>3</td>
<td>Connector O</td>
</tr>
<tr>
<td>4</td>
<td>Connector M</td>
</tr>
<tr>
<td>5</td>
<td>Multi-function rail cylinder row B</td>
</tr>
<tr>
<td>6</td>
<td>Plug F</td>
</tr>
<tr>
<td>7</td>
<td>Plug</td>
</tr>
<tr>
<td>8</td>
<td>Ignition system TEM-ZS3</td>
</tr>
<tr>
<td>9</td>
<td>Plug P1</td>
</tr>
<tr>
<td>10</td>
<td>Pickup on the flywheel</td>
</tr>
<tr>
<td>11</td>
<td>Direction of rotation of flywheel</td>
</tr>
<tr>
<td>12</td>
<td>Plug</td>
</tr>
<tr>
<td>13</td>
<td>Plug</td>
</tr>
<tr>
<td>14</td>
<td>Multi-function rail cylinder row A</td>
</tr>
<tr>
<td>15</td>
<td>Plug</td>
</tr>
<tr>
<td>16</td>
<td>Ground point on the crankcase</td>
</tr>
<tr>
<td>17</td>
<td>Ignition coils</td>
</tr>
<tr>
<td>18</td>
<td>TEM Evolution</td>
</tr>
<tr>
<td>19</td>
<td>Ring gear crankshaft</td>
</tr>
<tr>
<td>20</td>
<td>Camshaft</td>
</tr>
<tr>
<td>21</td>
<td>Earthing of the switching system</td>
</tr>
<tr>
<td>22</td>
<td>Spark plug</td>
</tr>
</tbody>
</table>
Electrical components

1. Plug C
2. Coolant temperature sensor before intercooler (202)
3. Knocking sensor (241...246)
4. Thermocouple (461...466)
5. Starter (7.5.1)
6. Starter relay VK1
7. Crankcase - overpressure (145)
8. Lube oil level (234)
9. Electric motor for pre-lube pump (2.5.1)
10. Lube oil pressure switch (196)
11. Camshaft pickup (319)
12. Multi-function rail (cylinder row A)
13. Inductive proximity switch (159)
14. Sensor for aspirated air temperature V16 engine (159)
15. Sensor for aspirated air temperature V12 engine (203)
16. Plug G
17. Plug N

The data in brackets refer to the terminal assignment plan.
A 2-35 Electrical components (example V16 engine)

1. Multi-function rail (cylinder row B)
2. Coolant temperature sensor engine outlet (206)
3. Temperature sensor (201)
4. Coolant temperature sensor engine inlet (207)
5. Lube oil temperature sensor (208)
6. Lube oil pressure transmitter before filter (196)
7. Knocking sensor (251...256)
8. Thermocouple (471...476)
9. Pickup on the flywheel (200)
10. Ignition system TEM-ZS2 / ZS3
11. Earthing rail
12. Plug F
13. Plug E
14. Plug H
15. Stepper motor (1.5.16)
16. Actuator (STG 30)
17. Ignition coil

The data in brackets refer to the terminal assignment plan.
Operation

Work prior to first commissioning and after every inspection

General

The following should be carried out before commissioning, after the engine has been out of operation for a long period and after maintenance and repair work:

- Check all lines and connections for leaks of the following media:
  - Gas
  - Lube oil
  - Coolant
  - Intake air
  - Exhaust gas

- Check linkage of the speed governor for easy action. Check operation of monitoring, shut-off and remote control systems.

- Check the control cable and the sensor with the TEM system self-test.

Filling of coolant

The coolant is filled through the filling nozzle according to operating materials specification with supplements. The coolant chambers are bled by a bleeding line with the coolant pump running. Then check the coolant level again and add coolant if necessary.

Filling of lube oil

The lube oil level is monitored during operation by the TEM system. The approximate lube oil level can be checked with the oil dipstick or is visible in the sight glass. When filling up with lube oil, this should be done in connection with the TEM system.

Too low a level of lube oil leads to non-release or switching off of the engine via monitoring of the lube oil level and the lube oil pressure.
**Pre-lubrication**

The engine is lubricated by the electric lubrication pump for constant standby at regular intervals. Pre-lubrication must have taken place before the engine has started.

**Gas supply**

---

**Caution, explosion hazard !**

*The ventilation system should be switched on before carrying out any work on the gas line.*

*Smoking and the use of naked flames is prohibited.*

Clean the whole line leading to the engine internally (incl. desulphurising system, gas compressor, cooler, gas pressure regulator and shut-off systems). All parts of the line must be dry, clean and free of welding beads, scales and other dirt particles. The joints should be checked for leaks using soapy water, by applying, for example, nitrogen at overpressure.

**Note for all heat transformers**

Before the insulation is closed, all the screws on pipe and connecting flanges in the exhaust gas system must be tightened. This measure is necessary because of "settling" of the seals.

It is essential to tighten them once more after approx. 100 operating hours or after 14 days.

Failure to do so will result in the manufacturer disclaiming responsibility for leaking seals and escaping exhaust gases.

When filling the water side, bleed constantly (failure to bleed air sufficiently leads to gas accumulations which could damage the boiler).

Particular attention must be paid to contamination of the heating water. Sludge and corrosion products from older heating water circuits and rolling and welding residue can accumulate and cause overheating, voltage peaks and material breakage for example due to local insulation effects.

The heating water side must therefore be checked after the first 10 hours and after a further 100 hours and, if necessary, be cleaned to remove sludge. Sludge drains and filters make this job easier.

**Exhaust side**

The exhaust gas parts resulting from engine combustion can deposit residue on the smoke pipes.

Although this tendency is only very slight in three-way catalysts, coating on the walls at the transmission surfaces cannot be ruled out over long operating periods. This coating can be removed mechanically or wet chemically.

**Note for oxidation catalyst**

In systems with an oxidation catalyst the catalyst no longer needs to be removed for commissioning.
Commissioning / Starting

Starting

The values for the suction intake air temperature must be maintained (see chapter 8, Technical data).

The following functions are performed automatically one after the other by the system management TEM system when starting.

1. Set the gas cross section at the mixer to start position for the gas type concerned.
2. Check that all module components are ready for starting.
3. Switch on the starter
4. Scavenge air and exhaust gas system
5. Switch on the ignition
6. Open the gas valve —> engine runs up
7. Switch off the starter when the speed is high enough and disengage
8. Engine accelerates up to rated speed and is ready for synchronisation

Warming up

The engines can be kept constantly at standby temperature by a separate coolant heating (resistance heating or heating by pump operation) even at standstill.

After starting, the engines generally run up quickly to operating temperature, i.e. the set heating lead temperature, by return flow of the heating water. This is independent of the temperature of the heating system. The automatic load connection leads to a reduction in the drop in temperature.

Room ventilation

In the case of engines installed in enclosed spaces, a check must be carried out after start-up as to whether the automatic inlet and outlet air shutters have opened and the fans have started up.

Inadequate engine room ventilation results in excessive room temperatures and a corresponding reduction in output by the engine and generator protection systems in the TEM system.

Lube oil system

The lube oil pressure is monitored and recorded in the TEM system and normally does not need to be checked by the operator again.

Regular checking of the lube oil level and the lube oil supply in the day tank is very important. It should be checked during the inspections with the engine at a standstill. Inspect every 24 h in continuous operation. In case of low lube oil levels the engine is switched off automatically and must be unlocked manually on the switching system after filling with lube oil.
Monitoring operation

System monitoring

All important system parameters of the engine, the generator and the connected heat utilisation system are constantly monitored by the TEM system.

The operating values of the systems must be checked against the recordings made by the TEM system at regular operating intervals (daily in the case of continuous operation). A log is best kept by continuously saving all data to a central PC.

In case of irregularities, defects and faults must be documented by printing out the last 24 h on the system PC printer and by recording them in the operating log. The causes of the fault must then be eliminated.

Engine Peripheral Systems

The temperatures, pressures and other relevant states are monitored automatically, the operating values saved continuously in the module control of the TEM system. If the set maximum values are reached, a warning is issued in the first instance. Then, if exceeded again, the engine is shut off (fault indication).

Coolant circuit

Filled up coolant while the engine is running is prohibited!

Small quantities may be topped up after the engine has been switched off. When filling frequently, make sure that the anti-corrosive content is observed.

Batteries

If the engine has an electric starter, the appropriate batteries and chargers must be checked weekly. The voltage given off by the backup battery of the TEM system is monitored automatically. This serves to back up data in the event of a power failure.

Please note:
The operating manual for the TEM system is available as a separate document and must be ordered separately.
Operating media

A1

B1

GAS
Operating media TBG 620
Operating media

General

Guarantee

If unsuitable operating media are used or if no proof can be brought that the used operating media meet the requirements, the engine manufacturer cannot guarantee trouble-free operation. This also applies for defective maintenance of the engines and the operating media.

The most important operating media for gas engine systems are listed in the enclosed operating media specifications. The values specified therein are binding unless specified otherwise in the engine or system-specific contracts.

Product selection

Due to the large number of products in national and international quality and availability and as a result of the constant further development, it is not possible for us to test all suitable products and to name them, we therefore cannot accept any responsibility for these products.

The supplier of the operating materials is solely responsible for the world-wide consistent quality of the products listed here and for products not listed here additionally for meeting the listed requirements for operating media and their operational safety. This also applies for the event that the manufacturer develops the listed products further.

The operating media (reference products) listed here are just a selection of a few manufacturers and their products. Other operating media not listed here can be used if they meet the necessary requirements, i.e. are at least equal in all criteria. The operating media named in this specification are to be used as reference products for comparison. The respective operating media suppliers can provide information about this and should confirm the suitability accordingly.

Mixability

Mixing different expendable types together, e.g. different lube oils with each other, different coolant additives with each other, may lead to malfunctions.

In any case the product supplier’s consent must be obtained before mixing and he must take over the responsibility. This also applies for other additives to the operating media.

Fuel gas

see technical circular TR 0199-99-3017.

Lube oil

see technical circular TR 0199-99-2105.

Engine coolant

see technical circular TR 0199-99-2091.
Operating media
TBG 620
Aids

Sealants and Locking Agents

- Observe storage stability, if any, given on the package!
- Upon transport, storage and disposing of the above-mentioned items, observe chapter 1, Regulations of the operating manual, if no according information is given on the package.
<table>
<thead>
<tr>
<th>Material designation</th>
<th>Type</th>
<th>Standards and specifications</th>
<th>Characteristics</th>
<th>Application examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEUTZ DW 43</td>
<td>Sealant</td>
<td></td>
<td>Solvent-free, rubber base soft elastic hardening, fast skin formation, temperature range 30 °C to 100 °C</td>
<td>Sealing of small joints</td>
</tr>
<tr>
<td>DEUTZ DW 47</td>
<td>Sealant</td>
<td>LV 0161 9672 FV 0160 9610</td>
<td>Silicone rubber, tenacious elastic, easily removable, temperature range max. 180 °C, oil max. 150 °C</td>
<td>Sealing of rough and uneven surfaces</td>
</tr>
<tr>
<td>DEUTZ DW 48</td>
<td>Sealant</td>
<td>LV 0161 9572 FV 0160 9610</td>
<td>Silicone rubber, tenacious elastic, high adhesion strength, temperature range -65 °C to 265 °C</td>
<td>Sealing of rough and uneven surfaces</td>
</tr>
<tr>
<td>DEUTZ DW 49</td>
<td>Sealant</td>
<td>LV 0161 9571 FV 0160 9607</td>
<td>Mixed polymerisate of vinyl- und acryl compounds, high adhesion strength and permanent elasticity, temperature range -40 °C to 130 °C</td>
<td>Sealing of core hole plugs</td>
</tr>
<tr>
<td>DEUTZ DW 50</td>
<td>Sealant</td>
<td></td>
<td>Liquid, hardening artificial resin, compatible with flat gaskets temperature range -40 °C to 180 °C</td>
<td>Sealing of housings</td>
</tr>
<tr>
<td>DEUTZ DW 51</td>
<td>Sealant</td>
<td>LV 0161 9573</td>
<td>Physically dry artificial resin, permanent elastic and vibration-free temperature range -30 °C to 150 °C</td>
<td>Sealing of surfaces</td>
</tr>
<tr>
<td>DEUTZ DW 55</td>
<td>Locking agent</td>
<td>FV 0160 9605</td>
<td>Anaerobic solvent-free single-component substance hardening upon metal contact when excluding oxygen, high strength, fluid, temperature range —55 °C to 150 °C</td>
<td>Securing and sealing of threads up to M12; joints up to max. gap width of 0.15 mm</td>
</tr>
<tr>
<td>DEUTZ DW 56</td>
<td>Locking agent</td>
<td>FV 0160 9605</td>
<td>Anaerobic solvent-free single-component substance hardening upon metal contact when excluding oxygen, high strength, viscous, temperature range —55 °C to 150 °C</td>
<td>Securing and sealing of threads up to R2*</td>
</tr>
<tr>
<td>DEUTZ DW 57</td>
<td>Locking agent</td>
<td>FV 0160 9605</td>
<td>Anaerobic solvent-free single-component substance hardening upon metal contact when excluding oxygen, low strength, fluid, temperature range —55 °C to 150 °C</td>
<td>Securing and sealing of threads up to M12;</td>
</tr>
<tr>
<td>DEUTZ DW 59</td>
<td>Locking agent</td>
<td>FV 0160 9605</td>
<td>Anaerobic solvent-free single-component substance hardening upon metal contact when excluding oxygen, high strength, medium viscous, temperature range —55 °C to 150 °C</td>
<td>Securing and sealing of threads up to M20; joints up to max. gap width of max. 0.15 mm</td>
</tr>
</tbody>
</table>

Operating media TBG 620
<table>
<thead>
<tr>
<th>Material designation</th>
<th>Type</th>
<th>Standards and specifications</th>
<th>Characteristics</th>
<th>Application examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEUTZ DW 60</td>
<td>Locking agent</td>
<td>FV 0160 9605</td>
<td>Anaerobic solvent-free single-component substance hardening upon metal contact when excluding oxygen, medium strength, fluid, temperature range —55 °C to 150 °C</td>
<td>Securing and sealing of threads up to M56 or R2&quot;</td>
</tr>
<tr>
<td>DEUTZ DW 61</td>
<td>Activator</td>
<td>FV 0160 9605</td>
<td>Accelerates and permits the complete hardening of anaerobic substances with passive materials</td>
<td>Only for passive materials</td>
</tr>
<tr>
<td>DEUTZ DW 62</td>
<td>Locking agent</td>
<td>FV 0160 9605</td>
<td>Anaerobic solvent-free single-component substance hardening upon metal contact when excluding oxygen, high strength, medium viscous, thixothropic, temperature range —55 °C to 175 °C</td>
<td>Joints up to a gap width of max. 0.12 mm</td>
</tr>
<tr>
<td>DEUTZ DW 63</td>
<td>Sealant</td>
<td>FV 0160 9605</td>
<td>Anaerobic solvent-free single-component substance hardening upon metal contact when excluding oxygen, low strength, viscous, thixothropic, temperature range —55 °C to 150 °C</td>
<td>Sealing of surfaces up to a gap width of max. 0.10 mm</td>
</tr>
<tr>
<td>DEUTZ DW 64</td>
<td>Locking agent</td>
<td>FV 0160 9605</td>
<td>Anaerobic solvent-free single-component substance hardening upon metal contact when excluding oxygen, high strength, medium viscous, temperature range —55 °C to 150 °C</td>
<td>Securing and sealing of threads up to M80 or R3&quot;</td>
</tr>
<tr>
<td>DEUTZ DW 65</td>
<td>Locking agent</td>
<td>FV 0160 9605</td>
<td>Anaerobic solvent-free single-component substance hardening upon metal contact when excluding oxygen, high strength, viscous, temperature range —55 °C to 150 °C</td>
<td>Joints up to a gap width of max. 0.25 mm</td>
</tr>
<tr>
<td>DEUTZ DW 66</td>
<td>Locking agent</td>
<td>FV 0160 9605</td>
<td>Anaerobic solvent-free single-component substance hardening upon metal contact when excluding oxygen, low strength, viscous, temperature range —55 °C to 150 °C</td>
<td>Securing and sealing of threads up to R3&quot;</td>
</tr>
<tr>
<td>DEUTZ DW 67</td>
<td>Sealant</td>
<td>FV 0160 0040</td>
<td>Anaerobic solvent-free single-component substance hardening upon metal contact when excluding oxygen, high strength, viscous, temperature range —55 °C to 150 °C</td>
<td>Sealing of surfaces up to a gap width of max. 0.50 mm</td>
</tr>
<tr>
<td>DEUTZ DW 68</td>
<td>Sealant</td>
<td>FV 0160 0039</td>
<td>Anaerobic solvent-free single-component substance hardening upon metal contact when excluding oxygen, low strength, viscous, thixothropic, temperature range —55 °C to 150 °C</td>
<td>Sealing of surfaces up to a gap width of max. 0.50 mm, securing and sealing of threads R2&quot;</td>
</tr>
</tbody>
</table>
### Gluing Agents

<table>
<thead>
<tr>
<th>Material designation</th>
<th>Type</th>
<th>Standards and specifications</th>
<th>Characteristics</th>
<th>Application examples</th>
</tr>
</thead>
</table>
| DEUTZ KL 1           | Gluing agent | LV 0161 9633  
FV 0160 9608 | Two-component, epoxy-resin based, water-, oil- and diesel fuel resistant, admiss. application temperature max. 150 °C  
Mixing ratio 1:1, gluing agent DEUTZ KL 1 and hardener DEUTZ KL 2 | Combines steel, aluminium, brass and plastic materials such as plexiglass, polyethylene and similar, gluing them together or among them |
| DEUTZ KL 2           | Hardening agent | LV 0161 9633  
FV 0160 9608 |                                                                                   |                                                  |

T 4-1 Sealants and locking agents

T 4-2 Gluing agents
Lubricants

<table>
<thead>
<tr>
<th>Material designation</th>
<th>Type</th>
<th>Standards and specifications</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEUTZ S1</td>
<td>FV 0160 9537</td>
<td>-180 °C to 1400 °C</td>
<td>Avoids burning in of screw connections in exhaust gas pipes</td>
</tr>
<tr>
<td>DEUTZ S2</td>
<td>LV 0161 9734 FV 0160 9506</td>
<td>-25 °C to 450 °C</td>
<td>Spray, reduces friction and wear on sliding surfaces with difficult access Generates an emergency lubrication and avoids sliding back.</td>
</tr>
<tr>
<td>DEUTZ S3</td>
<td>LV 0161 9733 FV 0160 9505</td>
<td>-35 °C to 450 °C</td>
<td>Spray for reducing friction and wear. Generates an emergency lubrication and avoids sliding back.</td>
</tr>
<tr>
<td>DEUTZ S4</td>
<td>LV 0161 9735</td>
<td>-40 °C to 450 °C</td>
<td>Preferably used for pre-treating components with a high application temperature. After the evaporation of the carrier oil (at 200 °C), an effectively lubricating solid film remains. Compatible with natural rubber and plastic materials.</td>
</tr>
<tr>
<td>DEUTZ S5</td>
<td>LV 0161 9738</td>
<td>-30 °C to 130 °C</td>
<td>For the long-term lubrication of antifriction- and slide bearings with high bearing pressures. Water-resistant, good emergency lubrication</td>
</tr>
<tr>
<td>DEUTZ S6</td>
<td>LV 0161 9741</td>
<td>-20 °C to 180 °C</td>
<td>For the long-term lubrication of antifriction- and slide bearings with medium bearing pressures and higher temperatures. Water-resistant, good emergency lubrication</td>
</tr>
<tr>
<td>Grease</td>
<td>DIN 51825-KP 2 N-30</td>
<td>-30 °C to 140 °C</td>
<td>Consistent grease for lubricating antifriction bearings, slide bearings and sliding surfaces. For example, for filling the spiral-toothed coupling between the injection pumps.</td>
</tr>
</tbody>
</table>

Other Aids

Please find below a reference list for the auxiliary materials used with which the best results have been achieved. Equivalent products can also be used; in this case, the supplier must guarantee the suitability of the product for the application.

When using the following products it is important to follow the supplier’s specifications regarding

- safety instructions,
- personal safety equipment,
- proper use,
- proper disposal

must be observed.
<table>
<thead>
<tr>
<th>Product group</th>
<th>Application</th>
<th>Product name</th>
<th>Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning agent for engine components</td>
<td>P3 Cold cleaner (liquid)</td>
<td>Henkel KGAA 40191 Düsseldorf</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vecom B 24 B (liquid)</td>
<td>Vecom GmbH 21107 Hamburg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carbon remover or Ameroid ACC-9 (liquid)</td>
<td>Drew Ameroid Deutschland GmbH 21107 Hamburg</td>
<td></td>
</tr>
<tr>
<td>for engine cooling system</td>
<td>P3 T 288 (powder)</td>
<td>Henkel KGAA 40191 Düsseldorf</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P3 Standard (powder)</td>
<td>Vecom GmbH 21107 Hamburg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vecom BA-S (powder)</td>
<td>Vecom GmbH 21107 Hamburg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vecom BA-30 (liquid)</td>
<td>Vecom GmbH 21107 Hamburg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SAF-Acid (powder)</td>
<td>Drew Ameroid Deutschland GmbH 21107 Hamburg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HDE-777 (liquid)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>for charge air cooler (water side)</td>
<td>P3 - T1166</td>
<td>Henkel KGAA 40191 Düsseldorf</td>
<td></td>
</tr>
<tr>
<td>and raw water circuit</td>
<td>P3 - croni (neutraliser)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SAF-Acid (only water softener)</td>
<td>Drew Ameroid Deutschland GmbH 21107 Hamburg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Concentration: 5 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Temperature: 55 °C - 75 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Porodox</td>
<td>Collardi GmbH 50825 Köln</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Concentration: 2 % - 10 %Temperature: 20 °C - 60 °C Treatment time: max. 16 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>for charge air cooler (air side)</td>
<td>ACC 9</td>
<td>Drew Ameroid Deutschland GmbH 21107 Hamburg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vecom B 85</td>
<td>Vecom GmbH 21107 Hamburg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P3 T-5308</td>
<td>Henkel KGAA 40191 Düsseldorf</td>
<td></td>
</tr>
<tr>
<td>for tank plants</td>
<td>Vecom B 24 B (liquid)</td>
<td>Vecom GmbH 21107 Hamburg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vecom B 14 (liquid)</td>
<td>Drew Ameroid Deutschland GmbH 21107 Hamburg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tank cleaner No. 4 (liquid)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>to remove preservatives</td>
<td>Eskapon S 255</td>
<td>Haug-Chemie GmbH 74889 Sinsheim</td>
<td></td>
</tr>
<tr>
<td>Thinners and removers of wax-</td>
<td>Reponal B150</td>
<td>Fuchs Europe GmbH 68169 Mannheim</td>
<td></td>
</tr>
<tr>
<td>like preservatives</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product group</td>
<td>Application</td>
<td>Product name</td>
<td>Supplier</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------</td>
<td>--------------</td>
<td>----------</td>
</tr>
<tr>
<td>Preservatives</td>
<td>Preserving oil for preserving the lube oil system and as a 15% additive for the distillate fuel for fuel systems</td>
<td>Run-in oil SAE30W-30</td>
<td>BP</td>
</tr>
<tr>
<td>Preservatives</td>
<td>for preserving the coolant system</td>
<td>Puriton 3956 for preserving the coolant system</td>
<td>Kühbier Chemie GmbH, 58566 Kierspe</td>
</tr>
<tr>
<td>Preservatives</td>
<td>ODACON Z</td>
<td></td>
<td>Reicon Chemie, 04103 Leipzig</td>
</tr>
<tr>
<td>Preservatives</td>
<td>for preserving bare external surfaces and parts (wax-like)</td>
<td>Gerserol Super</td>
<td>Deutsche Castrol, 76829 Landau</td>
</tr>
<tr>
<td>Preservatives</td>
<td>Protective grease for controller linkage and joints</td>
<td>Renolit MP2</td>
<td>Fuchs Europe, 68169 Mannheim</td>
</tr>
<tr>
<td>Preservatives</td>
<td>for rubber parts</td>
<td>fine talcum, white</td>
<td>Silbermann GmbH &amp; Co.KG, 86456 Gablingen</td>
</tr>
<tr>
<td>Water treatment</td>
<td>Hardness determination for cooling water</td>
<td>Aquamerk Art. No. 11129</td>
<td>E. Merck KGAA 64293 Darmstadt</td>
</tr>
<tr>
<td>Water treatment</td>
<td>Cooling water hardening</td>
<td>Vecom CN (powder)</td>
<td>Vecom GmbH 21107 Hamburg</td>
</tr>
<tr>
<td>Water treatment</td>
<td>Cooling water softening</td>
<td>Trisodiumphosphate (powder)</td>
<td>Benckiser GmbH, 67001 Ludwigshafen</td>
</tr>
</tbody>
</table>
Maintenance

Please bear in mind that the following maintenance schedules are Scheduled Maintenance Plans.

It is not possible to make a firm definition of the maintenance intervals for all applications due to the numerous different relationships between ambient conditions, operating mode and quality of fuels.

It may be necessary to shorten the specified maintenance intervals under harsher operating conditions. The scheduled maintenance plan must then be revised completely. Generally the on-site operating conditions are already defined in the planning phase.

Critical operation conditions are for example:

- Contamination of the combustion gases by ingredients which promote wear, e.g. silicon, sulphur, chlorine, ...
- Frequent cold starts
- Increased dust contamination of the suction intake air

Ask your service partner if in doubt.

Continuous supervision

The normal care of your engine comprises a daily visual inspection by technically skilled persons. The appropriate activities are listed in job card B 0-1-5.

Maintenance schedule

General

The maintenance schedule lists the measures for maintaining the nominal condition and thus the operational reliability of the engine and the appropriate maintenance intervals. The maintenance work procedures are described in the specified job cards (AK).

- The intervals prescribed in the maintenance schedule are maximum values and assume that installation, purpose and operating conditions comply with specifications. It must be ensured that all operating media such as combustion gas, lube oil and coolant are of the prescribed quality. You will find information about this in Chapter 4, Operating Media.

In particular it must be ensured that the gas quality meets the minimum requirements in accordance with TR 0199 - 99 - 3017 to avoid malfunctions and/or premature wear of the engine.

- This maintenance schedule only applies for the engine itself and the parts attached to the engine. System parts must be serviced at the intervals and according to the instructions specified by the manufacturer. You will find the appropriate information in the enclosed manufacturer documents (marked "MD" in the maintenance schedule).
- The work described must be performed by technically skilled persons or authorised specialists. The competencies are listed in the table of Deutz maintenance and service schedules.
Selection and structure

On reaching the specified intervals of time (months or operating hours), the activities specified in the maintenance schedule must be carried out.

Always use the job card (JC) referred to in the maintenance schedule.

Depending on the speed and gas group, the engine is assigned an appropriate maintenance schedule.

The maintenance schedule consists of several sections which should be used in parallel.

- The maintenance measures independent of operating hours.
  The activities to be carried out after reaching the specified time intervals in months are listed here.
- The maintenance measures dependent on operating hours.
  The activities to be carried out after reaching the specified time intervals in operating hours (Deutz maintenance and service schedules) are listed here.
- Maintenance measures outside the DEUTZ maintenance and service schedules
  The activities for which the time intervals are determined by analysis are listed here.
- The copy forms for proof of maintenance carried out.

Deutz maintenance and service schedules

Maintenance work dependent on operating hours is classified according to Deutz maintenance and service schedules. All the work listed must be performed carefully according to the maintenance schedule determined specifically for the engine.

<table>
<thead>
<tr>
<th>Deutz maintenance and service schedules</th>
<th>Executed by</th>
</tr>
</thead>
<tbody>
<tr>
<td>E10 each due once after commissioning and after E50, E60 and E70</td>
<td>technically skilled persons</td>
</tr>
<tr>
<td>E20 daily check</td>
<td></td>
</tr>
<tr>
<td>E30 periodic maintenance (small scope)</td>
<td></td>
</tr>
<tr>
<td>E40 periodic maintenance (medium scope)</td>
<td></td>
</tr>
<tr>
<td>E50 periodic maintenance (extended scope)</td>
<td>authorised specialists</td>
</tr>
<tr>
<td>E60 intermediate overhaul</td>
<td></td>
</tr>
<tr>
<td>E70 complete overhaul</td>
<td></td>
</tr>
</tbody>
</table>

Please note that DEUTZ maintenance and service schedules may be added or omitted depending on the speed and gas group.

- Make sure to observe the due dates for Deutz maintenance and service schedules according to the number of hours your engine has been in operation.
- Arrange the necessary appointment with your responsible service partner in good time. Report any irregularities of your engine when you arrange the appointment.
- Sign a service contract with your service partner if necessary. All the due maintenance work including repairs if agreed is then planned and expertly performed by the service...
partner according to the contract. Your service partner will be glad to give you the details.

Definition of activities in the maintenance schedule

<table>
<thead>
<tr>
<th>Adjust</th>
<th>Adjust torques, dimensions, pressures etc.; extra work may be necessary to renew parts.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain water</td>
<td>Drain condensed water for example.</td>
</tr>
<tr>
<td>Renew</td>
<td>Renew parts, function groups and liquids.</td>
</tr>
<tr>
<td>Recondition</td>
<td>Material removal within the permitted tolerances to reinstate a nominal condition.</td>
</tr>
<tr>
<td>Check</td>
<td>Check according to criteria in the job card. If not all criteria are fulfilled, the cause must be found and the nominal condition reinstated.</td>
</tr>
<tr>
<td>Clean</td>
<td>Cleaning by hand or machine (automatic), renewal of cleaning parts (e.g. air filters) may be necessary.</td>
</tr>
<tr>
<td>Visual inspection</td>
<td>Visual inspection according to criteria in the job card. If not all criteria are fulfilled, the cause must be found and the nominal condition reinstated.</td>
</tr>
<tr>
<td>Overhaul</td>
<td>Check function groups, rework or renew parts.</td>
</tr>
<tr>
<td>Maintain</td>
<td>Maintain according to job card. Checking of functions; reworking or renewal of parts may be necessary.</td>
</tr>
<tr>
<td>Change</td>
<td>Change lube oil for example.</td>
</tr>
</tbody>
</table>

Gas groups

The maintenance intervals also depend on the quality of the combustion gases.

The combustion gases are divided into two groups according to their wear properties for which different scheduled maintenance plans apply, see also Chapter 4, Technical Circular 0199 - 99 - 3017.

Use the maintenance schedule corresponding to the type of gas used in the system as a basis for the maintenance work.

<table>
<thead>
<tr>
<th>Gas group 1</th>
<th>Gas group 2 (bio-gases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural gas</td>
<td>Sewage gas</td>
</tr>
<tr>
<td>Pit gas</td>
<td>Landfill gas</td>
</tr>
<tr>
<td>Liquid gas - propane, butane, LNG (liquid natural gas)</td>
<td>Wood gas</td>
</tr>
<tr>
<td>Petroleum gas</td>
<td>Other bio-gases</td>
</tr>
<tr>
<td>Gases with a hydrogen content of H2 &gt; 30 Vol%, (e.g. coke oven gas)</td>
<td></td>
</tr>
</tbody>
</table>

The worst determined gas quality is essentially binding for defining the maintenance intervals. Please consult your service partner.
Silicon content

When using combustion gases with a silicon content $> 10 \text{ mg/m}^3 \text{CH}_4$ the TBOs (TBO = Time between overhaul) must be reduced in any case because of the strongly abrasive effect of silicon.

To guarantee the necessary life cycles, the silicon content of critical gases (gas-group 2, bio-gases) must be determined regularly at least 3x a year in the course of extensive gas analyses and the maintenance intervals may have to be shortened accordingly.
Overview of specific maintenance schedules

This engine is built exclusively for the purpose intended according to the scope of delivery as defined by the equipment manufacturer (use for the intended purpose). Depending on its intended purpose the engine is identified by a performance code or an abbreviations for the gas type which is punched into the rating plate. The rating plate is described in detail in chapter 2.

### Maintenance schedule 1

<table>
<thead>
<tr>
<th>Valid for</th>
<th>Engine type: V12-, V16- and V20-engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed:</td>
<td>n = 1,500 rpm (50 Hz applications)</td>
</tr>
<tr>
<td>Fuel gas :</td>
<td>Gas group 1</td>
</tr>
<tr>
<td>Performance code:</td>
<td>ICN</td>
</tr>
<tr>
<td>Type of application:</td>
<td>Current generators</td>
</tr>
</tbody>
</table>

The following activities must be carried out according to the maintenance intervals

#### Maintenance work independent of operating hours

- as required
- monthly
- after every 4 months
- after every 6 months
- after every 12 months
- after every 24 months

#### Maintenance work depending on operating hours

<table>
<thead>
<tr>
<th></th>
<th>Maintenance work depending on operating hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>E 10</td>
<td>Maintenance</td>
</tr>
<tr>
<td>E 20</td>
<td>Inspection</td>
</tr>
<tr>
<td>E 30</td>
<td>Maintenance (small scope)</td>
</tr>
<tr>
<td>E 40</td>
<td>Maintenance (medium scope)</td>
</tr>
<tr>
<td>E 50</td>
<td>Maintenance (extended scope)</td>
</tr>
<tr>
<td>E 60</td>
<td>intermediate overhaul</td>
</tr>
<tr>
<td>E 70</td>
<td>complete overhaul</td>
</tr>
</tbody>
</table>

#### Maintenance work dependent on operating hours outside the DEUTZ maintenance and service schedule

<table>
<thead>
<tr>
<th></th>
<th>Maintenance work dependent on operating hours outside the DEUTZ maintenance and service schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lube oil analysis;</td>
</tr>
<tr>
<td></td>
<td>according to TR 0199 - 99 - 2105</td>
</tr>
<tr>
<td></td>
<td>All other lube oil changes and analyses are to be agreed between the owner and the lab on the basis of the results of the analysis.</td>
</tr>
</tbody>
</table>
### Maintenance schedule 2

**Valid for:**
- Engine type: V12-, V16- and V20-engine
- Speed: \( n = 1,500 \text{ rpm} \) (50 Hz applications)
- Fuel gas: Gas group 2
- Performance code: ICN
- Type of application: Current generators

#### The following activities must be carried out according to the maintenance intervals

**Maintenance work independent of operating hours**

<table>
<thead>
<tr>
<th>Interval</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>as required</td>
<td></td>
</tr>
<tr>
<td>monthly</td>
<td></td>
</tr>
<tr>
<td>after every 4 months</td>
<td></td>
</tr>
<tr>
<td>after every 6 months</td>
<td></td>
</tr>
<tr>
<td>after every 12 months</td>
<td></td>
</tr>
<tr>
<td>after every 24 months</td>
<td></td>
</tr>
</tbody>
</table>

**Maintenance work depending on operating hours**

<table>
<thead>
<tr>
<th>Code</th>
<th>Activity</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>E 10</td>
<td>Maintenance</td>
<td>once in special cases</td>
</tr>
<tr>
<td>E 20</td>
<td>Inspection</td>
<td>daily</td>
</tr>
<tr>
<td>E 30</td>
<td>Maintenance (small scope)</td>
<td>after every 1,500 oh</td>
</tr>
<tr>
<td>E 40</td>
<td>Maintenance (medium scope)</td>
<td>after every 3,000 oh</td>
</tr>
<tr>
<td>E 50</td>
<td>Maintenance (extended scope)</td>
<td>after every 12,000 oh</td>
</tr>
<tr>
<td>E 60</td>
<td>intermediate overhaul</td>
<td>after every 24,000 oh</td>
</tr>
<tr>
<td>E 70</td>
<td>complete overhaul</td>
<td>after every 48,000 oh</td>
</tr>
</tbody>
</table>

**Maintenance work dependent on operating hours outside the DEUTZ maintenance and service schedule**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lube oil analysis; Initial analysis after 100 op. hrs</td>
<td>according to TR 0199 - 99 - 2105</td>
</tr>
</tbody>
</table>

All other lube oil changes and analyses are to be agreed between the owner and the lab on the basis of the results of the analysis.
# Maintenance schedule 3

<table>
<thead>
<tr>
<th>Valid for:</th>
<th>Engine type :</th>
<th>V12- and V16- engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed:</td>
<td>n = 1,800 rpm</td>
<td>(60 Hz applications)</td>
</tr>
<tr>
<td>Fuel gas :</td>
<td>Gas group 1</td>
<td></td>
</tr>
<tr>
<td>Performance code:</td>
<td>ICN</td>
<td></td>
</tr>
<tr>
<td>Type of application:</td>
<td>Current generators</td>
<td></td>
</tr>
</tbody>
</table>

## The following activities must be carried out according to the maintenance intervals

### Maintenance work independent of operating hours

- as required
- monthly
- after every 4 months
- after every 6 months
- after every 12 months
- after every 24 months

### Maintenance work depending on operating hours

<table>
<thead>
<tr>
<th>E 10</th>
<th>Maintenance</th>
<th>once in special cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>E 20</td>
<td>Inspection</td>
<td>daily</td>
</tr>
<tr>
<td>E 30</td>
<td>Maintenance (small scope)</td>
<td>after every 1,000 oh</td>
</tr>
<tr>
<td>E 40</td>
<td>Maintenance (medium scope)</td>
<td>after every 2,000 oh</td>
</tr>
<tr>
<td>E 50</td>
<td>Maintenance (extended scope)</td>
<td>after every 10,000 oh</td>
</tr>
<tr>
<td>E 60</td>
<td>intermediate overhaul</td>
<td>after every 20,000 oh</td>
</tr>
<tr>
<td>E 70</td>
<td>complete overhaul</td>
<td>after every 40,000 oh</td>
</tr>
</tbody>
</table>

### Maintenance work dependent on operating hours outside the DEUTZ maintenance and service schedule

<table>
<thead>
<tr>
<th>Lube oil analysis;</th>
<th>Initial analysis after 300 op. hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>according to TR 0199 - 99 - 2105</td>
<td></td>
</tr>
</tbody>
</table>

All other lube oil changes and analyses are to be agreed between the owner and the lab on the basis of the results of the analysis.
### Maintenance schedule 4

<table>
<thead>
<tr>
<th>Valid for</th>
<th>Engine type: V12- and V16- engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed:</td>
<td>n = 1,800 rpm (60 Hz applications)</td>
</tr>
<tr>
<td>Fuel gas :</td>
<td>Gas group 2</td>
</tr>
<tr>
<td>Performance code:</td>
<td>ICN</td>
</tr>
<tr>
<td>Type of application:</td>
<td>Current generators</td>
</tr>
</tbody>
</table>

#### The following activities must be carried out according to the maintenance intervals

**Maintenance work independent of operating hours**

- as required
- monthly
- after every 4 months
- after every 6 months
- after every 12 months
- after every 24 months

**Maintenance work depending on operating hours**

<table>
<thead>
<tr>
<th>E 10</th>
<th>Maintenance</th>
<th>once in special cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>E 20</td>
<td>Inspection</td>
<td>daily</td>
</tr>
<tr>
<td>E 30</td>
<td>Maintenance (small scope)</td>
<td>after every 1,000 oh</td>
</tr>
<tr>
<td>E 40</td>
<td>Maintenance (medium scope)</td>
<td>after every 2,000 oh</td>
</tr>
<tr>
<td>E 50</td>
<td>Maintenance (extended scope)</td>
<td>after every 10,000 oh</td>
</tr>
<tr>
<td>E 60</td>
<td>intermediate overhaul</td>
<td>after every 20,000 oh</td>
</tr>
<tr>
<td>E 70</td>
<td>complete overhaul</td>
<td>after every 40,000 oh</td>
</tr>
</tbody>
</table>

**Maintenance work dependent on operating hours outside the DEUTZ maintenance and service schedule**

<table>
<thead>
<tr>
<th></th>
<th>Lube oil analysis; Initial analysis after 100 op. hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>according to TR 0199 - 99 - 2105</td>
</tr>
</tbody>
</table>

All other lube oil changes and analyses are to be agreed between the owner and the lab on the basis of the results of the analysis.
## Maintenance schedule 1

### Valid for:
- **Engine type:** V12-, V16- and V20-engine
- **Speed:** \( n = 1,500 \text{ rpm} \) (50 Hz applications)
- **Fuel gas:** Gas group 1

### Maintenance work independent of operating hours

<table>
<thead>
<tr>
<th>Description</th>
<th>Job card</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check suction air intake filter, renew if necessary; according to E50, but earlier if the maintenance indicator is showing „RED“</td>
<td>B 6-3-6</td>
</tr>
<tr>
<td>Maintain crankcase vent; according to E40, but earlier if the maintenance indicator is showing „RED“</td>
<td>B 3-1-9</td>
</tr>
<tr>
<td>Trial run after maintenance work 1)</td>
<td>---</td>
</tr>
<tr>
<td>Run in engine; after maintenance work such as changing bearings, piston, cylinder liner 2)</td>
<td>W 0-1-3</td>
</tr>
<tr>
<td>Clean the engine</td>
<td>B 0-3-6</td>
</tr>
<tr>
<td>Trial run 3)</td>
<td>---</td>
</tr>
<tr>
<td>Maintaining the battery; according to E30, but monthly if 3) is applicable</td>
<td>B 13-4-1</td>
</tr>
<tr>
<td>Gas analysis</td>
<td>---</td>
</tr>
<tr>
<td>Check percentage of corrosion protection agent or antifreeze in the coolant</td>
<td>B 9-1-1</td>
</tr>
<tr>
<td>Inspect pressure drop in gas filter</td>
<td>MD</td>
</tr>
<tr>
<td>Renew gas filter insert</td>
<td>B 7-21-1</td>
</tr>
<tr>
<td>Gas pressure sensor, check set gas pressure</td>
<td>MD</td>
</tr>
<tr>
<td>Check gas pressure regulator</td>
<td>MD</td>
</tr>
<tr>
<td>Check shutoff valves of the gas control system</td>
<td>MD</td>
</tr>
<tr>
<td>Check the entire gas control system for leaks</td>
<td>MD</td>
</tr>
<tr>
<td>Lube oil change 4)</td>
<td>B 8-1-2</td>
</tr>
<tr>
<td>Renew lube oil filter cartridge 4)</td>
<td>B 8-10-4</td>
</tr>
<tr>
<td>Renew the coolant</td>
<td>B 9-0-4</td>
</tr>
</tbody>
</table>

1) To be performed by maintenance officers
2) To be performed by authorised experts
3) This activity must be performed when the engine on standby has not been operated for longer than one month. The engine must be preserved during long periods out of action, e.g. over the winter - see chapter 7.
4) The lube oil must be changed if the maintenance intervals determined in the lube oil analysis are not reached within 12 months. The lube oil filter cartridge must be used.
### Maintenance work depending on operating hours

<table>
<thead>
<tr>
<th>E10</th>
<th>E20</th>
<th>E30</th>
<th>E40</th>
<th>E50</th>
<th>E60</th>
<th>E70</th>
<th>Description</th>
<th>Job card</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1x after 50 oh</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>after every 24 hrs (daily)</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>after every 1,500 oh</td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td>after every 3,000 oh</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>after every 12,000 oh</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>after every 24,000 oh</td>
<td></td>
</tr>
<tr>
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<td></td>
<td>after every 48,000 oh</td>
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<td>x</td>
<td>x</td>
<td>x</td>
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<td>x</td>
<td>Visual inspection of the system</td>
<td>B 0-1-5</td>
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<td>Test and function run</td>
<td>TEM</td>
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<td>x</td>
<td>Checking valve clearance</td>
<td>B 1-1-1</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>Maintaining battery 1)</td>
<td>B 13-4-1</td>
</tr>
<tr>
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<td>x</td>
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<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>Checking speed governor linkage</td>
<td>B 5-4-2</td>
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<tr>
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<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>Maintaining crankcase bleed valve (Racor model) 1)</td>
<td>B 3-1-9</td>
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<tr>
<td></td>
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<td>x</td>
<td>x</td>
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<td></td>
<td>x</td>
<td>Renewing crankcase bleed valve (Mann model) 1)</td>
<td>B 3-1-6</td>
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<td>x</td>
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<td></td>
<td>Checking spark plugs, renewing if necessary</td>
<td>B 13-5-4</td>
</tr>
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<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
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<td>Renewing spark plugs</td>
<td>B 13-5-4</td>
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<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>Renewing lube oil filter cartridge 3)</td>
<td>B 8-10-4</td>
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<td></td>
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<td>Checking ignition time</td>
<td>B 13-5-3</td>
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<td>x</td>
<td>Auxiliary unit test using the TEM System</td>
<td>B 0-1-6</td>
</tr>
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<td></td>
<td>x</td>
<td>Renewing suction air intake filter, cleaning suction air filter housing</td>
<td>B 6-3-6</td>
</tr>
<tr>
<td>x</td>
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<td></td>
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<td>Checking engine fastening</td>
<td>W 3-7-1</td>
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<td>Checking starter pinion and ring gear</td>
<td>W 12-6-4</td>
</tr>
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<td>x</td>
<td>x</td>
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<td></td>
<td></td>
<td>x</td>
<td>Renewing or overhauling cylinder heads</td>
<td>W 1-4-4</td>
</tr>
<tr>
<td>x</td>
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<td></td>
<td></td>
<td></td>
<td>x</td>
<td>Cleaning combustion chambers</td>
<td>---</td>
</tr>
<tr>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>Checking cylinder liners</td>
<td>W 3-3-1</td>
</tr>
<tr>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>Renewing cylinder liners</td>
<td>W 3-3-1</td>
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<td>x</td>
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<td>x</td>
<td>Checking and endoscoping intercooler</td>
<td>W 6-4-11</td>
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<td>Cleaning intercooler</td>
<td>W 6-4-4</td>
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<td></td>
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<td></td>
<td></td>
<td>x</td>
<td>Checking and cleaning turbocharger 4)</td>
<td>MD</td>
</tr>
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<td>x</td>
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<td></td>
<td>x</td>
<td>Renewing or overhauling turbocharger 4)</td>
<td>MD</td>
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<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>Cleaning gas mixer</td>
<td>W 7-22-2</td>
</tr>
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<td>x</td>
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<td>Renewing gas mixer</td>
<td>W 7-22-1</td>
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<tr>
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<td></td>
<td></td>
<td>x</td>
<td>Checking rubber compensators</td>
<td>W 12-3-1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>Renewing rubber compensators</td>
<td>W 12-3-1</td>
</tr>
</tbody>
</table>

1) For engines with this equipment
2) Only 50 oh as per E50 to E70
3) For other lube oil filter changes, see TC 0199 - 99 - 2105
4) Maintenance intervals, see manufacturer documentation (MD)
<table>
<thead>
<tr>
<th>E10</th>
<th>E20</th>
<th>E30</th>
<th>E40</th>
<th>E50</th>
<th>E60</th>
<th>E70</th>
<th>Description</th>
<th>Job card</th>
</tr>
</thead>
<tbody>
<tr>
<td>1x after 50 oh</td>
<td>after every 24 hrs (daily)</td>
<td>after every 1,500 oh</td>
<td>after every 3,000 oh</td>
<td>after every 12,000 oh</td>
<td>after every 24,000 oh</td>
<td>after every 48,000 oh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>Checking hose pipes, vibration dampers and flexible lines</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>Checking engine side fittings and control instruments</td>
<td>---</td>
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<td></td>
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</tr>
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<td>x</td>
<td>x</td>
<td>Renew viscosity torsional vibration dampers 1)</td>
<td>---</td>
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<td></td>
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<tr>
<td>x</td>
<td></td>
<td>Checking crankshaft axial clearance</td>
<td>W 2-1-4</td>
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</tr>
<tr>
<td>x</td>
<td></td>
<td>Checking camshaft axial clearance</td>
<td>W 4-1-4</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>x</td>
<td></td>
<td>Checking valve tappet</td>
<td>W 4-2-1</td>
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<td></td>
<td>Renewing valve tappet</td>
<td>W 4-2-1</td>
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<tr>
<td>x</td>
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<td>Checking con rod liners</td>
<td>W 2-3-3</td>
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<td>Renewing con rod bearings</td>
<td>W 2-5-1</td>
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<tr>
<td>x</td>
<td></td>
<td>Checking piston</td>
<td>W 2-9-7</td>
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</tr>
<tr>
<td>x</td>
<td></td>
<td>Renewing piston</td>
<td>W 2-9-3</td>
<td></td>
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<td>Checking piston pin</td>
<td>W 2-12-4</td>
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</tr>
<tr>
<td>x</td>
<td></td>
<td>Renewing piston rings</td>
<td>W 2-10-1</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>x</td>
<td>x</td>
<td>Checking camshaft</td>
<td>W 4-5-1</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>x</td>
<td></td>
<td>Renewing camshaft bearing</td>
<td>W 4-1-1</td>
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</tr>
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<td></td>
<td>Renewing drive side crankshaft sealing ring</td>
<td>W 2-2-2</td>
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<td>Renewing free side crankshaft sealing ring 1)</td>
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<td></td>
<td>Measuring crankshaft, checking for tears, polishing</td>
<td>W 2-1-7</td>
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<td>Checking and cleaning wheel drive and control</td>
<td>W 4-4-1</td>
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<td>Renewing main bearing and axial bearing</td>
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<td>Renewing or overhauling pressure limiting valve</td>
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<td>Renewing exhaust gas compensators</td>
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1) For engines with this equipment
2) Only 50 oh as per E50 to E70
3) For other lube oil filter changes, see TC 0199 - 99 - 2105
4) Maintenance intervals, see manufacturer documentation (MD)

T 5-1  Maintenance work depending on operating hours
### Maintenance work dependent on operating hours outside the DEUTZ maintenance and service schedules

<table>
<thead>
<tr>
<th>Description</th>
<th>Job card</th>
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<tr>
<td>Lube oil analysis (according to TR 0199 - 99 - 2105)</td>
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<tr>
<td>Initial analysis after 300 op. hrs</td>
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<tr>
<td>All other lube oil changes and analyses are to be agreed between the owner</td>
<td></td>
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<tr>
<td>and the lab on the basis of the results of the analysis.</td>
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T 5-2  Maintenance work outside the DEUTZ maintenance and service schedules

We recommend you to record the proper execution of the work in the enclosed maintenance tables.
Proof of maintenance performed

Copy form for maintenance work independent of operating hours

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<th>Date</th>
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### Table for maintenance work dependent on operating hours

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</table>
Number of Deutz maintenance and service schedules up to and including complete overhaul

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<th>Deutz maintenance and service schedule</th>
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<tr>
<td>48.000</td>
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</table>

| Total | 4 | 16 | 12 | 2 | 1 | 1 |
## Maintenance schedule 2

**Valid for:**
- Engine type: V12-, V16- and V20-engine
- Speed: \( n = 1,500 \text{ rpm} \) (50 Hz applications)
- Fuel gas: Gas group 2

### Maintenance work independent of operating hours

<table>
<thead>
<tr>
<th>as required</th>
<th>monthly</th>
<th>after every 4 months</th>
<th>after every 6 months</th>
<th>after every 12 months</th>
<th>after every 24 months</th>
<th>Description</th>
<th>Job card</th>
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<tbody>
<tr>
<td>x</td>
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<td></td>
<td></td>
<td>x</td>
<td></td>
<td>Check suction air intake filter, renew if necessary; according to E50, but earlier if the maintenance indicator is showing &quot;RED&quot;</td>
<td>B 6-3-6</td>
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<tr>
<td>x</td>
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<td>x</td>
<td></td>
<td>Maintain crankcase vent; according to E40, but earlier if the maintenance indicator is showing &quot;RED&quot;</td>
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<td>x</td>
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<td></td>
<td>x</td>
<td></td>
<td>Trial run after maintenance work 1)</td>
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<tr>
<td>x</td>
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<td></td>
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<td>x</td>
<td></td>
<td>Run in engine; after maintenance work such as changing bearings, piston, cylinder liner 2)</td>
<td>W 0-1-3</td>
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<tr>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td>Clean the engine</td>
<td>B 0-3-6</td>
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<td>x</td>
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<td>x</td>
<td></td>
<td>Trial run 3)</td>
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<td>Maintaining the battery; according to E30, but monthly if 3) is applicable</td>
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<tr>
<td>x</td>
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<td>Check percentage of corrosion protection agent or antifreeze in the coolant</td>
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<tr>
<td>x</td>
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<td></td>
<td></td>
<td>x</td>
<td></td>
<td>Inspect pressure drop in gas filter</td>
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<td></td>
<td>Renew gas filter insert</td>
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<tr>
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<td>x</td>
<td></td>
<td>Gas pressure sensor, check set gas pressure</td>
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<td>Check gas pressure regulator</td>
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<td>Check shutoff valves of the gas control system</td>
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<td>Check the entire gas control system for leaks</td>
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<td>Lube oil change 4)</td>
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<td>Renew lube oil filter cartridge 4)</td>
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<td>Renew the coolant</td>
<td>B 9-0-4</td>
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</tbody>
</table>

1) To be performed by maintenance officers
2) To be performed by authorised experts
3) This activity must be performed when the engine on standby has not been operated for longer than one month. The engine must be preserved during long periods out of action, e.g. over the winter - see chapter 7.
4) The lube oil must be changed if the maintenance intervals determined in the lube oil analysis are not reached within 12 months. The lube oil filter cartridge must be used.
## Maintenance work depending on operating hours

<table>
<thead>
<tr>
<th>E10</th>
<th>E20</th>
<th>E30</th>
<th>E40</th>
<th>E50</th>
<th>E60</th>
<th>E70</th>
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<td>after every 24 hrs (daily)</td>
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<td>after every 3,000 oh</td>
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<td>after every 12,000 oh</td>
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<td>Renewing crankcase bleed valve (Mann model)</td>
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<td>Checking spark plugs, renewing if necessary</td>
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<td>Renewing spark plugs</td>
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<td>Checking ignition time</td>
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<td>Renewing suction air intake filter, cleaning suction air filter housing</td>
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<td>Cleaning intercooler</td>
<td>W 6-4-4</td>
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<td>Checking and cleaning turbocharger</td>
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<td>Renewing or overhauling turbocharger</td>
<td>MD</td>
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<td>Cleaning gas mixer</td>
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<td>Renewing gas mixer</td>
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<td>Renewing rubber compensators</td>
<td>W 12-3-1</td>
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</table>

1) For engines with this equipment
2) Only 50 oh as per E50 to E70
3) For other lube oil filter changes, see TC 0199 - 99 - 2105
4) Maintenance intervals, see manufacturer documentation (MD)
<table>
<thead>
<tr>
<th>E10</th>
<th>E20</th>
<th>E30</th>
<th>E40</th>
<th>E50</th>
<th>E60</th>
<th>E70</th>
<th>Description</th>
<th>Job card</th>
</tr>
</thead>
<tbody>
<tr>
<td>1x after 50 oh</td>
<td>after every 24 hrs (daily)</td>
<td>after every 1,500 oh</td>
<td>after every 3,000 oh</td>
<td>after every 12,000 oh</td>
<td>after every 24,000 oh</td>
<td>after every 48,000 oh</td>
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</tbody>
</table>

- x x Checking hose pipes, vibration dampers and flexible lines ---
- x x Checking engine side fittings and control instruments ---
- x x Renew viscosity torsional vibration dampers 1) ---
- x Checking crankshaft axial clearance W 2-1-4
- x Checking camshaft axial clearance W 4-1-4
- x Checking valve tappet W 4-2-1
- x Renewing valve tappet W 4-2-1
- x Checking con rod liners W 2-3-3
- x x Renewing con rod bearings W 2-5-1
- x Checking piston W 2-9-7
- x x Renewing piston W 2-9-3
- x x Checking piston pin W 2-12-4
- x x Renewing piston rings W 2-10-1
- x x Checking camshaft W 4-5-1
- x Renewing camshaft bearing W 4-1-1
- x Renewing con rods W 2-3-6
- x Renewing drive side crankshaft sealing ring W 2-2-2
- x Renewing free side crankshaft sealing ring 2) W 2-2-4
- x Measuring crankshaft, checking for tears, polishing W 2-1-7
- x Checking and cleaning wheel drive and control W 4-4-1
- x Renewing main bearing and axial bearing W 2-7-3
- x Renewing or overhauling lube oil pump W 8-4-5
- x Renewing or overhauling pressure limiting valve ---
- x Renewing exhaust gas compensators ---

1) For engines with this equipment
2) Only 50 oh as per E50 to E70
3) For other lube oil filter changes, see TC 0199 - 99 - 2105
4) Maintenance intervals, see manufacturer documentation (MD)

T 5-1 Maintenance work depending on operating hours
### Maintenance work dependent on operating hours outside the DEUTZ maintenance and service schedules

<table>
<thead>
<tr>
<th>Description</th>
<th>Job card</th>
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</thead>
<tbody>
<tr>
<td>Lube oil analysis (according to TR 0199 - 99 - 2105)</td>
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<tr>
<td>Initial analysis after 100 op. hrs</td>
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<tr>
<td>All other lube oil changes and analyses are to be agreed between the owner and the lab on the basis of the results of the analysis.</td>
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T 5-2  Maintenance work outside the DEUTZ maintenance and service schedules

---

We recommend you to record the proper execution of the work in the enclosed maintenance tables.
Proof of maintenance performed

Copy form for maintenance work independent of operating hours

<table>
<thead>
<tr>
<th>Date</th>
<th>Activity</th>
<th>Signature</th>
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Table for maintenance work dependent on operating hours

<table>
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Number of Deutz maintenance and service schedules up to and including complete overhaul

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### Maintenance schedule 3

**Valid for:**
- **Engine type:** V12- and V16- engine
- **Speed:** \( n = 1,800 \text{ rpm} \) (60 Hz applications)
- **Fuel gas:** Gas group 1

#### Maintenance work independent of operating hours

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<thead>
<tr>
<th>as required</th>
<th>monthly</th>
<th>after every 4 months</th>
<th>after every 6 months</th>
<th>after every 12 months</th>
<th>after every 24 months</th>
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<th>Job card</th>
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<tbody>
<tr>
<td>x</td>
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<td></td>
<td></td>
<td></td>
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<td>Check suction air intake filter, renew if necessary; according to E50, but earlier if the maintenance indicator is showing &quot;RED&quot;</td>
<td>B 6-3-6</td>
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<tr>
<td>x</td>
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<td>Maintain crankcase vent; according to E40, but earlier if the maintenance indicator is showing &quot;RED&quot;</td>
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<td>x</td>
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<td>Trial run after maintenance work 1)</td>
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<td></td>
<td>Run in engine; after maintenance work such as changing bearings, piston, cylinder liner 2)</td>
<td>W 0-1-3</td>
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<tr>
<td>x</td>
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<td></td>
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<td></td>
<td>Clean the engine</td>
<td>B 0-3-6</td>
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<td>Trial run 3)</td>
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<td>Maintaining the battery; according to E30, but monthly if 3) is applicable</td>
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<td>x</td>
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<td>Gas analysis</td>
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<td>Check percentage of corrosion protection agent or antifreeze in the coolant</td>
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<tr>
<td>x x</td>
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<td></td>
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<td>Inspect pressure drop in gas filter</td>
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<td>Renew gas filter insert</td>
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<td>Gas pressure sensor, check set gas pressure</td>
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<td>Check gas pressure regulator</td>
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<td>Check shutoff valves of the gas control system</td>
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<td>Check the entire gas control system for leaks</td>
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<td>Lube oil change 4)</td>
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<td>Renew lube oil filter cartridge 4)</td>
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<td>Renew the coolant</td>
<td>B 9-0-4</td>
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</table>

1) To be performed by maintenance officers
2) To be performed by authorised experts
3) This activity must be performed when the engine on standby has not been operated for longer than one month. The engine must be preserved during long periods out of action, e.g. over the winter - see chapter 7.
4) The lube oil must be changed if the maintenance intervals determined in the lube oil analysis are not reached within 12 months. The lube oil filter cartridge must be used.
Maintenance work depending on operating hours

<table>
<thead>
<tr>
<th>E10</th>
<th>E20</th>
<th>E30</th>
<th>E40</th>
<th>E50</th>
<th>E60</th>
<th>E70</th>
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<td>Checking spark plugs, renewing if necessary</td>
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<td>Checking and endoscopying intercooler</td>
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1) For engines with this equipment
2) Only 50 oh as per E50 to E70
3) For other lube oil filter changes, see TC 0199 - 99 - 2105
4) Maintenance intervals, see manufacturer documentation (MD)
<table>
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<tr>
<th>E10</th>
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<th>E40</th>
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<th>E60</th>
<th>E70</th>
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<td>Measuring crankshaft, checking for tears, polishing W 2-1-7</td>
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1) For engines with this equipment
2) Only 50 oh as per E50 to E70
3) For other lube oil filter changes, see TC 0199 - 99 - 2105
4) Maintenance intervals, see manufacturer documentation (MD)

T 5-1 Maintenance work depending on operating hours
### Maintenance work dependent on operating hours outside the DEUTZ maintenance and service schedules

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<th>Description</th>
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<td>All other lube oil changes and analyses are to be agreed between the owner</td>
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<td>and the lab on the basis of the results of the analysis.</td>
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T 5-2  Maintenance work outside the DEUTZ maintenance and service schedules

We recommend you to record the proper execution of the work in the enclosed maintenance tables.
Proof of maintenance performed

Copy form for maintenance work independent of operating hours

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Table for maintenance work dependent on operating hours

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### Number of Deutz maintenance and service schedules up to and including complete overhaul

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Total: 4 20 16 2 1 1
Maintenance schedule 4

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Maintenance work independent of operating hours

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<th>as required</th>
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<th>after every 4 months</th>
<th>after every 6 months</th>
<th>after every 12 months</th>
<th>after every 24 months</th>
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<td>Run in engine; after maintenance work such as changing bearings, piston, cylinder liner 2)</td>
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<td>Check percentage of corrosion protection agent or antifreeze in the coolant</td>
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<td>Gas pressure sensor, check set gas pressure</td>
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<td>Check shutoff valves of the gas control system</td>
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1) To be performed by maintenance officers
2) To be performed by authorised experts
3) This activity must be performed when the engine on standby has not been operated for longer than one month. The engine must be preserved during long periods out of action, e.g. over the winter - see chapter 7.
4) The lube oil must be changed if the maintenance intervals determined in the lube oil analysis are not reached within 12 months. The lube oil filter cartridge must be used.
# Maintenance work depending on operating hours

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¹) For engines with this equipment
²) Only 50 oh as per E50 to E70
³) For other lube oil filter changes, see TC 0199 - 99 - 2105
⁴) Maintenance intervals, see manufacturer documentation (MD)
### T 5-1 Maintenance work depending on operating hours

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¹) For engines with this equipment
2) Only 50 oh as per E50 to E70
3) For other lube oil filter changes, see TC 0199 - 99 - 2105
4) Maintenance intervals, see manufacturer documentation (MD)
Maintenance work dependent on operating hours outside the DEUTZ maintenance and service schedules

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T 5-2  Maintenance work outside the DEUTZ maintenance and service schedules

We recommend you to record the proper execution of the work in the enclosed maintenance tables.
Proof of maintenance performed

Copy form for maintenance work independent of operating hours

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Table for maintenance work dependent on operating hours

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<td></td>
</tr>
<tr>
<td>Hours</td>
<td>Deutz maintenance and service schedule</td>
<td>Date</td>
<td>Signature</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------</td>
<td>------</td>
<td>-----------</td>
</tr>
<tr>
<td></td>
<td>E10</td>
<td>E30</td>
<td>E40</td>
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<tr>
<td>32.000</td>
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<tr>
<td>33.000</td>
<td>17</td>
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<tr>
<td>35.000</td>
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<tr>
<td>36.000</td>
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<tr>
<td>37.000</td>
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<tr>
<td>38.000</td>
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<tr>
<td>39.000</td>
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<td></td>
</tr>
<tr>
<td>40.000</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Number of Deutz maintenance and service schedules up to and including complete overhaul

<table>
<thead>
<tr>
<th>Total</th>
<th>4</th>
<th>20</th>
<th>16</th>
<th>2</th>
<th>1</th>
<th>1</th>
</tr>
</thead>
</table>
Operating check log

Keep an operating check log! A copy form is provided on the next page. Please not down all irregularities (warnings, faults) and maintenance work in this log. This means you always have a good idea when maintenance work is due, and you can document all irregularities for our service personnel. If you have connected a printer to your TEM system, print out a copy of the measured values in the event of warnings or faults.

Danger of destruction!
Further operation of the engine in the case of a warning or restarting after a fault without eliminating the cause can lead to total engine failure.
Operating check log (form for copying)

Do not reset any warning/fault messages before you have ascertained the cause.
Please see the notes in the operating manual.

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Module</th>
<th>Operating hours</th>
<th>Event</th>
<th>Measure</th>
<th>Signature / Printer doc. no.</th>
</tr>
</thead>
</table>

T 5-1 Operating check log (form for copying)
Tools for competence class 1

Order address

The tools can be ordered from your DEUTZ Power Systems Service.

Tools sorted according to order numbers

<table>
<thead>
<tr>
<th>Name</th>
<th>Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Description / Use</td>
<td>(The illustrations are examples)</td>
</tr>
<tr>
<td>2 Module</td>
<td></td>
</tr>
<tr>
<td>3 Competence class</td>
<td></td>
</tr>
<tr>
<td>4 Order number / Order from ...</td>
<td></td>
</tr>
</tbody>
</table>

Torque wrench

1 Measuring range 0-21 Nm (0-2.1 kpm)
2 00 General
3 (1)
4 1203 0350 / Service Partner
## Tool kit

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Standard set</td>
</tr>
<tr>
<td>2</td>
<td>00 General</td>
</tr>
<tr>
<td>3</td>
<td>(1)</td>
</tr>
<tr>
<td>4</td>
<td>1212 8419 / Service Partner</td>
</tr>
</tbody>
</table>

**comprising:**

Tool case

- Open-end spanner 46
- Open-end spanner 36 x 41 DIN 3110
- Socket 22 x 12.5 DIN 3124
- Socket 24 x 20 DIN 3124
- Socket 27 x 20 DIN 3124
- Socket 30 x 20 DIN 3124
- Socket 32 x 20 DIN 3124
- Socket key size 36, extra deep
- Socket key, inside size 17
- Slider CH 1772/39
- Extension CH 1772/38
- Extension D 601/602
- Adapter A 20 x 12.5 DIN 3123
- Torque wrench 0-210 Nm (0-21 kpm)
- Extension for torque wrench
- Turning bar extension
- Ratchet ½"
- Ratchet ¾"
- Extension for ¾" slider
- Right angle screwdriver 5 DIN 911
- Right angle screwdriver, gunmetal 5 DIN 911
Right angle screwdriver 6 DIN 911
Right angle screwdriver 8 DIN 911
Right angle screwdriver 10 DIN 911
Right angle screwdriver 12 DIN 911
Pin wrench 3/16"
Pliers A 10 DIN 5254
Pliers A 19 DIN 5254
Pliers C 40 DIN 5254
Brush
Handle
Feeler gauge 0.05 - 0.5 mm
Extractor device 401
Pin for loosening the retaining bolts
Ring spanner size 22
Extension for brushes for pipe cooler
Round brush CH 1988/2
Round brush CH 1988/4
Wrench (starter wrench) 27
Test case for lube oil and coolant

1 Equipment and aids for the lube oil and coolant properties tests
2 00 General
3 (1)
4 1213 0382 / Service Partner

Comprising:

For coolant test:
- 1213 0395 Test rods for pH value
- 1213 0396 Test material for total hardness
- 1213 0397 Test material for carbonate hardness
- 1213 0398 Test material for chloride content
- 1213 0399 Test rod for sulphate content

For lube oil test:
- 1213 0384 Complete set, consisting of:
  - 1213 0385 Instrument for testing water content
  - 1213 0386 Measuring cylinder
  - 1213 0387 Suction measuring instrument
  - 1213 0388 Float vessels (test water content)
  - 1213 0389 Spare gasket
  - 1213 0390 Tweezers
  - 1213 0391 Pipette
- 1213 0393 Test tube A (check water content)
- 1213 0394 Test tube B (check water content)
- 1213 0400 Glass rods for drip sample
- 1213 0401 Filter paper for drip sample
- 1213 0402 Instrument for viscosity comparison
### Tool kit

<table>
<thead>
<tr>
<th>Name</th>
<th>Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Description / Use</td>
<td>(The illustrations are examples)</td>
</tr>
<tr>
<td>2 Module</td>
<td></td>
</tr>
<tr>
<td>3 Competence class</td>
<td></td>
</tr>
<tr>
<td>4 Order number / Order from ...</td>
<td></td>
</tr>
</tbody>
</table>

#### Standard set

- **Module 00 General**
- **(1)**
- **1215 0000 / Service Partner**

Comprising:

- **1215 8074** Tool case
- **0115 4248** Open end spanner 8 x 10 DIN 3110
- **0115 4250** Open end spanner 12 x 14 DIN 3110
- **0115 4251** Open end spanner 13 x 17 DIN 3110
- **0115 4252** Open end spanner 14 x 15 DIN 3110
- **0115 4254** Open end spanner 19 x 22 DIN 3110
- **0115 4255** Open end spanner 24 x 27 DIN 3110
- **0703 8432** Open end spanner 30 x 32 DIN 3110
- **0112 4755** Ring spanner 13 x 17 DIN 838
- **0115 4230** Ring spanner 19 x 22 DIN 838
- **0115 4231** Ring spanner 24 x 27 DIN 838
- **0115 4367** Set of feeler gauges 0.2 – 0.45
- **0710 9764** Socket 10 x 12.5 DIN 3124
- **0710 9767** Socket 13 x 12.5 DIN 3124
- **0110 3966** Socket 14 x 12.5 DIN 3124
- **0110 3967** Socket 17 x 12.5 DIN 3124
- **0110 3968** Socket 19 x 12.5 DIN 3124
- **0110 2416** Socket 22 x 12.5 DIN 3124
- **0115 2905** T-handle A 12.5 DIN 3122
- **0110 2415** Extension B 12.5 x 250 DIN 3123
- **0115 4232** Universal joint C 12.5 DIN 3123
- **0110 3385** Screwdriver A 0.8 x 4.0 DIN 5265
- **0110 4281** Screwdriver A 1 x 5.5 DIN 5265
<table>
<thead>
<tr>
<th>Name</th>
<th>Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Figure</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td><strong>Acid tester</strong></td>
<td>(The illustrations are examples)</td>
</tr>
<tr>
<td>1 For checking the battery fluid density</td>
<td>1 For checking the battery fluid density</td>
</tr>
<tr>
<td>2 13 Electrical system</td>
<td>2 13 Electrical system</td>
</tr>
<tr>
<td>3 (1)</td>
<td>3 (1)</td>
</tr>
<tr>
<td>4 1215 7944 / Service Partner</td>
<td>4 1215 7944 / Service Partner</td>
</tr>
</tbody>
</table>

**Lube oil filter key**

1 For loosening the lube oil filter cartridge
2 08 Lube oil system
3 (1)
4 1215 8153 / Service Partner
STOP
Troubleshooting

The following table is a list of faults which may occur during engine operation and their possible causes. It does not claim to be a full list.

The causes of the faults are listed in ascending order of effort required to localise them.

The tables listed below contain measures which may help to eliminate the fault. If the fault persists even after carrying out the measures, please contact your Service Partner.

Fault table

<table>
<thead>
<tr>
<th>Fault</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine fails to start</td>
<td>6 / 4</td>
</tr>
<tr>
<td>Engine does not reach the specified output or speed</td>
<td>6 / 4</td>
</tr>
<tr>
<td>Engine fires irregularly</td>
<td>6 / 4</td>
</tr>
<tr>
<td>Engine &quot;knocks&quot; and runs intermittently.</td>
<td>6 / 5</td>
</tr>
<tr>
<td>Engine stops suddenly or is switched off by TEM after a fault</td>
<td>6 / 5</td>
</tr>
<tr>
<td>Engine gets too hot or TEM indicates &quot;lack of coolant&quot;</td>
<td>6 / 6</td>
</tr>
<tr>
<td>Lube oil pressure too low / TEM &quot;Lube oil pressure too low&quot;</td>
<td>6 / 6</td>
</tr>
<tr>
<td>Lube oil in coolant</td>
<td>6 / 6</td>
</tr>
<tr>
<td>Coolant in lube oil</td>
<td>6 / 6</td>
</tr>
<tr>
<td>Lube oil in coolant</td>
<td>6 / 7</td>
</tr>
</tbody>
</table>
## Troubleshooting remedies

### Engine fails to start

<table>
<thead>
<tr>
<th>TEM message</th>
<th>Possible cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine fails to start</td>
<td>Battery flat or defective</td>
<td>Check battery, recharge / renew if necessary</td>
</tr>
<tr>
<td></td>
<td>Starter defective</td>
<td>Check starter, renew if necessary</td>
</tr>
<tr>
<td></td>
<td>Power supply to unit terminal box interrupted</td>
<td>Check cable harness and repair / renew if necessary</td>
</tr>
<tr>
<td></td>
<td>Ignition system defective</td>
<td>Check the ignition system</td>
</tr>
<tr>
<td></td>
<td>Gas stop valves closed</td>
<td>Open gas stop valves</td>
</tr>
<tr>
<td></td>
<td>Gas pipe not bled</td>
<td>Bleed gas line</td>
</tr>
</tbody>
</table>

### Engine does not reach the specified output or speed

<table>
<thead>
<tr>
<th>TEM message</th>
<th>Possible cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas pressure</td>
<td>Gas stop valves not fully open</td>
<td>Open the gas stop valves fully / check gas filter and renew if necessary</td>
</tr>
<tr>
<td></td>
<td>too little gas</td>
<td>Check gas pressure</td>
</tr>
<tr>
<td></td>
<td>Air filter soiled</td>
<td>Check air filter, renew if necessary</td>
</tr>
<tr>
<td>Gas mixer stop</td>
<td>Gas-air mixture defective (too lean / too rich)</td>
<td>Check regulation of the gas mixer</td>
</tr>
<tr>
<td></td>
<td>No valve clearance</td>
<td>Setting valve clearance</td>
</tr>
</tbody>
</table>

### Engine fires irregularly

<table>
<thead>
<tr>
<th>TEM message</th>
<th>Possible cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine misfiring ¹</td>
<td>Ignition control unit defective</td>
<td>Check ignition control unit, renew if necessary</td>
</tr>
<tr>
<td></td>
<td>Ignition coils defective</td>
<td>Check ignition coils, renew if necessary</td>
</tr>
<tr>
<td></td>
<td>Electrode spacing at spark plug too great</td>
<td>Check spark plug, adjust / renew if necessary</td>
</tr>
<tr>
<td></td>
<td>Spark plugs defective</td>
<td>Check spark plugs, renew if necessary</td>
</tr>
<tr>
<td></td>
<td>Pickup (camshaft or control shaft) gap too great / near limit</td>
<td>Check gap and set if necessary</td>
</tr>
</tbody>
</table>

¹ The smooth running detector of the TEM system can be used to detect misfiring.
**Engine "knocks" and runs intermittently.**

<table>
<thead>
<tr>
<th>TEM message</th>
<th>Possible cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine fails to start</td>
<td>Ignition cable defective</td>
<td>Check ignition cable, renew if necessary</td>
</tr>
<tr>
<td></td>
<td>Ignition coils defective</td>
<td>Check ignition coils, renew if necessary</td>
</tr>
<tr>
<td></td>
<td>Pickup (camshaft or control shaft) gap too great / or near limit</td>
<td>Check gap and set if necessary</td>
</tr>
<tr>
<td></td>
<td>Gas pipe not bled</td>
<td>Bleed gas line</td>
</tr>
<tr>
<td></td>
<td>Inlet or outlet valves leaking</td>
<td>Check valves, grind if necessary</td>
</tr>
<tr>
<td></td>
<td>Oil carbon residue on pistons or outlet valves</td>
<td>Clean components</td>
</tr>
</tbody>
</table>

**Engine stops suddenly or is switched off by TEM after a fault**

<table>
<thead>
<tr>
<th>TEM message</th>
<th>Possible cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ignition failed (cable break)</td>
<td>Check cable harness and repair / renew if necessary</td>
<td></td>
</tr>
<tr>
<td>Ignition control unit defective</td>
<td>Check ignition control unit, renew if necessary</td>
<td></td>
</tr>
<tr>
<td>Pickup (camshaft or control shaft) gap too great / or near limit</td>
<td>Check gap and set if necessary</td>
<td></td>
</tr>
<tr>
<td>Gas supply interrupted</td>
<td>Check gas pipe</td>
<td></td>
</tr>
<tr>
<td>Gas pressure regulator jams</td>
<td>Check gas pressure regulator and repair / renew if necessary</td>
<td></td>
</tr>
<tr>
<td>Gas mixer stop lean</td>
<td>Gas pressure too high</td>
<td>Check gas pressure, correct gas pressure at the gas pressure regulator</td>
</tr>
<tr>
<td>Overspeed</td>
<td>Speed governor defective</td>
<td>Check speed governor, repair if necessary 1)</td>
</tr>
<tr>
<td>Fault cooling water pump</td>
<td>Coolant pump defective (pump shaft broken, bearing defective)</td>
<td>Check coolant pump and repair / renew if necessary</td>
</tr>
<tr>
<td>Overtemperature cooling water</td>
<td>Coolant channels in the engine sludged or blocked by scale</td>
<td>Clean the coolant system</td>
</tr>
<tr>
<td>Low cooling water</td>
<td>Too little coolant</td>
<td>Check / correct coolant level, find reason for loss of coolant and repair</td>
</tr>
<tr>
<td></td>
<td>Coolant pump losing too much coolant</td>
<td>Check axial sealing rings of the coolant pump, renew if necessary</td>
</tr>
<tr>
<td>Lube oil level too low / overtemperature lube oil</td>
<td>Lube oil level too low</td>
<td>Check / correct lube oil level</td>
</tr>
</tbody>
</table>

1) only by authorised experts
### Engine gets too hot or TEM indicates “lack of coolant”

<table>
<thead>
<tr>
<th>TEM message</th>
<th>Possible cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fault cooling water pump</td>
<td>Coolant pump defective (pump shaft broken, bearing defective)</td>
<td>Check coolant pump and repair / renew if necessary</td>
</tr>
<tr>
<td>Overtemperature cooling water</td>
<td>Coolant channels in the engine sludged or blocked by scale</td>
<td>Clean the coolant system</td>
</tr>
<tr>
<td>Low cooling water</td>
<td>Too little coolant</td>
<td>Check / correct coolant level, find reason for loss of coolant and repair</td>
</tr>
<tr>
<td></td>
<td>Coolant pump losing too much coolant</td>
<td>Check axial sealing rings of the coolant pump, renew if necessary</td>
</tr>
<tr>
<td></td>
<td>Three-way valve secondary heating circuit defective</td>
<td>Check three-way valve secondary heating circuit, renew if necessary</td>
</tr>
<tr>
<td></td>
<td>Heat transmission primary to secondary poor</td>
<td>Clean sludged elements of the heat transformer</td>
</tr>
</tbody>
</table>

### Lube oil pressure too low / TEM “Lube oil pressure too low” or “Lube oil level too low”

<table>
<thead>
<tr>
<th>TEM message</th>
<th>Possible cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lube oil filter soiled</td>
<td>Lube oil filter soiled</td>
<td>Replace filter</td>
</tr>
<tr>
<td>Lube oil level too low / over-temperature lube oil</td>
<td>Lube oil level too low</td>
<td>Check / correct lube oil level</td>
</tr>
<tr>
<td>Lube oil pressure too low</td>
<td>Manifold to lube oil pump soiled</td>
<td>Clean manifold</td>
</tr>
<tr>
<td></td>
<td>Lube oil pump heavily worn</td>
<td>Check lube oil pump, renew if necessary</td>
</tr>
<tr>
<td></td>
<td>Safety valve on the lube oil pump leaking</td>
<td>Check safety valve and repair / renew if necessary</td>
</tr>
<tr>
<td></td>
<td>Lube oil pressure gauge defective</td>
<td>Check lube oil pressure gauge, renew if necessary</td>
</tr>
<tr>
<td></td>
<td>Regulating valve defective</td>
<td>Check regulating valve, repair if necessary*</td>
</tr>
<tr>
<td></td>
<td>Bearing clearance of the crankshaft and con-rod bearings too great (wear)</td>
<td>Check bearing clearances, reposition components if necessary</td>
</tr>
</tbody>
</table>

### Coolant in lube oil

<table>
<thead>
<tr>
<th>TEM message</th>
<th>Possible cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cylinder liner seal in crankcase leaking</td>
<td>Remove cylinder liner and reseal, analyse lube oil sample</td>
</tr>
</tbody>
</table>
## Lube oil in coolant

<table>
<thead>
<tr>
<th>TEM message</th>
<th>Possible cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lube oil cooler leaking</td>
<td>Check lube oil cooler, renew if necessary</td>
</tr>
</tbody>
</table>
Preservation

Technical Circular TC 0199-99-2116
# Technical data

## Test and setting values

### General

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work procedure</td>
<td>Otto four-stroke engine with four-valve technology</td>
</tr>
<tr>
<td>Mixture charging</td>
<td>Turbocharging with mixture cooling</td>
</tr>
<tr>
<td>Liquid-cooled mixture cooler</td>
<td></td>
</tr>
<tr>
<td>Cylinder arrangement</td>
<td>V-engine with 90° cylinder angle</td>
</tr>
<tr>
<td>No. of cylinders</td>
<td>12, 16 and 20</td>
</tr>
<tr>
<td>Actuator</td>
<td>V12 and V16 engine</td>
</tr>
<tr>
<td></td>
<td>V20 engine</td>
</tr>
<tr>
<td></td>
<td>Heinzmann StG 30 - 01</td>
</tr>
<tr>
<td></td>
<td>Heinzmann StG 2080 - 01</td>
</tr>
<tr>
<td>Combustion gas type</td>
<td>V12 and V16 engine</td>
</tr>
<tr>
<td></td>
<td>V20 engine</td>
</tr>
<tr>
<td></td>
<td>Gases of gas group 1 and 2</td>
</tr>
<tr>
<td></td>
<td>Gases of gas group 1</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Gas group 1 - 50Hz</td>
</tr>
<tr>
<td></td>
<td>V12 engine</td>
</tr>
<tr>
<td></td>
<td>85.5 %</td>
</tr>
<tr>
<td></td>
<td>V16 engine</td>
</tr>
<tr>
<td></td>
<td>85.8 %</td>
</tr>
<tr>
<td></td>
<td>V20 engine</td>
</tr>
<tr>
<td></td>
<td>84.7 %</td>
</tr>
<tr>
<td>Gas group 2 - 50Hz</td>
<td>V12 engine</td>
</tr>
<tr>
<td></td>
<td>87.2 %</td>
</tr>
<tr>
<td></td>
<td>V16 engine</td>
</tr>
<tr>
<td></td>
<td>87.2 %</td>
</tr>
<tr>
<td></td>
<td>V20 engine</td>
</tr>
<tr>
<td></td>
<td>84.9 %</td>
</tr>
<tr>
<td>Gas group 1 - 60Hz</td>
<td>V12 engine</td>
</tr>
<tr>
<td></td>
<td>85.7 %</td>
</tr>
<tr>
<td></td>
<td>V16 engine</td>
</tr>
<tr>
<td></td>
<td>85.8 %</td>
</tr>
<tr>
<td>Gas group 2 - 60Hz</td>
<td>V12 engine</td>
</tr>
<tr>
<td></td>
<td>86.8 %</td>
</tr>
<tr>
<td></td>
<td>V16 engine</td>
</tr>
<tr>
<td></td>
<td>86.9 %</td>
</tr>
<tr>
<td>Speeds</td>
<td></td>
</tr>
<tr>
<td></td>
<td>at 50 Hz</td>
</tr>
<tr>
<td></td>
<td>1500 rpm</td>
</tr>
<tr>
<td></td>
<td>at 60 Hz</td>
</tr>
<tr>
<td></td>
<td>1800 rpm</td>
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<tr>
<td>Power</td>
<td>Gas group 1 - 50Hz</td>
</tr>
<tr>
<td></td>
<td>V12 engine</td>
</tr>
<tr>
<td></td>
<td>1050 kW</td>
</tr>
<tr>
<td></td>
<td>V16 engine</td>
</tr>
<tr>
<td></td>
<td>1400 kW</td>
</tr>
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<td></td>
<td>V20 engine</td>
</tr>
<tr>
<td></td>
<td>2000 kW</td>
</tr>
<tr>
<td>Gas group 2 - 50Hz</td>
<td>V12 engine</td>
</tr>
<tr>
<td></td>
<td>970 kW</td>
</tr>
<tr>
<td></td>
<td>V16 engine</td>
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<tr>
<td></td>
<td>1294 kW</td>
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<tr>
<td></td>
<td>V20 engine</td>
</tr>
<tr>
<td></td>
<td>1750 kW</td>
</tr>
<tr>
<td>Gas group 1 - 60Hz</td>
<td>V12 engine</td>
</tr>
<tr>
<td></td>
<td>1050 kW</td>
</tr>
<tr>
<td></td>
<td>V16 engine</td>
</tr>
<tr>
<td></td>
<td>1400 kW</td>
</tr>
<tr>
<td>Gas group 2 - 60Hz</td>
<td>V12 engine</td>
</tr>
<tr>
<td></td>
<td>1050 kW</td>
</tr>
<tr>
<td></td>
<td>V16 engine</td>
</tr>
<tr>
<td></td>
<td>1400 kW</td>
</tr>
<tr>
<td>Bore</td>
<td>170 mm</td>
</tr>
<tr>
<td>Stroke</td>
<td>195 mm</td>
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### Technical data

**TBG 620**

<table>
<thead>
<tr>
<th>Component</th>
<th>V12 engine</th>
<th>V16 engine</th>
<th>V20 engine</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capacity per cylinder</strong></td>
<td>4.426 dm³</td>
<td>53.1 dm³</td>
<td>70.8 dm³</td>
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<tr>
<td><strong>Total displacement</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V12 engine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V16 engine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V20 engine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ignition sequence</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V12</td>
<td>A1 B2 A5 B4 A3 B1 A6 B5 A2 B3 A4 B6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V16</td>
<td>A1 B2 A6 B5 A8 B7 A3 A7 B6 A4 B8 A2 B3 A5 B1 B4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V20</td>
<td>A1 B7 A2 B5 A4 B3 A6 B1 A8 B2 A10 B4 A9 B6 A7 B8 A5 B10 A3 B9</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dimensions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V12 engine</td>
<td>Length</td>
<td>4,700 mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Width</td>
<td>1,800 mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Height</td>
<td>2,650 mm</td>
<td></td>
</tr>
<tr>
<td>V16 engine</td>
<td>Length</td>
<td>5,500 mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Width</td>
<td>1,800 mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Height</td>
<td>2,650 mm</td>
<td></td>
</tr>
<tr>
<td>V20 engine</td>
<td>Length</td>
<td>6,300 mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Width</td>
<td>1,750 mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Height</td>
<td>2,550 mm</td>
<td></td>
</tr>
<tr>
<td><strong>Weights</strong></td>
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<td></td>
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</tr>
<tr>
<td>V12 engine</td>
<td>Engine</td>
<td>4,200 kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Power unit</td>
<td>8,480 kg</td>
<td></td>
</tr>
<tr>
<td>V16 engine</td>
<td>Engine</td>
<td>5,800 kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Power unit</td>
<td>10,830 kg</td>
<td></td>
</tr>
<tr>
<td>V20 engine</td>
<td>Engine</td>
<td>7,800 kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Power unit</td>
<td>17,580 kg</td>
<td></td>
</tr>
<tr>
<td><strong>Cylinder head, complete</strong></td>
<td></td>
<td></td>
<td>45 kg</td>
</tr>
<tr>
<td><strong>Cylinder liner</strong></td>
<td></td>
<td></td>
<td>16 kg</td>
</tr>
<tr>
<td><strong>Piston, complete</strong></td>
<td></td>
<td></td>
<td>10 kg</td>
</tr>
<tr>
<td><strong>Con rod, complete</strong></td>
<td></td>
<td></td>
<td>15 kg</td>
</tr>
<tr>
<td><strong>Camshaft</strong></td>
<td>V12 engine</td>
<td>44 kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V16 engine</td>
<td>56 kg</td>
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</tr>
<tr>
<td></td>
<td>V20 engine</td>
<td>48 kg</td>
<td></td>
</tr>
<tr>
<td><strong>Crankshaft with counterweights</strong></td>
<td>V12 engine</td>
<td>511 kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V16 engine</td>
<td>452 kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V20 engine</td>
<td>611 kg</td>
<td></td>
</tr>
<tr>
<td><strong>Main bearing cover</strong></td>
<td></td>
<td></td>
<td>16 kg</td>
</tr>
<tr>
<td><strong>Oil pan</strong></td>
<td>V12 engine</td>
<td>90 kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V16 engine</td>
<td>100 kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V20 engine</td>
<td>340 kg</td>
<td></td>
</tr>
<tr>
<td><strong>Flywheel</strong></td>
<td></td>
<td></td>
<td>316 kg</td>
</tr>
<tr>
<td><strong>Vibration damper</strong></td>
<td>V20 engine</td>
<td>42 kg</td>
<td></td>
</tr>
</tbody>
</table>
### Technical data

<table>
<thead>
<tr>
<th>Component</th>
<th>V12 engine</th>
<th>V16 engine</th>
<th>V20 engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercooler without cover</td>
<td>75 kg</td>
<td>75 kg</td>
<td>113 kg</td>
</tr>
<tr>
<td>Lube oil pump, complete</td>
<td>37 kg</td>
<td>42 kg</td>
<td>42 kg</td>
</tr>
</tbody>
</table>

* All data are approximate values

<table>
<thead>
<tr>
<th>Component</th>
<th>V12 engine</th>
<th>V16 engine</th>
<th>V20 engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coolant content total</td>
<td>139 dm³</td>
<td>179 dm³</td>
<td>262 dm³</td>
</tr>
<tr>
<td>Coolant temperatures Engine max. inlet / outlet</td>
<td>80 / 92 °C</td>
<td>80 / 92 °C</td>
<td></td>
</tr>
<tr>
<td>Coolant temperatures with glycol inlet / outlet</td>
<td>80 / 92 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intake air temperature min.</td>
<td>20 °C</td>
<td></td>
<td></td>
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</table>

### Cylinder head

<table>
<thead>
<tr>
<th>Component</th>
<th>Valve shaft / valve bridge</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve clearance Gas group 1 - 50Hz</td>
<td>Inlet</td>
<td>0.3 mm</td>
</tr>
<tr>
<td></td>
<td>Outlet</td>
<td>0.7 mm</td>
</tr>
<tr>
<td>Valve clearance Gas group 2 - 50Hz</td>
<td>Inlet</td>
<td>0.3 mm</td>
</tr>
<tr>
<td></td>
<td>Outlet</td>
<td>0.9 mm</td>
</tr>
<tr>
<td>Valve clearance Gas group 1 - 60Hz</td>
<td>Inlet</td>
<td>0.3 mm</td>
</tr>
<tr>
<td></td>
<td>Outlet</td>
<td>0.9 mm</td>
</tr>
<tr>
<td>Valve clearance Gas group 2 - 60Hz</td>
<td>Inlet</td>
<td>0.3 mm</td>
</tr>
<tr>
<td></td>
<td>Outlet</td>
<td>1.1 mm</td>
</tr>
</tbody>
</table>
### Speed controller

Set Altronic frequency generator for camshaft.

- Turn engine until pulse screw is visible.
- Turn in frequency generator to stop.
- Unscrew 0.75 - 1 turn (270°-360°)

Set Jacquet frequency generator for camshaft.

- Turn engine until pulse screw is visible.
- Turn in frequency generator to stop.
- Turn out 2.25 turns (810°)
- Turn out further until the mark is facing in running direction

Set Jacquet frequency generator for flywheel.

- Turn in frequency generator to stop.
- Turn out 1 turn (360°)
- Turn out further until the mark is facing in running direction

<table>
<thead>
<tr>
<th>Actuator</th>
<th>Heinzmann</th>
<th>Stg 30 - 01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control output shaft</td>
<td>Angle of rotation</td>
<td>42°</td>
</tr>
<tr>
<td></td>
<td>max. torque</td>
<td>28 Nm</td>
</tr>
<tr>
<td></td>
<td>Holding torque</td>
<td>14 Nm</td>
</tr>
<tr>
<td></td>
<td>Throughput time</td>
<td>170 ms</td>
</tr>
<tr>
<td>Power consumption</td>
<td>Steady state</td>
<td>1 A</td>
</tr>
<tr>
<td></td>
<td>at load change</td>
<td>3-4 A</td>
</tr>
<tr>
<td></td>
<td>max. current</td>
<td>4.5 A</td>
</tr>
<tr>
<td></td>
<td>limited current</td>
<td>2.5 A</td>
</tr>
<tr>
<td>Storage temperature</td>
<td></td>
<td>-55 to +110</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>Standard</td>
<td>-25 to +90</td>
</tr>
<tr>
<td></td>
<td>Special version</td>
<td>-40 to +90</td>
</tr>
<tr>
<td>Air humidity</td>
<td></td>
<td>up to 100 %</td>
</tr>
<tr>
<td>Type of protection</td>
<td>Housing</td>
<td>IP 44</td>
</tr>
<tr>
<td>Weight</td>
<td></td>
<td>12.3 kg</td>
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</table>
### Technical data

<table>
<thead>
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<th>Actuator</th>
<th>Heinzmann Stg 2080 - 01</th>
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</thead>
<tbody>
<tr>
<td>Control output shaft</td>
<td></td>
</tr>
<tr>
<td>Angle of rotation</td>
<td>36 °</td>
</tr>
<tr>
<td>max. torque</td>
<td>11 Nm</td>
</tr>
<tr>
<td>Holding torque</td>
<td>5.5 Nm</td>
</tr>
<tr>
<td>Throughput time</td>
<td>60 ms</td>
</tr>
<tr>
<td>Power consumption</td>
<td></td>
</tr>
<tr>
<td>Steady state</td>
<td>1 A</td>
</tr>
<tr>
<td>at load change</td>
<td>3-4 A</td>
</tr>
<tr>
<td>max. current</td>
<td>4.5 A</td>
</tr>
<tr>
<td>limited current</td>
<td>2.5 A</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-55 to +110</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td>-25 to +90</td>
</tr>
<tr>
<td>Special version</td>
<td>-40 to +90</td>
</tr>
<tr>
<td>Air humidity</td>
<td>up to 100 %</td>
</tr>
<tr>
<td>Type of protection</td>
<td>Housing</td>
</tr>
<tr>
<td>Weight</td>
<td>6.6 kg</td>
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</tbody>
</table>

#### Fuel system / gas system

Gas pressure of the gas control line* | 20 - 100 mbar

* may deviate from the setpoint depending on the system and gas type

#### Lube oil system

<table>
<thead>
<tr>
<th>Lube oil content</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>V12 engine</td>
<td>205 dm³</td>
</tr>
<tr>
<td>V16 engine</td>
<td>265 dm³</td>
</tr>
<tr>
<td>V20 engine</td>
<td>1,080 dm³</td>
</tr>
</tbody>
</table>

#### Electrical system

<table>
<thead>
<tr>
<th>Starter (electric)</th>
<th>Supply voltage</th>
<th>24 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power consumption</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V12 engine</td>
<td>9 kW</td>
<td></td>
</tr>
<tr>
<td>V16 engine</td>
<td>15 kW</td>
<td></td>
</tr>
<tr>
<td>V20 engine</td>
<td>18 kW</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Starter (compressed air)</th>
<th>Supply pressure</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>min.</td>
<td>16 bar</td>
<td></td>
</tr>
<tr>
<td>max.</td>
<td>30 bar</td>
<td></td>
</tr>
<tr>
<td>Contents of air bottle</td>
<td>2,000 dm³</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Battery</th>
<th>Voltage</th>
<th>12 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V12 engine</td>
<td>4 x 143 Ah</td>
<td></td>
</tr>
<tr>
<td>V16 engine</td>
<td>4 x 215 Ah</td>
<td></td>
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<tr>
<td>V20 engine</td>
<td>6 x 215 Ah</td>
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</tr>
<tr>
<td>Battery acid density</td>
<td>Charge status</td>
<td>Normal</td>
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<tr>
<td>---------------------</td>
<td>--------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td></td>
<td>well charged</td>
<td>1.28 kg/l</td>
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<tr>
<td></td>
<td>semi-charged (re-charge)</td>
<td>1.20 kg/l</td>
</tr>
<tr>
<td></td>
<td>discharged (recharge, renew if necessary)</td>
<td>1.12 kg/l</td>
</tr>
<tr>
<td>Spark plug</td>
<td>Electrode gap</td>
<td></td>
</tr>
</tbody>
</table>
## Tightening specifications

### General

<table>
<thead>
<tr>
<th>Component</th>
<th>Specification</th>
<th>Torque (Nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screw connections base frame</td>
<td>According to manufacturer's specifications</td>
<td></td>
</tr>
<tr>
<td>Engine claw to crankcase</td>
<td>M14 x 45/100-12.9</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>M14 x 140 - 10.9</td>
<td>200</td>
</tr>
<tr>
<td>Engine mounting on engine claw</td>
<td>M16 x 90 - 10.9</td>
<td>220</td>
</tr>
<tr>
<td>Engine mounting on crankcase</td>
<td>M14 x 40 - 10.9</td>
<td>160</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nuts / bolts</th>
<th>8.8</th>
<th>10.9</th>
<th>12.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard values according to H 0385-1</td>
<td>M4</td>
<td>2.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Screw connection class II</td>
<td>M5</td>
<td>5.0</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>M6</td>
<td>8.5</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>M8</td>
<td>20</td>
<td>30</td>
</tr>
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<td></td>
<td>M10</td>
<td>42</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>M12</td>
<td>70</td>
<td>110</td>
</tr>
<tr>
<td></td>
<td>M14</td>
<td>110</td>
<td>170</td>
</tr>
<tr>
<td></td>
<td>M16</td>
<td>180</td>
<td>260</td>
</tr>
<tr>
<td></td>
<td>M18</td>
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<td>500</td>
</tr>
<tr>
<td></td>
<td>M22</td>
<td>480</td>
<td>700</td>
</tr>
<tr>
<td></td>
<td>M24</td>
<td>600</td>
<td>850</td>
</tr>
<tr>
<td></td>
<td>M27</td>
<td>900</td>
<td>1300</td>
</tr>
<tr>
<td></td>
<td>M30</td>
<td>1200</td>
<td>1700</td>
</tr>
</tbody>
</table>

Vibration dampers on pipes according to manufacturer's specifications

<table>
<thead>
<tr>
<th>Cylinder head</th>
<th>M10x1</th>
<th>40 Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve bridge lock nut</td>
<td>M12x1.5</td>
<td>45 Nm</td>
</tr>
<tr>
<td>Lock nut on rocker arm</td>
<td>M8x55 / 85</td>
<td>25 Nm</td>
</tr>
</tbody>
</table>

| Crankcase                                        | Hatch cover on the crankcase | 25 Nm       |

| Fuel system / gas system                         | Cover for gas filter housing | 8 Nm        |

© 0206
### Lube oil system
- Lube oil filter on console: 25 Nm
- Pressure limiting valve pre-lube pump: Cap nut, 70 Nm

### Cooling system
- Coolant pipes: Cup nut
  - Pipe Ø 6 mm: 35 Nm
  - Pipe Ø 8 mm: 45 Nm
  - Pipe Ø 10 mm: 60 Nm
  - Pipe Ø 12 mm: 75 Nm
- Hollow screws
  - M10 x 1: 18 Nm
  - M12 x 1.5: 29 Nm
  - M14 x 1.5: 39 Nm
  - M16 x 1.5: 49 Nm

### Electrical system
- Spark plug on cylinder head: 52 Nm
TBG 620
Job cards
Job cards

Symbol description

<table>
<thead>
<tr>
<th>Tools</th>
<th>- List of necessary tools and special tools.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auxiliary material</td>
<td>- List of necessary sealing compounds, locking agents, adhesives, lubricants, cleaning agents etc.</td>
</tr>
<tr>
<td>Spare parts</td>
<td>- List of maintenance and repair parts which must always or sometimes be renewed.</td>
</tr>
<tr>
<td>References</td>
<td>- List of chapters, job cards, logs etc. to which this job card makes reference.</td>
</tr>
</tbody>
</table>

You will find this symbol next to all safety instructions. Follow these meticulously. The attention of operating personnel should be drawn to these safety instructions. In addition, general statutory safety and accident prevention regulations applying in your country must be complied with.

You will find this symbol next to instructions of a general nature. Follow these meticulously.

Gaskets used in this engine are asbestos-free. Please use appropriate spare parts for maintenance and repair work.
Job card list

The job cards are listed in two lists on the following pages.

- According to job card title
- According to job card number
<table>
<thead>
<tr>
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<td>B 7-20-1</td>
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<td>Removing and installing spark plugs, checking ignition cable</td>
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</tbody>
</table>
Safety regulations for handling components made of elastomers containing fluoride (e.g. Viton)

References
- Chapter 1, Rules for disposal

General information

Gaskets, round sealing rings and moulded parts are manufactured partly from elastomers containing fluoride (FPM) to withstand high thermal stress.

At unscheduled temperatures above 315°C (caused for example by an engine fire) the material decomposes and forms caustic acids. The residue is tacky and black in appearance.

Proceed as follows if high temperatures have caused damage to gaskets or round sealing rings:

- Check all gaskets which have suffered from the heat visually.
- Wear gloves (neoprene).
- Remove and dispose of residual material
  - see chapter 1, Disposal regulations
- Destroy clothing which has been contaminated by residue of the gaskets.

Touching the residue material with your hands, even after cooling down, may be damaging to health.
Regulations for cutting, grinding, soldering and welding work

References
- Accident prevention regulations

General information
The contractor of cutting, grinding, soldering and welding work must alert the persons enlisted to do the work to the dangers and ensure that the points listed below are observed and complied with.

Persons entrusted with cutting, grinding, soldering and welding work must be familiar with and observe the valid regulations and specifications, especially the rules for accident prevention of the respective national legislations.

The following points must be observed additionally to the specified regulations and specifications.

Electrics / electronics
- Disconnect the battery ground and remove and stow away the battery safely if necessary.
- Pull out the cable set plugs of electrical and electronic components (e.g. TEM switch cabinet, MKS junction box, EMR2-control unit, ignition system, sensors).
- Remove electrical and electronic components in the immediate vicinity of the working area.
- Always connect the ground terminal of the welding gear in the immediate vicinity of the welding point to avoid vagrant currents. Make sure there is a perfect ground connection, remove varnish in the area of the ground terminal if necessary.

Danger of explosion
Work which could lead to a strong development of heat on gas or fuel pipes and vessels may only be carried out when these have been completely emptied and bled or...
flushed.

- Shut off gas pipes and fuel pipes.

**Health hazard**

- Air well, suck off fumes and dust particles.
- Cordon off the working area during arc welding to protect bystanders against the harmful effects of optical radiation.
Visual inspection of the system

Tools
- Commercially available tools

References
- B 5-4-2 Checking the speed governor linkage
- B 6-3-6 Renewing the suction air intake filter
- B 7-20-1 Checking the gas pressure of the gas regulating line
- B 7-21-1 Renewing the gas filter insert
- B 13-4-1 Servicing the battery

General information

Danger of burns!
When working on the hot engine.

The read operating values and liquid levels must be logged with the TEM system.

Daily check

Engine Monitoring System
- Check the display data and control lamps on the switching system.
  - See the operating manual of the engine monitoring system.
- The operating values should be taken from the engine monitoring system and compared with the values in the commissioning log.
  - If values are out of tolerance, find the cause and eliminate it immediately.

Engine
- Check the engine for smooth running and noise.
  - If the engine is not running smoothly or abnormal noise can be heard, the causes must be found and eliminated immediately.

Lube oil circuit
- Check the lube oil circuit and all connected components for leaks.
  - If leaks are detected, find and eliminate the cause immediately.

Coolant circuits
- Check the coolant circuit and all connected components for leaks.
  - If leaks are detected, find and eliminate the cause immediately.

Suction air intake system
- Check the maintenance indicator of the suction intake air filter.
- Renew the suction intake air filter if necessary - see job card B 6-3-6.

Gas system

- Check the gas pressure of the gas control line - see job card B 7-20-1.
- Renew the gas filter insert if necessary - see job card B 7-21-1.
- Check the gas system and all connected components for leaks.
  - If leaks are detected, find and eliminate the cause immediately.

Compressed air system

- if available - drain water from the air bottle, see job card B 10-7-1.
- Check the compressed air system and all connected components for leaks.
  - If leaks are detected, find and eliminate the cause immediately.

Starter system

- if available - check battery - see job card B 13-4-1.
- Check the electrical component and connectors for corrosion and tight fit.

If the engine is out of operation, the following additional tests can be made.

Speed governor

- Check the easy action of the speed governor, see job card B 5-4-2.

Exhaust gas system

- Check the exhaust gas system and all connected components for firm fit and leaks.
  - Defects which are detected must be eliminated immediately.
Auxiliary unit test by means of TEM system (TEM Evolution)

General information

Different test steps of the steps listed below may not be programmed depending on the engine variant and equipment.

The test mode serves for examining the reaction of the aggregate and individual auxiliary aggregates to the commands from the control. It is only possible when the engine is at a standstill and the quick stop is not actuated.

An engine start is not possible in test mode.

The number of auxiliary aggregates offered for testing depends on the engine type and the equipment of the system. Therefore only auxiliary aggregates are offered for testing which have had their parameters released.

If the test result is okay, this is displayed by a green checkmark. If errors occur in the auxiliary aggregate tests (displayed by a red cross) or there is a deviation from the specified values, please contact the DEUTZ Service.

Individual auxiliary aggregates (e.g. starter) can only be activated in touch mode for safety reasons. The auxiliary aggregates only remain switched on for as long as the key is pressed, switching on and off is not possible.

The job can be used as a copy form.

Conducting the tests

References

- Operating Manual TEM System
Release auxiliary unit test mode

- Switch on manual mode
  - »Measured values and operation« (F1 switch off Auto mode)
- Switch on test mode in the mask "Auxiliary aggregates 1" (F9).

F8 switch auxiliary unit on and off
F10 auxiliary unit touch mode: The auxiliary unit is only switched on for as long as the button is pressed.

<table>
<thead>
<tr>
<th>Test mode</th>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>

Ignition

- Switch on ignition (F8)
  - The ignition runs a self-test and reports the result after 10 seconds
- Switch off ignition (F8)

- red flash
  - Ignition is not OK
  - Check wiring
  - Check supply to ignition
  - Check ignition communication
  - Repeat test

- green tick
  - Ignition OK

<table>
<thead>
<tr>
<th>Ignition</th>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>
**Speed governor**

- Switch on speed governor (F8)
  
  The speed governor runs a calibration sequence. To do this it runs from 0 % auf 100 % and back.

  The double valve position is indicated in Volts.

- Switch off speed governor (F8)

- Go to the »Speed governor« mask.
  
  Before the final speed governor test: Check the calibration voltage for 0 % and for 100 % (0 % approx. 1.7 V and 100 % approx. 2.9 V)

- Switch on speed governor test mode (F10)
  
  - Set nominal position and check on the actuator (20 %, 50 %, 75 % and 100 %)
  
  - Switch off speed governor test mode (F10)

- Return to the »Auxiliary units 1« mask

**Note [V20]**

- Both actuators are calibrated simultaneously in TBG 620 V20.

---

**Pre-lubrication pump engine**

- Switch on pre-lubrication pump (F8)

  - [TBG 620, TBG 616] pre-lubricate for 20 min

  - [TBG 632] pre-lubricate for 3 min

- Check the direction of rotation,

- Check oil pressure (1 ... 3 bar)

- Leave pre-lubrication pumps switched on

**Note [632]**

- switch off after 3 min in TBG 632

---

**Speed governor**

<table>
<thead>
<tr>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>

**Pre-lubrication pump engine**

<table>
<thead>
<tr>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>
Pre-lubrication pump generator

The pre-lubrication pump is switched on and off with the menu item »Compartment ventilator colder« Feedback also takes place via this menu item.

- Switch on pre-lubrication pump (F8)
- Check the direction of rotation.
- Check oil pressure.

\[
\begin{align*}
x & = \text{Holding pressure} & y & = \text{Lifting pressure} \\
1 & = \text{Pressure set-up for engine start} & 2 & = \text{Start release (approx. 110-120 bar)} \\
3 & = \text{Operating pressure (approx. 50-60 bar)} & 4 & = \text{Pressure drop at engine stop}
\end{align*}
\]

- Leave pre-lubrication pump switched on

Pre-lubrication pump generator

<table>
<thead>
<tr>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>

Starter

Note prior to starter test:
- Ignition switched off
- Pre-lube pump switched on

- Switch on starter briefly (F10)
- Check function, speed and oil pressure

In engines with compressed air starter

Set the pre-pressure start air and throttle the starter before actuating it.

Starter

<table>
<thead>
<tr>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>
Pre-heater

- Switch on pre-heater (F8)
- Check function
- Switch off pre-heater (F8)

There is no feedback in the »Auxiliary units 1« mask.

Bleed the pre-heater first and open all valves

<table>
<thead>
<tr>
<th>Pre-heater</th>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>

Pump engine cooling circuit

- Switch on the engine cooling circuit pump (F8)
- Check the direction of rotation.
- Observe the differential pressure monitor and set if necessary
- Check the differential pressure - wait at least 30 seconds
- Switch off the engine cooling circuit pump (F8)

- red flash (in front of »$\Delta p$« symbol)
  no differential pressure available
- green tick (in front of »$\Delta p$« symbol)
  differential pressure present

<table>
<thead>
<tr>
<th>Differential pressure engine cooling circuit</th>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>

Mixture cooling circuit pump

- Switch on the mixture cooling circuit pump (F8)
- Check the direction of rotation.
- Observe the differential pressure monitor and set if necessary
- Check the differential pressure - wait at least 30 seconds
- Switch off the mixture cooling circuit pump (F8)

[MCP]
- Pump table cooler fan running

- red flash (in front of »$\Delta p$« symbol)
  no differential pressure present
- green tick (in front of »$\Delta p$« symbol)
  differential pressure present

<table>
<thead>
<tr>
<th>Differential pressure mixture cooling circuit</th>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>
[HC] heating circuit pump

- Switch on the heating circuit pump (F8)
- Check the direction of rotation.
- Observe the differential pressure monitor and set if necessary
- Check the differential pressure - wait at least 30 seconds
- Switch off the heating circuit pump (F8)

~ red flash (in front of »Δp« symbol)
  no differential pressure present
a green tick (in front of »Δp« symbol)
  differential pressure present

Differential pressure heating circuit | ok | nok

[EC] Emergency cooling circuit pump

- Switch on the emergency cooling circuit pump (F8)
- Check the direction of rotation.
- Observe the differential pressure monitor and set if necessary
- Check the differential pressure - wait at least 30 seconds
- Switch off the emergency cooling circuit (F8)

[ECS]

- Pump table cooler fan running

~ red flash (in front of »Δp« symbol)
  no differential pressure present
a green tick (in front of »Δp« symbol)
  differential pressure present

Differential pressure emergency cooling circuit | ok | nok
[only TBG 632] crankcase blower

- Switch on crankcase blower (F8)
- Check direction of rotation and function
- Switch off crankcase blower (F8)

**LED I/QX...1.12 plug-in card VME 32 I/O does not light**

- »Feedback differential pressure switch crankcase blower«
  - no differential pressure present

**LED I/QX...1.12 plug-in card VME 32 I/O does not light**

- »Feedback differential pressure switch crankcase blower«
  - differential pressure present

<table>
<thead>
<tr>
<th>Differential pressure heating circuit</th>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>

**Filling valves lube oil**

- Switch on lube oil filling valves briefly (touch mode F10)
- Check function

**Note**

- There is no feedback in the »Auxiliary units 1« mask.

<table>
<thead>
<tr>
<th>Filling valves lube oil</th>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>

**[TBG 632] Emptying valve lube oil**

- Switch on lube oil emptying valves briefly (touch mode F10)
- Check function

**Note**

- There is no feedback in the »Auxiliary units 1« mask.

<table>
<thead>
<tr>
<th>Lube oil drain valve</th>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>
Gas mixer (A)

- Switch on the rich setting (F8)
- Switch on the lean setting (F8)
- The number of steps must be reduced until the lean stop is reached (check stop).
- Watch the gas mixer whether it sets in lean direction.
- Switch off the lean setting (F8)
- Go to start position (F8)
- The gas mixer moves until it has reached the 0 steps position
- Repeat the rich and lean settings
- Check the number of steps
- The same number of steps must be set every time
- Go to stop position (F8)
- The gas mixer must adjust in lean direction until it has reached the lean stop (F8).
- Go to start position (F8)
- The stepper motor card then calibrates the momentary position to minus start position and then moves the parameterised number of steps to the start position.

Note

The »rich« stop is marked by a blue (+) symbol
The »lean« stop is marked by a blue (−) symbol
»Intermediate position« is marked by a blue (↔) symbol

Gas mixer (A) | ok | nok
---|---|---

Gas mixer (B)

- Gas mixer B is tested in the same way as gas mixer A.

Gas mixer (B) | ok | nok
---|---|---
[DK] Gas tightness check (A)

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>Switch on gas tightness check (A) (F8)</td>
</tr>
<tr>
<td>2</td>
<td>Check function</td>
</tr>
<tr>
<td>3</td>
<td>Switch off gas tightness check (A) (F8)</td>
</tr>
</tbody>
</table>

- **Tightness check**: ok
  - Green tick (after »Status«) in less than 2 seconds
  - Tightness check not successful
- **Gas valve 1 (A1) and 2 (A2)**
  - Switch gas valve 1 (A1) on and off (F10)
  - Check function
  - Switch gas valve 2 (A2) on and off (F10)
  - Check function

<table>
<thead>
<tr>
<th>Gas valve 1 (A1) and 2 (A2)</th>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Switch on gas tightness check (B) (F8)</td>
</tr>
<tr>
<td>5</td>
<td>Check function</td>
</tr>
<tr>
<td>6</td>
<td>Switch off gas tightness check (B) (F8)</td>
</tr>
</tbody>
</table>

- **Tightness check**: ok
  - Green tick (after »Status«) in less than 2 seconds
  - Tightness check not successful
- **Gas leak inspection**: ok
  - Green tick (after »Status«) after 30 seconds
  - Tightness check successful
Gas valve 1 (B1) and 2 (B2)

- Switch gas valve 1 (B1) on and off (F10)
- Check function
- Switch gas valve 2 (B2) on and off (F10)
- Check function

Gas valve 1 (B1) and 2 (B2) | ok | nok

[ZG] Gas pressure regulator B

- Switch on increase gas pressure B (F8).
  If the gas pressure regulator is at minus stop (displayed by a blue minus sign), the minus stop must disappear after about 50 steps. The gas pressure regulator then increases the gas pressure until it reaches the plus stop (indicated by a blue plus sign). Watch the gas pressure regulator to make sure it really does set to “higher pressure”

- Switch off increase gas pressure B and switch on reduce gas pressure B
  The number of steps must be reduced until the minus stop is reached (check stop). Watch the gas pressure regulator whether it sets in minus direction.

- Switch off reduce gas pressure B and start position gas pressure regulator. Switch on B.
  The gas pressure regulator B moves until it has reached the 0 steps position

- Switch on stop position gas pressure regulator B.
  The stepper motor card then calibrates the momentary position to minus start position and then moves the parameterised number of steps to the start position.

Note

- The »minus« stop is marked by a blue (+) symbol
- The »plus« stop is marked by a blue (−) symbol
- »Intermediate position« is marked by a blue (↔) symbol

Gas pressure regulator B | ok | nok

Test regulating valves
The positioning time of the drive should be within the following limits
DN 32 to 80 = 30 to 60 s
DN ≥ 100 = 40 to 80 s
If the valve runtime deviates too greatly, the regulation may become unstable.
Engine cooling water valve

- Switch on the »warmer« setting (F8)
  - Check the setting direction, stop »warm« (−) must be displayed.
- Switch off the »warmer« setting (F8)
- Switch on the »colder« setting (F8)
  - Check the setting direction, stop »cold« (+) must be displayed.
- Switch on the »colder« setting (F8)

Note
  After both stops have been moved to, the current valve position in % is displayed

Note
  The »warm« stop is marked by a blue (+) symbol
  The »cold« stop is marked by a blue (−) symbol
  »Intermediate position« is marked by a blue (↔) symbol

Mixture cooler valve

- Switch on the »warmer« setting (F8)
  - Check the setting direction, stop »warm« (−) must be displayed.
- Switch off the »warmer« setting (F8)
- Switch on the »colder« setting (F8)
  - Check the setting direction, stop »cold« (+) must be displayed.
- Switch on the »colder« setting (F8)

Note
  After both stops have been moved to, the current valve position in % is displayed

Note
  The »warm« stop is marked by a blue (+) symbol
  The »cold« stop is marked by a blue (−) symbol
  »Intermediate position« is marked by a blue (↔) symbol
[HC] Heating water

1. Switch on the »warmer« setting (F8)
   Check the setting direction, stop »warm« (−) must be displayed.
2. Switch off the »warmer« setting (F8)
3. Switch on the »colder« setting (F8)
   Check the setting direction, stop »cold« (+) must be displayed.
4. Switch on the »colder« setting (F8)

Note
After both stops have been moved to, the current valve position in % is displayed.

Note
The »warm« stop is marked by a blue (+) symbol
The »cold« stop is marked by a blue (−) symbol
»Intermediate position« is marked by a blue (↔) symbol

[EC] Emergency cooler

1. Switch on the »warmer« setting (F8)
   Check the setting direction, stop »warm« (−) must be displayed.
2. Switch off the »warmer« setting (F8)
3. Switch on the »colder« setting (F8)
   Check the setting direction, stop »cold« (+) must be displayed.
4. Switch on the »colder« setting (F8)

Note
After both stops have been moved to, the current valve position in % is displayed.

Note
The »warm« stop is marked by a blue (+) symbol
The »cold« stop is marked by a blue (−) symbol
»Intermediate position« is marked by a blue (↔) symbol
[BY] Exhaust bypass valve

- Switch on open exhaust bypass valve (F8)
- Check setting direction
- Switch on open exhaust bypass valve (F8)
  The stop must be fed back

**Note**

The stop is marked by a blue (−) symbol

<table>
<thead>
<tr>
<th>Exhaust gas bypass valve</th>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>

[only TBG 632] Charging pressure regulating valve [waste gate]

- Switch on open charging pressure regulating valve (F8)
- Check setting direction
- Switch off open charging pressure regulating valve (F8)
  The stop must be fed back

**Note**

The stop is marked by a blue (−) symbol

<table>
<thead>
<tr>
<th>Charging pressure control valve</th>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>

Compressor bypass

- Switch on open compressor bypass valve (F8)
- Check setting direction
- Switch off open compressor bypass valve (F8)
  The stop must be fed back

**Note**

The stop is marked by a blue (−) symbol

<table>
<thead>
<tr>
<th>Compressor bypass</th>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>

[TBG 632 and KTB] Filling jacket water day tank

- Switch on filling jacket water day tank (F8)
- Check whether the solenoid valve opens and closes.
- Switch off filling jacket water day tank (F8)

<table>
<thead>
<tr>
<th>Filling jacket water day tank</th>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>
[TBG 632 and KTB] Leak test jacket water day tank

- Switch on leak test jacket water day tank (F8)
  ~ red flash
  Leak test unsuccessful - find error.
- green tick
  Leak test successful

Leak test jacket water day tank

ok | nok
---|---

[AKR] Anti-knocking governor

- Switch on anti-knocking governor (F8)
- Wait 30 seconds
- Switch off anti-knocking governor (F8)
- green tick disappears (after 30 seconds)
  Anti-knocking governor is not OK
- green tick after 30 seconds
  Anti-knocking tick is OK

Filling jacket water day tank

ok | nok
---|---

Go to the "Auxiliary units 2" (F6) mask for the following tests

Reset emergency off module

- Switch on reset emergency off module (F10)
  green LED relay -K136 lights up briefly
- »Safety chain« flashes (title bar mask) - emergency off module not reset - trouble-shooting
  »Safety chain« is not displayed (title bar mask)
  Emergency off module reset

Emergency off module

ok | nok
---|---

Bypass differential pressure monitor

- Switch on bypass differential pressure monitor (F8)
- Check function
- Switch off bypass differential pressure monitor (F8)
  a after 30 seconds (green tick in front)
    Bypass differential pressure monitor not successful
  a green tick
    Bypass differential pressure monitor successful

<table>
<thead>
<tr>
<th>Bypass differential pressure monitor</th>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>

Request circuit breaker

- Switch on request circuit breaker (F8)
- Check whether the request is available at the synchronising unit
- Switch off request circuit breaker (F8)

**Note**

The request is only output by the TEM-Evo system if the safety chain is not faulty.

<table>
<thead>
<tr>
<th>Request circuit breaker</th>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>

[RL] Switch on compartment ventilator flaps

- Switch on compartment ventilator flaps (F8)
- Check whether the compartment ventilator flaps open
- Switch off compartment ventilator flaps (F8)

<table>
<thead>
<tr>
<th>compartment ventilator flaps</th>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>

[RL] Compartment ventilation graduated switching

- Switch on compartment ventilation step 1, 2 (F8)
- Check whether the compartment ventilation switches to the selected step
- Switch off compartment ventilation step 1, 2 (F8)

<table>
<thead>
<tr>
<th>Compartment ventilation step 1, 2</th>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>
[RL] Compartment ventilation frequency controlled

- Switch on the compartment ventilation »warmer« (F8)
- Check function
- Switch off the compartment ventilation »warmer« (F8)

[GKS] Mixture table cooler graduated switching

- Switch on mixture table cooler step 2, 3 and 4 (F8)
- Check whether the fans on the table cooler switch to the selected step
- Switch off mixture table cooler step 2, 3 and 4 (F8)

[GKS] Mixture table cooler frequency controlled

- Switch on the mixture table cooler »warmer« (F8)
- Check function
- Switch off the mixture table cooler »warmer« (F8)

- Switch on the mixture table cooler »colder« (F8)
- Check function
- Switch off the mixture table cooler »colder« (F8)

[ECS] Emergency table cooler graduated switching

- Switch on emergency table cooler step 2, 3 and 4 (F8)
- Check whether the fans on the table cooler switch to the respective selected step
- Switch off emergency table cooler step 2, 3 and 4 (F8)
### [ECS] Emergency table cooler frequency controlled

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch on the emergency table cooler »warmer« (F8)</td>
<td>Check function</td>
</tr>
<tr>
<td>Switch off the emergency table cooler »warmer« (F8)</td>
<td></td>
</tr>
<tr>
<td>Switch on the emergency table cooler »colder« (F8)</td>
<td>Check function</td>
</tr>
<tr>
<td>Switch off the emergency table cooler »colder« (F8)</td>
<td></td>
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</tbody>
</table>

**Emergency table cooler frequency controlled**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>ok</strong></td>
<td><strong>nok</strong></td>
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</tbody>
</table>

### [AVW] Suction intake air pre-heating

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<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Switch on the suction intake air pre-heating »warmer« (F8)</td>
<td>Check function</td>
</tr>
<tr>
<td>Switch off the suction intake air pre-heating »warmer« (F8)</td>
<td></td>
</tr>
</tbody>
</table>

**Note**

- The actuating valve for the flow must be set in »open« direction.

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<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch on the suction intake air pre-heating »colder« (F8)</td>
<td>Check function</td>
</tr>
<tr>
<td>Switch off the suction intake air pre-heating »colder« (F8)</td>
<td></td>
</tr>
</tbody>
</table>

**Note**

- The actuating valve for the flow must be set in »closed« direction.

**Note**

- The »warm« stop is marked by a blue (+) symbol
- The »cold« stop is marked by a blue (−) symbol
- »Intermediate position« is marked by a blue (↔) symbol

**Suction intake air pre-heating**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ok</strong></td>
<td><strong>nok</strong></td>
</tr>
</tbody>
</table>

### [GKNK] Pump mixture emergency cooling circuit

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<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Switch on the mixture emergency cooling circuit pump (F8)</td>
<td>Check function</td>
</tr>
<tr>
<td>Switch off the mixture emergency cooling circuit pump (F8)</td>
<td></td>
</tr>
</tbody>
</table>

**Mixture emergency cooling circuit**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ok</strong></td>
<td><strong>nok</strong></td>
</tr>
</tbody>
</table>
**[GKNK frequency controlled] Mixture emergency cooler**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Switch on the mixture emergency cooler »warmer« (F8)</td>
</tr>
<tr>
<td>2.</td>
<td>Check function</td>
</tr>
<tr>
<td>3.</td>
<td>Switch off the mixture emergency cooler »warmer« (F8)</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Switch on the mixture emergency cooler »colder« (F8)</td>
</tr>
<tr>
<td>2.</td>
<td>Check function</td>
</tr>
<tr>
<td>3.</td>
<td>Switch off the mixture emergency cooler »colder« (F8)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mixture emergency cooler</th>
<th>ok</th>
<th>nok</th>
</tr>
</thead>
</table>

Cleaning the engine

Auxiliary material
- Cleaning agent
- Drain plugs, covers
- Compressed air

References
- Chapter 4, Aids

General information

Danger of injury!
Only work with the engine at a standstill.
Secure the engine against starting.

Danger of intoxication!
Provided adequate ventilation!
Suck off fumes, do not inhale!

Risk of injury!
Wear protective glasses and gloves!

Preparation

- Switch off the engine and wait for it to cool down.
- Select cleaning agents: see chapter 4, Auxiliary materials.
- Disconnect the battery.
- Remove protective covers.
- Remove heat shields from the exhaust pipes.
- Seal engine openings (e.g. air inlet) or fit water-tight covers.
- Cover electrical and electronic components (e.g. three-phase current generators, starters) so that they are water-tight.

If the engine is partially dismantled, housing openings must be sealed or fitted with water-tight covers.
Cleaning

High pressure cleaning systems may **not** be used:

- Sensitive components (e.g. filters, sensors, rubber bushes, sealing rings, cables) could be damaged.
- Joints and bearings coated with lubricant or grease filled.

  - Spray engine with cleaning agent.
  - Observe exposure time according to manufacturer instructions.
  - Spray or wash down engine with a powerful water jet.

Repeat if the engine is still not clean enough.

Removed protective covers and heat protection panels must be cleaned separately.

Finishing work

**Protective covers and heat protection panels must be dried before replacing. Otherwise there is a danger of fire due to formation of gas or deflagration inside the housing covers and panels.**

- Blow out accumulated water with compressed air.
- Remove covers from electrical and electronic components.
- Remove covers and seals from engine openings.
- Dry and install the exhaust pipe heat shields.
- Dry and install the protective covers.
- Connect the battery.
Checking and adjusting inlet and outlet valve clearance

Tools
- Commercially available tools
- Feeler gauge
- Spark-plug wrench
- Torque wrench

Spare parts
- Sealing rings
- poss. shaped gasket for cylinder head cover

References
- B 4-6-1 Installing, removing and actuating engine turning gear

Technical data

<table>
<thead>
<tr>
<th>Test and setting values</th>
<th>Valve shaft / valve bridge</th>
<th>0.05 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve clearance compensation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valve clearance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas group 1 - 50Hz</td>
<td>Inlet</td>
<td>0.3 mm</td>
</tr>
<tr>
<td></td>
<td>Outlet</td>
<td>0.7 mm</td>
</tr>
<tr>
<td>Gas group 2 - 50Hz</td>
<td>Inlet</td>
<td>0.3 mm</td>
</tr>
<tr>
<td></td>
<td>Outlet</td>
<td>0.9 mm</td>
</tr>
<tr>
<td>Gas group 1 - 60Hz</td>
<td>Inlet</td>
<td>0.3 mm</td>
</tr>
<tr>
<td></td>
<td>Outlet</td>
<td>0.9 mm</td>
</tr>
<tr>
<td>Gas group 2 - 60Hz</td>
<td>Inlet</td>
<td>0.3 mm</td>
</tr>
<tr>
<td></td>
<td>Outlet</td>
<td>1.1 mm</td>
</tr>
</tbody>
</table>

| Tightening specifications       |                             |         |
| Valve bridge lock nut           | M10x1                       | 40 Nm   |
| Lock nut on rocker arm          | M12x1.5                     | 45 Nm   |
| Cylinder head hood on cylinder head | M8x55 / 85               | 25 Nm   |
General information

Inlet and outlet valves will only form a seal when closed if the specified clearance is available in the valve drive between the camshaft and the valve shaft.

If the valve clearance is too small the valves are only closed briefly or not at all.

This results in a drop in performance for to the subsequent compression loss.

The valve seat and valve head may burn due to overheating. There is also a danger of an engine fire due to flashover in the exhaust or suction intake channel.

If the valve clearance is too great, the valves open later and close earlier.

Because the valves are only fully open briefly, the filling level of the engine drops. Drop in performance is the result.

This also causes considerable wear in the valve control.

Exact setting and observation of the valve clearance prolongs the life and increases the operational reliability of the engine.

A large valve clearance determined in the test is due to wear in the valve drive.

Depending on the difference between the actual value and the reference value, the valve clearance curve of the respective cylinder must be monitored and the cause investigated immediately.

The actual values must be noted in the “Valve clearance actual values table”. A copy of the table is enclosed.

Test and setting sequence.

For the valve setting the inlet and outlet valve of the cylinder to be set must be completely closed, i.e. the valve drive must be on the base circle of the cam. This is guaranteed when the cylinder firing 360° KW before the cylinder to be set is in valve overlap, i.e. the outlet valve closes whilst the inlet valve opens.

The setting is made according to the order of ignition, starting with cylinder A1. In the figure below the ignition order, ignition spacings in degrees of crankshaft and the overlap cylinder assigned to every firing cylinder are specified. To determine the right position of the cylinder to be set the assigned overlap cylinder is observed during slow turning. It must be turned until the valves are just overlapping. The whole overlap range of the overlap cylinder is suitable for the valve setting of the firing cylinder.

The whole valve setting can be made with 2 revolutions of the crankshaft (Step 1 and Step 2).

In the schematic engine figure below the position of the firing cylinders and the overlapping cylinders for the first and second crankshaft revolution are shown. The figure only shows the position, the order is determined by the firing order.
12 cylinder engine

Firing angle offset

<table>
<thead>
<tr>
<th>Ignition TDC</th>
<th>A1</th>
<th>B2</th>
<th>A5</th>
<th>B4</th>
<th>A3</th>
<th>B1</th>
<th>A6</th>
<th>B5</th>
<th>A2</th>
<th>B3</th>
<th>A4</th>
<th>B6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overlap</td>
<td>A6</td>
<td>B5</td>
<td>A2</td>
<td>B3</td>
<td>A4</td>
<td>B6</td>
<td>A1</td>
<td>B2</td>
<td>A5</td>
<td>B4</td>
<td>A3</td>
<td>B1</td>
</tr>
</tbody>
</table>

T 1  Test and setting sequence V12.
### 16 cylinder engine

#### Firing angle offset

<table>
<thead>
<tr>
<th>Ignition TDC</th>
<th>A1</th>
<th>B2</th>
<th>A6</th>
<th>B5</th>
<th>A8</th>
<th>B7</th>
<th>A3</th>
<th>A7</th>
<th>B6</th>
<th>A4</th>
<th>B8</th>
<th>A2</th>
<th>B3</th>
<th>A5</th>
<th>B1</th>
<th>B4</th>
</tr>
</thead>
</table>

| Overlap | B6 | A4 | B8 | A2 | B3 | A5 | B1 | B4 | A1 | B2 | A6 | B5 | A8 | B7 | A3 | A7 |

---

T 2  Test and setting sequence V16
20 cylinder engine

Firing angle offset

Ig. TDC  A1  B7  A2  B5  A4  B3  A6  B1  A8  B2  A10  B4  A9  B6  A7  B8  A5  B10  A3  B9

Overl.  A10  B4  A9  B6  A7  B8  A5  B10  A3  B9  A1  B7  A2  B5  A4  B3  A6  B1  A8  B2

Step 1

Step 2

T 3  Test and setting order V20
Remove cylinder head cover.
- Pull off the spark plug connector.
- Unscrew screws and remove the cylinder head cover with gasket.

Only check and set the valve clearance compensation and valve clearance when the engine is cold.
Follow the correct test and setting sequence.

Install engine turning device, see job card B 4-6-1.
Turn the engine in direction of rotation until cylinder A1 is in the ignition TDC range.

Checking clearance compensation

- Push feeler gauges between the valve shaft and the valve bridge (arrows).
- Press the toggle lever onto the valve bridge with your finger.
  - The feeler gauges must be removable with little resistance. The valve clearance compensation must be set if not.
Setting clearance compensation

1. Loosen nut 1.
2. Push feeler gauges between the valve shaft and the valve bridge (arrows).
3. Press the toggle lever onto the valve bridge with your finger.
4. Set the valve clearance compensation with screw 2.
   - The feeler gauges must be removable with little resistance when pressing down the toggle lever at the same time.
5. Tighten nut 1.
   - Hold against screw 2.
6. Check the valve clearance compensation again with the feeler gauge.
   - Reset the valve clearance compensation in case of deviations.
Checking valve clearance

- Push feeler gauge between the valve bridge and the toggle lever (arrow).
  - The feeler gauge must be insertable and removable with little resistance. The valve clearance must be set if not.

Setting valve clearance

- Loosen nut 1.
- Push feeler gauge between the valve bridge and the toggle lever (arrow).
- Set the valve clearance with screw 2.
  - The feeler gauge must be insertable and removable with little resistance.
- Tighten nut 1.
  - Hold against screw 2.
- Check the valve clearance again with the feeler gauge.
- Reset the valve clearance in case of deviations.
- Turn the engine in rotation direction until the next cylinder is in overlap.
- Repeat the test and setting procedure until the valve clearance is set on all cylinders.
- Remove engine turning device, see job card B 4-6-1.

Attach cylinder head cover.
- Check the gasket of the cylinder head hood and renew if necessary.
- Fit the cylinder head covers with gasket and tighten the screws.
- Plug spark plug connector.
Valve clearance actual values table

The total adjustment time can be determined by the actual value data. This can enable predictions to be made about the previous wear in the valve drive.

<table>
<thead>
<tr>
<th>Date</th>
<th>Cylinder</th>
<th>Valve</th>
<th>Cylinder</th>
<th>Valve</th>
<th>Date</th>
<th>Cylinder</th>
<th>Valve</th>
<th>Cylinder</th>
<th>Valve</th>
<th>Date</th>
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</tbody>
</table>

T 4 Table of actual valve clearance values (over all series)
Checking the crankcase pressure

References
- B 3-1-6 Renewing crankcase bleed valve
- B 3-1-9 Maintenance of crankcase vent (Racor)

General information

The crankcase pressure is checked by the TEM system with the engine running. It depends on the installation site and height of the engine. The appropriate value must be taken from the commissioning log.

If the specified setpoint is not reached, the crankcase bleed valve must be serviced, see job card B 3-1-9.
Renewing inspection hole cover gasket

Tools
- Commercially available tools
- Scraper

Spare parts
- Gasket for inspection hole cover

Technical data

<table>
<thead>
<tr>
<th>Tightening specifications</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hatch cover on the crankcase</td>
<td>25 Nm</td>
</tr>
</tbody>
</table>

General information

⚠️
Danger of injury!
Only work with the engine at a standstill.
Secure the engine against starting.

Removing/installing the inspection hole cover

A 1 Inspektion hole cover

- Remove line 1 if necessary.
- Unscrew screws 2.
- Remove inspection hole cover 3 with gasket.
- Clean the sealing surface.
- Mount inspection hole cover 3 with gasket.
- Tighten screws 2.
Mount line 1 if necessary.
Renewing crankcase bleed valve

General information
The number of crankcase bleed valves installed depends on the engine. The removal and installation example describes one crankcase bleed valve. For multiple crankcase bleed valves proceed appropriately.

Danger of injury!
Only work with the engine at a standstill.
Secure the engine against starting.

Removing crankcase bleed valve

- Loosen hose clips 1 and remove bleed hose 2.
- Loosen tightening clamp 3.
- Remove crankcase bleed valve 4 from above.
Installing crankcase bleed valve

- Insert crankcase bleed valve 4 from above.

Note installation position of the bleed connection.

- Tighten tightening clamp 3.
- Push on bleed hose 2 and tighten hose clips 1.

After renewing the crankcase bleed valve the crankcase pressure should be checked, see job card B-3-1-2.
Maintenance of crankcase vent (Racor)

Tools
- Commercially available tools

Auxiliary material
- Diesel fuel

Spare parts
- Filter element (with O-seals)
- Base insert, if required

General information
The crankcase vent must be maintained when
- the maintenance intervals have been reached,
- the red indicator button is fully visible in the maintenance indicator.

Cleaning the filter elements is not permissible.

Observe the regulations for disposal!
Collect operating materials and dispose of properly according to national regulations.

Dismantling crankcase vent

1. Crankcase vent Racor

Open locks 2 and remove the container 4 carefully from the bottom.
- There may be lube oil in the container.

Pull filter element 5 from upper section of filter 3.
Assembling crankcase vent

- Remove base insert 6 from the container 4.

If a base insert is not fitted, this must be retrofitted.

- Clean components with diesel fuel, check and renew if necessary.

A 2 Filter (cross-sectional diagram)

- If present, check oil outlet and non-return valve for free passage.
- Check the diaphragm of the non-return valve for damage.
- Check all parts of the crankcase vent (e.g. hoses, rubber parts of the connecting and discharge lines) visually, renew if necessary.
- Insert new O-seal 7 in upper section of filter 3.
- Insert new filter element 5 with new O-seal 8 in filter top section 3.
- Install base insert 6 in container 4.

Note installation position.

- Wet the new filter element with lube oil.
- Position container 4 and close locks 2.
Check drain hose

- Check the condition and laying of the flexible drain hose 9 and correct if necessary.

> The drain hose must be laid without tension and free from chafing.
> Make sure it is far enough away from hot parts.

Resetting the maintenance indicator

- Unscrew cap of maintenance indicator 1.
- Push in the red indicator button.
- Mount and tighten cap.

Instructions for putting (returning) the system into operation

> Depending on the design, back absorption through the oil drainage pipe can be prevented by a return valve, a siphon trap or an oil outlet pipe that ends below the oil level (submerged pipe). Before operating for the first time, the siphon trap must be filled with oil. Where there are separate collectors with submerged pipes, a check must be made to ensure that the pipe is actually below the oil level. If necessary, top up the oil in the collector until there is a sufficient amount.
Maintenance crankcase bleeding (Dynapure AS 200 / AS 500 model)

Tools
- Commercially available tools
- Special tools available from:
  - Umwelt Technik 99 AG, Sunnehof, CH-8493 Saland, Switzerland
- Assembly tool, order no. 909-190500
- Disassembly tool, order no. 909-190501
- Vibration measuring instrument for imbalance check

Spare parts
- Filter insert
- Basic filter
- Filter disk
- Aluminum grille
- Cover seal
- Engine gaskets

Technical data

<table>
<thead>
<tr>
<th>Test and setting values</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Imbalance of the drum maximum at 50 Hz, 2,810 rpm</td>
<td>7.0 mm/s</td>
</tr>
<tr>
<td>Imbalance of the drum maximum at 60 Hz, 3,340 rpm</td>
<td>8.0 mm/s</td>
</tr>
</tbody>
</table>

General information

The sucked in air/oil mixture is spun and accelerated by a rotating drum so strongly that the micro-fine oil mist particles form small droplets and are separated from the air in the rotating filter drum by the sieving and inertia effect.

The oil recycled in such a way flows back through the outlet in the machine room or oil tank.

Danger of injury!
Only work with the engine at a standstill.
Secure the engine against starting.

Risk of injury!
Disconnect the electric motor from the power supply when working on the crankcase bleeding.
Remove filter insert and basic filter

- Loosen clamping ring 1.
- Remove housing cover 2 with gasket 3.

---

Danger of imbalance!

Mark the interface of the filter insert 4 in the drum 5

- Remove filter insert.
- Check basic filter 6 for soiling and renew if necessary.

The drum 5 may become imbalanced when the basic filter 6 is changed.
Balancing of the drum is absolutely essential.

Install filter insert and basic filter

- Insert filter insert 4.
  - Pay attention to the mark.
- Fit housing cover 2 with gasket 3.
- Close clamping ring 1.
- Check crankcase bleeding for leaks and perfect functioning.
Remove filter disk with aluminum grille.

- Loosen clamping ring 1.
- Remove housing cover 2 with gasket 3.
- Unscrew screws 7 and remove turbowheel 8.
- Pull drum 5 off the electric motor shaft with the disassembly tool.
- Unscrew screws 9 and remove retaining drum 10.
- Remove filter disk 11 and aluminum grille 12.
- Check wire grille 13, renew if necessary.

Install filter disk with aluminum grille.

- Insert wire grille 13, aluminum grille 12, filter disk 11 and retaining drum 10 and tighten screws 9.
- Push drum 5 up to the stop on the electric motor shaft with the assembly tool.
- Fit on turbo wheel 8 and tighten screws 7.
- Fit housing cover 2 with gasket 3.
- Close clamping ring 1.
- Check crankcase bleeding for leaks and perfect functioning.
Installing, removing and actuating engine turning gear

Tools
- Commercially available tools
- Engine turning device if necessary

General information

If no engine turning device is available, the engines can be turned with the bar (order number 0216 3939) on the flywheel after removing the protective covers.

Always turn the engine in the direction of rotation to avoid damage.

Danger of injury!
Only work with the engine at a standstill.
Secure the engine against starting.

Using the engine turning device

The turning device 1 is spring-loaded for safety reasons.
To turn the engine, press in the hexagon with toothed wheel and turn.
A 1  Installation example engine turning device

A 2  Installation example engine turning device

A 3  Installation example engine turning device
Checking the speed governor linkage

Tools
- Commercially available tools

Auxiliary material
- Lubricant, see chapter 4, Aids

General information

Danger of injury!
Only work with the engine at a standstill.
Secure the engine against starting.

Check speed governor linkage, V12 and V16 engines

Press the lever 1 to full load stop.

An even resistance must be felt when pressing, lubricate the joints and repeat the test if necessary.

Move the connecting rod 2 in the direction of the arrow and checked the joint heads for clearance.

If the uneven resistance can still be felt, this indicates a defect in the actuator or the throttle valve.

If the joint heads are not free of clearance, they can be renewed.
Please contact your DEUTZ Power Systems Service if this is the case.
Check speed governor linkage, V20 engines

The V20 engine is equipped with two actuators the output shafts of which act directly on the rotary disk valves.

An even resistance must be tangible when turning.

If the uneven resistance can still be felt, this indicates a defect in the actuator or the rotary disk valve.

Please contact your DEUTZ Power Systems Service if this is the case.
Renewing the suction air intake filter

Tools
- Commercially available tools

Spare parts
- Suction air intake filter

General information

Danger of injury!
Only work with the engine at a standstill.
Secure the engine against starting.

Renew the suction air intake filters when
- the maintenance interval has been reached,
- the maintenance indicator on the air filter displays this even after the engine is switched off.

Temporary appearance of the display in the maintenance indicator during operation of the engines does not indicate a soiled air filter.

Removing filter insert, V12 and V16 engines

Removing filter insert

Unscrew wing nut 1.
Remove cover from the air filter housing.
Unscrew nut 2.
Remove suction air intake filter.
Clean the inside of the air filter housing with a cloth.

Fitting filter insert

Insert new suction air intake filter.
Tighten nut 2.
Mount cover on air filter housing.
Tighten wing nut 1.
Removing and installing the filter insert, V20 engines

Removing filter insert

Open catches 3 and lift up cover 4 of the air filter housing.
Remove suction air intake filter 5.
Clean the inside of the air filter housing with a cloth.

Fitting filter insert

Insert new suction air intake filter and push together (arrow).

Note the flow direction of the suction air intake filter.

Close the cover of the air filter housing and lock catches 3.
Checking the gas pressure of the gas regulating line

References
- B 7-21-1 Renewing the gas filter insert

Technical data

<table>
<thead>
<tr>
<th>Test and setting values</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas pressure of the gas control line*</td>
<td>20 - 100 mbar</td>
</tr>
<tr>
<td>* may deviate from the setpoint depending on the system and gas type</td>
<td></td>
</tr>
</tbody>
</table>

General information

The gas pressure in the gas regulator line can be read from the pressure gauge. This is supplied by the pre-pressure regulator line and depends on the gas type and quality.

Checking the gas pressure in the gas regulator line

Press the button 1 and read the gas pressure.

If the prescribed value is not reached, the gas filter insert must be renewed, see job card B 7-21-1.
Renewing the gas filter insert

Tools
- Commercially available tools

Spare parts
- Gaskets
- Filter insert

References
- B 7-20-1 Checking the gas pressure of the gas regulating line

Technical data

<table>
<thead>
<tr>
<th>Tightening specifications</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover for gas filter housing</td>
<td>8 Nm</td>
</tr>
</tbody>
</table>

General information

Caution, explosion hazard!

The ventilation system should be switched on before carrying out any work on the gas line.

Smoking and the use of naked flames is prohibited.

Removing the gas filter insert

1. Close the ballcock (arrow) to shut off the gas intake.
Loosen nuts 1 and remove the cover from the gas filter housing 2.

Remove filter insert 3 from cover 4.

Clean cover and gas filter housing.

Installing the gas filter insert

Renew seal 5.

Mount new filter insert 3 on cover 4.
Note the position of the filter insert on the cover (arrow).

- Place cover with filter insert 6 into gas filter housing.

Note the position of the filter insert on the gas filter housing (arrows).

- Turn on nuts and tighten diagonally.
- Open ballcock to restore gas supply.
- Check the cover and gas filter housing for leaks.
  - To do this, spray the cover with leak search spray or soap suds and watch for formation of bubbles.
Lube oil sampling

**Tools**
- Commercially available tools
- Lube oil sample container

**Auxiliary material**
- Lube oil according to operating media specifications, chapter 4, Aids

**General information**

Trouble-free operation and resistance to undue wear depend to a great extent on the lube oil condition. Checking the lube oil is therefore one of the most important maintenance jobs.

An analysis should be carried out by the lube oil manufacturer because a detailed examination is only possible in the laboratory. If no other possibilities are available, DEUTZ Power Systems will carry out the analysis for reimbursement of expenses.

The necessary data for lube oil analysis are:

- Lube oil brand and type
- Reading shown on the operating hours counter
- Lube oil consumption since last sample.

The lube oil must be renewed if the result of the analysis is negative.

The lube oil sample must be taken from the lube oil circuit while the engine is running and at operating temperature.

---

**Risk of scalding!**

When working with hot operating materials.

---

**Lube oil tap**

A 1 Position of the lube oil tapping valve
Start engine and run up to operating temperature (oil temperature >80°C).

Press coupling piece 2 with hose pipe 3 into the lube oil tap valve 1 until it snaps in.

**Danger of burns !**

*After snap-in of the coupling, lube oil emerges immediately at about 4 bar and 100°C.*

Drain the required amount of lube oil into the lube oil sample container.

Release the lube oil tap valve 1 and pull off the coupling 2 with hose pipe 3.
Changing lube oil

Tools
- Commercially available tools

Spare parts
- Lube oil according to operating media specifications

References
- Chapter 4, Operating media
- Operating Manual TEM System
- Technical Circular TC 0199-99-2105

General information

The lube oil change is performed in connection with the TEM System. Depending on the system version, there is an option for "remote oil change" which enables control of two solenoid valves for automatic switching between the pre-lubrication and pumping modes. Oil can then be changed via modem.

The lube oil change should be performed on the warm engine (lube oil temperature at least 80°C).

Danger of injury!
Only work with the engine at a standstill.
Secure the engine against starting.

Risk of scalding!
When working with hot operating materials.

Observe the regulations for disposal!
Collect operating materials and dispose of properly according to national regulations.
Switch the three-way valve 1 on the pre-lubrication pump so that the used oil can be pumped out.

In the TEM system
- Select the menu item "Service menu"
- Select the "Oil change" menu item.
- Select the "Pump out oil" menu item - (pumping starts and ends after the time programmed in TEM).

If the oil pan is not empty after the programmed time (pre-lubrication pump switches off), the pumping process must be continued with the "Pump out oil" menu item.

If the oil pan is empty before the programmed time (pre-lubrication pump sucks in air), the pre-lubrication pump can be shut off with the "Oil pan empty" menu item.

Switch the three-way valve 1 on the pre-lubrication pump back to engine mode.

The lube oil filter cartridges should always be renewed when changing the lube oil, see job card B 8-10-4.
Pour in lube oil

- In the TEM system
  - Select the "Refill" menu item - (fresh oil filling begins).

The filling process is controlled automatically by the TEM system.
On reaching the filling volume the filling process is ended automatically by the lube oil level switch.

- At the end of fresh oil filling
  - Select the "Pre-lubricate" menu item - (pre-lubrication process begins).

The pre-lube process lasts about 20 minutes, the engine cannot be started beforehand.
Overhaul pressure limiting valve of the pre-lube pump

Tools
- Commercially available tools
- Torque wrench
- Depth gauge

Spare parts
- Sealing rings (DIN 7603-A 21x26-Cu)
- Poss. control piston
- Poss. compression spring

Technical data

<table>
<thead>
<tr>
<th>Tightening specifications</th>
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</thead>
<tbody>
<tr>
<td>Pressure limiting valve pre-lube pump</td>
<td>Cap nut</td>
</tr>
</tbody>
</table>

General information

Danger of injury!

Only work with the engine at a standstill.

Secure the engine against starting.

Dirt particles may collect on the control piston of the pre-lube pump's pressure limiting valve. The control piston is then no longer fully in contact with the piston seat and leaks. Some of the pumped engine oil is taken off directly due to this leak. The oil pressure required for pre-lurication is then no longer achieved.
Overhaul pressure limiting valve of the pre-lube pump

Dismantle the pressure limiting valve

A 1  84923-0 cap nut

1. Unscrew the cap nut.

A 2  84929-0 Measure setting dimension

2. Determine dimension X with caliper gauge and note for later installation.
   - measured from the top of the setting screw to the lock nut.
Loosen lock nut and unscrew setting screw.

Remove compression spring and control piston.
Clean the seat on the control piston (arrows) and in the housing of the pressure control valve.

Check components (compression spring, control piston) for wear, renew if necessary.

Assemble pressure limiting valve

Insert control piston and compression spring.
Renew sealing ring and screw in setting screw with lock nut.
A 5  84929-0 Measure setting dimension

- Turn in setting screw to dimension X.

The dimension X determined when removing must be retained otherwise the set oil pressure will be changed.

A 6  84930-0 Set oil pressure

- Tighten lock nut.

Hold at the setting screw.

After tightening the lock nut, check the dimension X again with the depth measuring appliance, loosen the lock nut again if necessary and reset the dimension X.

- Renew sealing ring and tighten cap nut.
Renewing lube oil filter cartridge

Tools
- Commercially available tools
- Strip key

Auxiliary material
- Container for waste oil

Spare parts
- Lube oil according to operating media specifications
- Lube oil filter cartridge

References
- Chapter 4, Operating media
- Operation manual TEM System

Technical data

<table>
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<tr>
<th>Lube oil system</th>
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<tbody>
<tr>
<td>Lube oil filter on console</td>
</tr>
</tbody>
</table>

General information

Danger of injury!
Only work with the engine at a standstill.
Secure the engine against starting.

Risk of scalding!
When working with hot operating materials.

Observe the regulations for disposal!
Collect operating materials and dispose of properly according to national regulations.
Removing the lube oil filter cartridge

A 1 Remove the lube oil filter

- Unscrew and remove the lube oil filter cartridge with commercially available strip key.
- Collect the remaining oil which runs out.

When unscrewing the lube oil cartridge fine plastic chips are produced when the catch is released. These chips do not get into the lube oil system and pose no danger.

Install the lube oil filter cartridge

A 2 Install the lube oil filter

- Clean the seal surface of the filter block.
- Wet the gasket of the new lube oil filter cartridge slightly with lube oil.
- Fit lube oil filter cartridge to filter block and tighten.
A 3  Tighten the lube oil filter

  Check lube oil filter cartridge for leaks.
  - build up oil pressure with pre-lubrication pump to do so.
Emptying and filling the cooling system

Tools
- Commercially available tools

Auxiliary material
- Collecting vessel for coolant

Spare parts
- Gaskets

References
- Chapter 4, Operating media
- B 9-1-1 Checking percentage of corrosion protection agent or antifreeze in coolant

General information

For various work, e.g. on the cylinder head, crankcase, heat exchanger and pipes, the coolant must be partially or totally drained.

If no antifreeze is added, the coolant must be drained totally from the engine and the add-on parts when shutting down the engine for a longer time and in case of frost.

Danger of burns!
Corrosion protection is not a fire hazard in the hardened state.

Danger of injury!
Only work with the engine at a standstill.
Secure the engine against starting.

Observe the regulations for disposal!
Collect operating materials and dispose of properly according to national regulations.
Emptying the cooling system

1. Position the collecting vessel in the appropriate place.
2. Shut off water pipes from and to the engine.
3. Unscrew screws.
4. Drain the coolant.
5. After total drainage of the coolant, re-tighten the drain screws.
6. Use new gaskets and sealing rings.
Filling the cooling system

Use the required quality of coolant as described in chapter 4, Operating materials.
Use the right percentage of corrosion protection agent or antifreeze following job card B 9-1-1.

- Fill the engine cooling system with the prepared coolant.
  - The filled cooling system bleeds automatically.
  - When refilling, it is necessary to bleed the coolant pipe at the highest point.
  - Loosen the hollow screws until the coolant emerges without bubbles.
- Open water pipes from and to the engine.
- Check pipes, connections and the engine for leaks after filling and repair if necessary.
- Check the coolant level again, top up if necessary.
Checking percentage of corrosion protection agent or antifreeze in coolant

Tools
- Commercially available tools
- Measuring instrument (from test case order no. 12158292)

Spare parts
- Corrosion protection agent or antifreeze if necessary

References
- Chapter 4, Operating media

General information

Corrosion protection agent is added to the coolant to protect the coolant areas from corrosion. However, this protection is only given when a certain minimum content of corrosion protection agent is not exceeded. If there is more corrosion protection agent than necessary in the coolant, the cooling effect is reduced.

If an antifreeze is added to the coolant, this should also have corrosion protection properties. A corrosion protection agent does not need to be added in this case. The antifreeze percentage must be dosed accordingly for the above mentioned reasons.

If the cooling system needs refilling, the percentage of antifreeze or corrosion protection agent in the coolant must be measured. Then the coolant should be corrected according to the following description.

Danger of burns!

Corrosion protection is not a fire hazard in the hardened state.

Checking the percentage of corrosion protection agent or antifreeze

- Remove the coolant sample from the cooler, compensation tank or draining tap.
- Check the percentage additive with the measuring instrument, see TR 0199-99-2091.
Correct the corrosion protection agent and antifreeze percentage

\[ A = B \times \frac{(C - D)}{100} \]

- Drain necessary volume of coolant.
- Mix the drained coolant with the volume of additive to be refilled well.
- Fill in mixture.

\[ A = (1 - \frac{B}{C}) \times D \]

- Drain necessary volume of coolant.
- Fill up cooling system with pure water.

\[ A = \text{amount of additionally required additive} \]
\[ B = \text{Total filling volume} \]
\[ C = \text{Setpoint} \]
\[ D = \text{Measured value} \]

\[ A = \text{coolant to be drained} \]
\[ B = \text{Setpoint} \]
\[ C = \text{Measured value} \]
\[ D = \text{Total filling volume} \]

Note water quality - see chapter 4, Operating materials

Bleed the cooling system.
**Drain water from and fill air bottle (starter air tank)**

**Tools**
- Commercially available tools

1. Open drain valve 1 slowly until water emerges. If no water emerges, close the drain valve again.
2. Fill up the air bottle to 30 bar every time before switching off the engine.

Do not open the drain cock too far because water is displaced if the flow speed is too great and only air escapes. A rising pipe 2 is installed on vertically erected air bottles. The air pressure in the air bottle presses the water through out through the rising pipe into the open. If no water emerges for several maintenance periods, have the air bottle checked.

![Diagram](image-url)
Servicing the battery

Tools
- Commercially available tools
- Acid tester (order no. 12157944)

Auxiliary material
- Distilled water
- Acid protection grease
- Cloth

Technical data

<table>
<thead>
<tr>
<th>Test and setting values</th>
<th>Battery acid density</th>
<th>Normal</th>
<th>Tropical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charge status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>well charged</td>
<td>1.28 kg/l</td>
<td>1.23 kg/l</td>
<td></td>
</tr>
<tr>
<td>semi-charged (re-charge)</td>
<td>1.20 kg/l</td>
<td>1.12 kg/l</td>
<td></td>
</tr>
<tr>
<td>discharged (recharge, renew if necessary)</td>
<td>1.12 kg/l</td>
<td>1.08 kg/l</td>
<td></td>
</tr>
</tbody>
</table>

General information

Caution, explosion hazard!
The gases emitted by the battery are explosive.
Avoid sparks and naked flames.

Danger of burn!
Do not allow battery acid to come into contact with skin or clothing.
Wear protective glasses and clothing.

Danger of short-circuit!
Do not rest tools on the battery.
Cover the battery poles.

Danger of injury!
Only work with the engine at a standstill.
Secure the engine against starting.

Keep battery clean and dry.
Check battery and cable connectors

A 1  Battery poles

- Remove dirty clamps.
- Clean the battery poles and clamps.
- Plug on and tighten clamps.
- Grease clamps with acid-proof grease.
- When reassembling, ensure that clamps make good contact. Tighten clamp bolts hand-tight.

Make sure the clamps have good contact.

Check acid level

A 2  Battery sealing caps

- Unscrew and remove sealing caps 1.
- Visually check the acid level.
  - without control inserts 2: liquid level 10 - 15 mm above top edge of plate.
Check acid density

- with control inserts 2: liquid level up to their floor.

Only use distilled water for refilling.

A 3 Check acid density

Measure the acid density with a commercially available acid tester.

During measurement, temperature should preferably be 20 °C.

If the battery is recharged, all the stoppers must be removed before charging.
Check the acid level after charging and correct if necessary.
Correct the acid density

- if acid density too low:
  \[ A = B \times \frac{(C - D)}{(E - D)} \]

  - Suck amount of acid to be refilled from the battery.
  - Fill determined amount of battery acid into the battery.

- if acid density too high:
  \[ A = B \times \frac{(C - D)}{(C - 1)} \]

  - Suck amount of water to be refilled from the battery.
  - Fill determined amount of water into the battery.

A = Amount of acid to be refilled
B = Cell content
C = Nominal density
D = Acid density in the cell
E = Density of acid to be refilled

A = Amount of water to be refilled
B = Cell content
C = Acid density in the cell
D = Nominal density
Removing and installing spark plugs, checking ignition cable

Tools
- Commercially available tools
- Spark-plug wrench
- Feeler gauge 0.25 mm
- Torque wrench

Auxiliary material
- Compressed air
- Safety goggles

Spare parts
- Sealing rings for spark plugs
- Spark plugs if necessary

Technical data

<table>
<thead>
<tr>
<th>Test and setting values</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Spark plug</td>
<td>0.25 mm</td>
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<table>
<thead>
<tr>
<th>Tightening specifications</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Spark plug on cylinder head</td>
<td>52 Nm</td>
</tr>
</tbody>
</table>

General information

If there is an electrode gap of more than 0.25 mm when testing, the spark plug may be adjusted. As the earth electrodes may only be bent twice, the correction of the electrode gap should be noted in the operating check log.

Danger of injury!
Only work with the engine at a standstill.
Secure the engine against starting.

Mortal danger!
When working on the high voltage ignition system.
Removing the spark plug

- Pull ignition cable 1 from ignition coil 2.
- Pull spark-plug connector 3 off the spark plug.
- Check the spark plug shaft for dirt.

The sealing rings of the spark plug protective pipe must be renewed when oil gets into the spark-plug shaft.

Please contact your service partner if coolant gets into the spark-plug shaft.

- Blow out spark plug shaft with compressed air.

Particles of dirt can cause injury when cleaning with compressed air.

Wear safety glasses and close-fitting clothing.

- Remove spark plug.

Wear safety glasses and close-fitting clothing.
Checking and adjusting the spark plug

- Check electrode gap with feeler gauge.
- Set the electrode gap by slightly bending the earth electrode to the setpoint if necessary.

If the middle electrode is burnt out or soiled, the spark plug must be renewed.
Cleaning the spark plug is not permissible!

Checking the ignition cable

- Visually inspect the ignition cable for damage and renew if necessary.

Installing the spark plug

If the spark plug is renewed, the new spark plug must be checked for damage.
The electrode gap must also be checked and set if necessary.

- Renew the sealing ring of the spark plug.
- Insert and tighten spark plug.
- Plug the ignition cable to the ignition coil.
Service

Sales & Service Index

This Sales & Service Index offers you an overview of the DEUTZ Power Systems branches in your vicinity, including the products for which they are responsible and the range of services provided. Even when no direct product responsibility is mentioned, your local branch will be happy to help you with expert advice. The Index is constantly updated. Please ask your DEUTZ Power Systems service partner for the latest edition.

Order no.: 0312 0807 (CD-ROM)

DEPIC

The DEutz Parts Identification for Customers (DEPIC) offers you spare parts identification individually adapted to your systems. DEPIC enables you to generate an order list almost automatically, making ordering your spare parts more efficient. Order no.: on request (CD-ROM)

Tutorial programs

The degree of availability, reliability and service life of equipment and drive assemblies are determined to a great extent by professional operation and service by qualified and experienced operators and service technicians. The DEUTZ AG Power Systems also offers service-related seminars for DEUTZ Power Systems products to the staff of customers and operators. Apart from the standard seminars, held in our Training Centre in Mannheim, it is also possible to arrange special seminars, either in the Training Centre or at another location requested by the customer. Information about the seminar program will be distributed in a circular. Please ask your DEUTZ Power Systems Service representative.
Engine coolant for DEUTZ medium and large size engines

This 5th Exchange is issued amongst other things because of a

- Revision of the data on water quality
- Introduction of the DEUTZ protective agent for cooling circuit in 20 litre cans
- Updating of product recommendations, Enclosures 1 and 2.

Contents

1 General
2 Water quality
3 Protective agents for cooling circuit
   3.1 Chemical anticorrosion agent
   3.2 Antifreeze agents with corrosion inhibitors
   3.3 Corrosion inhibitors
4 Details on cooling circuit
   4.1 Monitoring of cooling circuit
   4.2 Cleaning of cooling circuit
   4.3 Coolant disposal

Enclosures 1 and 2: Product recommendations for cooling circuit protective agents
Enclosure 3: Disposal of DEUTZ cooling systems protective agent (only in German issue)
1 General

Coolants of liquid-cooled engines must be treated and monitored since damage may sustained by engine otherwise due to

- corrosion
- cavitation
- freezing

2 Water quality

The correct water quality is important for the preparation of the coolant. If no specifications are provided by the manufacturer/supplier, clear and clean water must be used within the following limit values of analysis:

<table>
<thead>
<tr>
<th>Limit values of analysis</th>
<th>min.</th>
<th>max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH value at 20°C</td>
<td>6,5</td>
<td>8,5</td>
</tr>
<tr>
<td>Chloride ion content mg/dm³</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>Sulphate ion content mg/dm³</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>Total hardness °dGH</td>
<td>3</td>
<td>12</td>
</tr>
</tbody>
</table>

*1 Share of carbonate hardness in the overall hardness min. 3°dGH.

For more information on the water quality please consult your local waterworks or use the DEUTZ test kit, Order No. 12130382.

Water treatment is indicated if water qualities differ from the above indicated limit values of analysis.

- **pH value too low**
  Add diluted caustic soda or potash lye and mix.
  Preparation of small sample mixtures is recommended.

- **Total water hardness too high**:
  Mix with softened water °2

- **Total hardness and/or carbonate hardness too low**
  Mix with water of a higher hardness °3

- **Chloride and/or sulphate content too high**
  Mix with softened water °2

°2 Softened water is distilled water, pH-neutral condensate or water treated by ion exchangers.

°3 Water of a higher hardness is available in most cases in form of potable water (town water).

Use the DEUTZ test kit (order No. 12130382) for a determination, if the limit values of analysis of the water to be admixed are unknown.

For safety reasons it is mandatory to carry out another water analysis after water treatment.

Sea water, river water, brackish water or industrial waste water are in no case suitable for the preparation of the coolant since damage may be sustained by the engine.
3 Protective agent for cooling circuit

The coolant is prepared by adding a protective agent to the cooling water as a protection of the cooling circuit. The following additives are commonly used:

- Chemical anticorrosion agent
- Antifreeze agent with corrosion inhibitors
- Corrosion inhibiting oil

The type of additive can be selected according to the following table:

<table>
<thead>
<tr>
<th>Protection against corrosion</th>
<th>Chemical anticorrosion agent</th>
<th>Antifreeze agent with corrosion inhibitors</th>
<th>Corrosion inhibiting oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection against cavitation</td>
<td>satisfactory</td>
<td>satisfactory</td>
<td>good</td>
</tr>
<tr>
<td>Protection against freezing</td>
<td>none</td>
<td>up to –45°C according to mixing ratio</td>
<td>none</td>
</tr>
<tr>
<td>Maintenance requirement</td>
<td>low</td>
<td>low *4</td>
<td>very high</td>
</tr>
<tr>
<td>Operating reliability</td>
<td>good</td>
<td>good</td>
<td>insufficient</td>
</tr>
<tr>
<td>Costs</td>
<td>medium</td>
<td>very high</td>
<td>medium</td>
</tr>
</tbody>
</table>

*4 Only the antifreeze effect is checked normally, to be exchanged every 2 years.

Enclosure 1 lists up some representative products which are recommended by us and which as indicated by the manufacturers/suppliers are suitable for the processing of coolants. Also other equivalent products of other manufacturer/suppliers may be used as an alternative. Suitability of the protective agent for the cooling circuit must be warranted/guaranteed by the manufacturer/supplier. No liability is accepted by us.

The various protective agents for the cooling circuit are described below.

3.1 Chemical anticorrosion agent

Chemical anticorrosion agents are compounds which by way of chemical reaction form a protective film on the metal surfaces. Their advantage compared to corrosion inhibiting oils lies in the ease of application and monitoring.

Liquid additives may be admixed directly in the engine, additives in powder form are to be pre-mixed. The manufacturer’s instructions must be adhered to with regard to the concentration of the chemical anticorrosion agent and subsequent monitoring.

The manufacturer/supplier shall warrant that his additives do not have a detrimental effect on the materials used in the engine (e.g. seals/gaskets).

Be careful with aluminium components in the cooling circuit. Not all chemical anticorrosion agents are suitable in such cases; correct dosing is of particular importance since too low a concentration of the chemical anticorrosion agent will have a damaging effect on the system. Also considered in the list of recommended products (see Enclosure 1) is the suitability of the anticorrosion agent for engines with aluminium components.

Make sure that aluminium components are properly grounded, no additional electric currents may be induced by these aluminium components via defective insulations (single pole sensors and monitoring sensors).
Chemical anticorrosion agents containing silicates may have a negative effect on the service life of the axial-face seals. Such products should only be used for engines which separately mounted coolant pumps equipped with seals which are resistant to these chemical anticorrosion agents.

Filter systems are available as an alternative, capable of filtering out solid particles from the cooling circuit in addition to providing a protection against corrosion. These filters contain a chemical anticorrosion agent in solid form which is gradually dissolved in the cooling water.

Chemical anticorrosion agents and antifreezes as per Section 3.2 are compatible.

Not all chemical anticorrosion agents and antifreeze agents are compatible. Carcinogenic nitrosamines will form when mixing amine based chemical anticorrosion agents with nitrate based antifreeze agents. For compatibility please consult the manufacturer/supplier.

Most of the recommended chemical anticorrosion agents may be mixed with the antifreeze agent from DEUTZ (an antifreeze based on ethylene glycol) without incurring any risk.

### 3.2 Antifreeze agents with corrosion inhibitors

Antifreeze agents are generally used for DEUTZ engines only if ambient temperatures below zero are likely to occur. The antifreeze agent may be added to the chemical anticorrosion agent (manufacturer/supplier to be contacted for compatibility) or may be added to the water as the only protective agent against freezing and corrosion. Antifreeze agents based on ethylene glycol are used in general. The anticorrosive substances contained in the antifreeze are agents which prevent corrosion by forming a protective film on the surface of the components.

Provide for the following concentrations:

<table>
<thead>
<tr>
<th>Antifreeze agent</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
<th>25%</th>
<th>30%</th>
<th>35%</th>
<th>40%</th>
<th>45%</th>
<th>50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>90%</td>
<td>85%</td>
<td>80%</td>
<td>75%</td>
<td>70%</td>
<td>65%</td>
<td>60%</td>
<td>55%</td>
<td>50%</td>
</tr>
</tbody>
</table>

Antifreeze effective up to

-4°C -7°C -10°C -13°C -18°C -22°C -28°C -35°C -45°C

When the antifreeze agent is used as the only anticorrosion agent (without any chemical anticorrosion agent) it must be left in the coolant both during winter and summer time; minimum concentration 35%.

Use of antifreeze reduces the heat transfer coefficient (thermal capacity) of the coolant. Check whether the cooling circuit is laid out accordingly.

Admixture of a corrosion inhibiting oil emulsion is not permissible.

Best results are obtained with the **DEUTZ protective agent for cooling circuits** as an antifreeze with anticorrosion inhibitors. This ethylene glycol based protective agent for cooling circuits is matched to the materials used on DEUTZ medium and large size engines and is subject to permanent control and monitoring. This agent is obtainable from the DEUTZ organisation and is supplied in form of

- 5 litre containers Part No. 0101 1490
- 20 litre containers Part No. 0101 6416
- 210 litre barrel Part No. 1221 1500

© 2004 Page 4 of 6
If the DEUTZ protective agent for the cooling circuit should not be available for important reasons such as supply restrictions abroad, other products may be used in exceptional cases. Such alternative products have been grouped together in product groups and are listed up in Annex 1. Products of the same product group may be mixed. Products of different product groups may not be mixed. The entire cooling circuit must be cleaned thoroughly before a product change.

3.3 Corrosion inhibiting oil

Use of corrosion inhibiting oils is a problem because of the poor stability of the emulsion, the resulting difficulties in monitoring and the potential damage involved.

Corrosion inhibiting oils are emulsive mineral oils with additives which form a thin protective film on the components of the cooling circuit preventing corrosion and furring.

The emulsion must be prepared in a container outside the engine cooling water circuit adding the specified amount of corrosion inhibiting oil to the water stirring the mixture thoroughly. Concentration as specified by the manufacturer/supplier.

Loss of coolant to be made up for, excessively low concentrations of corrosion inhibiting oil to be compensated by adding a highly concentrated emulsion.

Corrosion inhibiting oils must not be used for:

- cooling circuits with connection to a comfort heating system
- gas engines

4 Details of the cooling circuit

4.1 Regular checking of the cooling circuit

The cooling circuit must be checked regularly (see current Operating Instructions) which includes checking for contamination and checking of the coolant level as well as the concentration of the protective agents of the cooling circuit.

- Chemical anticorrosion agent:
  Check concentration; suitable tools for testing such as test rods are supplied by the manufacturers/suppliers.

- Antifreeze agent with corrosion inhibitors
  Check antifreeze and anticorrosion effects with antifreeze tester.

- Corrosion inhibiting oil
  Check concentration of corrosion inhibiting oil with refractometer, check condition of emulsion.

Renew coolant always in case of:

- ingress of raw water
- Ingress of lube oil
- pronounced turbidity due to corrosion residues or other suspended matter
- a spent corrosion inhibiting emulsion
- the antifreeze agent to be renewed every 2 years.
4.2 Cleaning of cooling circuit

The cooling circuit must be cleaned if contaminated, corrosion inhibiting oil emulsion is spent or in the case of lube oil or raw water ingress. The entire coolant must be drained in such case and the cooling circuit must be flushed using a suitable detergent. The cooling circuit must also be cleaned when changing over to another type of protective agent for the cooling circuit.

Suitable detergents are offered on the market, suitability must be guaranteed by the manufacturer/supplier, however.

4.3 Coolant disposal

The coolant must not be drained into the sewage system. Disposal to be taken care of by a company specialised in waste disposal in accordance with the national legal requirements and the instructions of the manufacturer/supplier.

For disposal of the DEUTZ protective agent for the cooling circuit within the Federal Republic of Germany please refer to Annex 3 (published in German only).

DEUTZ AG  
Service Information Systems

Annexes
## Recommended Products

**Protective agents for cooling circuit**

### Annex 1 to

**TR 0199 - 99 - 2091**

**5th Exchange**

**01/2004**

## Antifreeze Agents with Corrosion Inhibitors

Product Group A: for medium and large size engines

Product Group B: for medium size engines

<table>
<thead>
<tr>
<th>Product Group</th>
<th>Manufacturer/Supplier</th>
<th>Product Name</th>
<th>Notes/available in</th>
</tr>
</thead>
</table>
| A             | DEUTZ AG              | *Cooling system protective agent*  
PN 0101 1490  
PN 0101 6416  
PN 1221 1500 | 5 litre container  
20 litre container  
210 litre barrel |
| A             | ARAL                  | Antifreeze Extra |  |
| A             | AVIA                  | Antifreeze APN  |  |
| A             | BASF                  | Glysantin G48/Protect Plus |  |
| A             | BUCHER (Schweiz)      | Motorex Antifreeze Protect Plus G48 |  |
| A             | INA Industrija        | INA Antifriz AL Super |  |
| A             | The Burma OIL         | Castrol Antifreeze NF |  |
| A             | FUCHS EUROPE          | FUCHS FRICOFIN |  |
| A             | TOTAL                 | ELF Glacelf MDX |  |
| A             | OMV                   | OMV coolant plus |  |
| A             | Shell                 | GlycoShell |  |
| A             | VALVOLINE             | G48 Antifreeze |  |
| A             | Veedol                | Veedol Antifreeze NF |  |
| A             | BP                    | BP antif-frost Code No. X 2270 A |  |
| A             | Hunold                | Kühlerschutz ANF |  |
| A             | INEOS                 | Napgel C2270/1 |  |
| A             | Mobil                 | Frostschutz 600 |  |
| B             | AGIP                  | Antifreeze special | USA, south-America |
| B             | ARTECO/Texaco         | Havoline XLC | Europe, south-America |
| B             | CALTEX                | Havoline XLC | Asia, Australia |
| B             | ChevronTexaco         | Chevron Extended Life Coolant |  |
| B             | Orvema b.v.           | Orvema Protex LL | Netherlands |
| B             | TOTAL                 | ELF Glacelf Auto Supra  
Total Organifreeze |  |
| B             | Texaco USA            | Havoline Extended Life Coolant (HELC)  
Extended Life Coolant (TEL) | USA, w/o Nitrit and Molybdenum  
USA, with Nitrit |
### Chemical Anticorrosion Agents

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>BEDIA</td>
<td>Bedia Liquid BL1 *</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Filter systems</td>
</tr>
<tr>
<td></td>
<td>Bedia BS/BT mit BP1 *</td>
<td>-</td>
<td>-</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bedia BL2</td>
<td>-</td>
<td>-</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>DREW AMEROID</td>
<td>DEWT-NC</td>
<td>-</td>
<td>-</td>
<td>X</td>
<td>Powder</td>
</tr>
<tr>
<td></td>
<td>Liquidewt</td>
<td>-</td>
<td>-</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maxiguard</td>
<td>-</td>
<td>-</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Fuchs</td>
<td>FUCHS ANTICORIT S 2000 A</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Houseman Limited</td>
<td>Cooltreat 651 *</td>
<td>-</td>
<td>-</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>NALFLEET</td>
<td>9-108</td>
<td>-</td>
<td>-</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9-111 *</td>
<td>-</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9-131 C</td>
<td>-</td>
<td>-</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>REICON</td>
<td>ODACON Z</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Perry (W. Lösing)</td>
<td>Liquid Perry *</td>
<td>-</td>
<td>X</td>
<td>X</td>
<td>Filter systems</td>
</tr>
<tr>
<td></td>
<td>Perry Filter *</td>
<td>-</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Texaco</td>
<td>Havoline XLI</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Total WT Supra</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>UNITOR ASA</td>
<td>Dieselguard NB Pulver</td>
<td>-</td>
<td>-</td>
<td>X</td>
<td>not to be mixed with antifreeze agent</td>
</tr>
<tr>
<td></td>
<td>ROCOR NB Liquid</td>
<td>-</td>
<td>-</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Vecom</td>
<td>CWT Diesel / QC 2</td>
<td>-</td>
<td>-</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

* Product contains silicates

### Corrosion inhibiting oils – not for gas engines –

<table>
<thead>
<tr>
<th>Manufacturer/ supplier</th>
<th>Product name</th>
<th>Diesel engines 234, 616, 2016, 604, 620, 2020, 628, 640, 645</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEUTSCHE Castrol</td>
<td>CASTROL PRODUCT 481/43</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Deutsche Shell AG</td>
<td>Shell 9156</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>ESSO AG</td>
<td>Kutwell 40</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Mobil</td>
<td>Coolant Inhibitor</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
Technical Circular
0199 - 99 - 2105 en
5th Exchange
Product:
DEUTZ Gas Engines

Date: 27.10.2003
This Circular supersedes: 0199-99-2105/4 of 11.05.2001

DEUTZ gas engines – Lube oil

This 5th Exchange Circular is issued essentially for:

- providing more precise data on lube oils for special gases
- revising the limit values of the lube oil analysis
- updating the lube oil table.

The technical advancement of DEUTZ gas engines featuring high efficiencies and low exhaust emissions requires special, particularly adapted lube oils with a low ash content. DEUTZ OIL TG-40 LA is recommended by us for use in DEUTZ gas engines. This oil is adapted to the needs of gas engines and gas given excellent in-service results in heavy-duty engines operation. If this oil is not available, lube oils listed in enclosure 1 can be used as an alternative. For gas engines operating on special gases (e.g. dumping grounds, sewage plants) which are exposed to higher contamination (limits referred to 100% CH4)

- Chlorine (Cl) > 30 mg/m³
- Fluorine (F) > 15 mg/m³
- Total chlorine + fluorine (Cl + F) > 30 mg/m³
- Sulphur (S) > 300 mg/m³

special lube oils according to enclosure 2 are recommended, in spite of the higher sulphate ash content, if the specified limit values are exceeded or the anticipated lube oil service life is not attained due to the influence of attendant fuel gas substances.

Lube oil service life

The lube oil service life is dependent on:

- Gas quality
- Lube oil grade
- Ambient conditions
- Engine mode of operation

It is therefore necessary to determine for each engine plant the lube oil change intervals by analysis of the used oil.
For bio gas, the 1st analysis should be carried out after 100 running hours and for the other types of gas after 300 running hours. Further intervals to be observed for analysis and lube oil change should be agreed between the operator and the laboratory on the basis of the following limit values.

<table>
<thead>
<tr>
<th>Limit values for lube oil analysis</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measuring method</strong></td>
<td></td>
</tr>
<tr>
<td>Viscosity at 100°C</td>
<td>min. 12 mm²/sec (cSt)</td>
</tr>
<tr>
<td></td>
<td>max. increase 3 mm²/sec</td>
</tr>
<tr>
<td></td>
<td>max. 18 mm²/sec</td>
</tr>
<tr>
<td>Water content</td>
<td>max. 0.2%</td>
</tr>
<tr>
<td>Glycol content</td>
<td>max. 500 ppm</td>
</tr>
<tr>
<td>Total base number TBN</td>
<td>&gt; 40% of new oil min. 2,0 mgKOH/g</td>
</tr>
<tr>
<td>AN</td>
<td>≤ of simultaneous TBN</td>
</tr>
<tr>
<td>SAN</td>
<td>0 mgKOH/g</td>
</tr>
<tr>
<td>i pH *</td>
<td>≥ 4,5</td>
</tr>
<tr>
<td>Oxide 5,8 µm</td>
<td>20 A/cm</td>
</tr>
<tr>
<td>Nitr. 6,1 µm</td>
<td>20 A/cm</td>
</tr>
<tr>
<td>Wearing metals:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Engine 1015 Engine 616 Engine 620 Engine 632 604B/C Engine 632 Engine 632 604B/C</td>
</tr>
<tr>
<td></td>
<td>1015 2015 616 2016 620 2020 (604B/C) 632 2032</td>
</tr>
<tr>
<td>Aluminium max. mg/kg</td>
<td>20 10 10 10 5</td>
</tr>
<tr>
<td>Chromium max. mg/kg</td>
<td>10 5 5 5 5</td>
</tr>
<tr>
<td>Copper max. mg/kg</td>
<td>20 25 15 10</td>
</tr>
<tr>
<td>Iron max. mg/kg</td>
<td>30 30 20 20</td>
</tr>
<tr>
<td>Lead max. mg/kg</td>
<td>20 20 20 10</td>
</tr>
<tr>
<td>Tin max. mg/kg</td>
<td>10 10 5 5</td>
</tr>
<tr>
<td>Silicium max. mg/kg</td>
<td>15 15 15 15</td>
</tr>
<tr>
<td>out of dust **</td>
<td></td>
</tr>
</tbody>
</table>

* Biogas

** In the case of engines running on sewage and landfill gas the contamination can also be caused by siloxanes. The elements exposed to wear must be carefully observed. The Si limit value is reached if the proportion of wearing metals increases to max. 300 mg/kg.
Not only the limit values but also the course of the recordings of a number of analyses of the oil should be considered in the assessment of the wear components to be sure to detect variations of the engine condition earliest possible.

You are advised to document the analysis of the oil and produce this evidence for reference, if necessary. In the case of abnormal wear within a series of analyses, you are obliged to make available the documented analysis to DEUTZ Product Engineering if engines under warranty are involved.

Following a series of three analyses, the analysis can be limited to the oil sample taken during lube oil change, provided the operating conditions remain the same.

Explanatory notes to the limit values of the lube oil analysis

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Term</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBN (mgKOH/g)</td>
<td>Total Base Number</td>
<td>Total base number, identifying the alkaline reserve of the oil and characterising the chemical capacity of neutralization</td>
</tr>
<tr>
<td>AN</td>
<td>Total Acid Number</td>
<td>covers weak and strong acids</td>
</tr>
<tr>
<td>SAN</td>
<td>Strong Acid Number</td>
<td>covers strong acids only, e.g. sulphuric acid</td>
</tr>
<tr>
<td>pH</td>
<td>Initial pH-Value</td>
<td>Initial pH value</td>
</tr>
<tr>
<td>Oxid. 5.8 µm</td>
<td>Oxidation</td>
<td>covering carbonyl compounds in the IR spectrum (infrared) of 5.8 µm</td>
</tr>
<tr>
<td>Nitr. 6.1 µm</td>
<td>Nitration</td>
<td>Nitrification by ground bacteria, measured in the IR spectrum (infrared) of 6.1 µm</td>
</tr>
<tr>
<td>A/cm</td>
<td>Absorption per cm of wavelength in the spectrogram</td>
<td></td>
</tr>
<tr>
<td>KOH</td>
<td>Potassium hydroxide</td>
<td></td>
</tr>
</tbody>
</table>

Lube oil change

Lube oil to be changed after

- Analysis
- Coolant ingress into lube oil
- Servicing work on maintenance level E 60 (see Operation Manual)
- Repair work exceeding the scope of maintenance level E 50 (see Operation Manual)
- at least once a year if engine is run less than 2,000 running hours annually.

New intervals for lube oil change must be fixed in case the mode of operation is changed, following service work E60 and/or repair work equivalent to E60.

The lube oil sample is to be taken

- with the engine running by means of the quick coupler directly form the lube oil circuit or
- directly after the engine has came to a standstill form the oil pan.

Fill the cubic centimetres taken as the initial sample back into the engine. Then fill into a clean test bottle.
Lube oil filter change

Lube oil filter cartridges to be changed

- together with the first lube oil change
- thereafter every 1,500 to 3,000 operating hours (see maintenance chart in Operation Manual)
- minimum once a year.

If water is analysed in the lube oil or a SAN is measured in the lube oil or servicing work acc. to maintenance level E 60 and/or repair work corresponding to E60 in terms of scope has been carried out, also filter cartridges must be changed in the course of the next lube oil change.

DEUTZ AG
Service Information Systems

Encl. Lube Oil Tables
### Lube Oil Table
#### DEUTZ Gas Engines

Lube oils for gas engines operating with all types of low contaminated gases

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Type of lube oil</th>
<th>Viscosity-class SAE</th>
<th>Base oil</th>
<th>Sulphate ash weight per cent</th>
<th>Total base number (TBN) mgKOH/g</th>
<th>Viscosity at 40°C</th>
<th>Viscosity at 100°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEUTZ</td>
<td>DEUTZ ÖL TG-40 LA</td>
<td>40</td>
<td>Mineral</td>
<td>0,43</td>
<td>5,7</td>
<td>156,0</td>
<td>14,5</td>
</tr>
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<td>ARAL AG</td>
<td>Degasol LA</td>
<td>40</td>
<td>Mineral</td>
<td>0,48</td>
<td>4,5</td>
<td>137,0</td>
<td>13,7</td>
</tr>
<tr>
<td>BP AG</td>
<td>Energol IC-DG 40S</td>
<td>40</td>
<td>Mineral</td>
<td>0,48</td>
<td>4,5</td>
<td>137,0</td>
<td>13,7</td>
</tr>
<tr>
<td>CEPSA</td>
<td>Troncoil Gas</td>
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<td>Mineral</td>
<td>0,35</td>
<td>4,6</td>
<td>133,8</td>
<td>13,8</td>
</tr>
<tr>
<td>Exxon Mobil</td>
<td>Pegasus HPC</td>
<td>15W-40</td>
<td>Mineral</td>
<td>0,48</td>
<td>5,5</td>
<td>138,0</td>
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</tr>
<tr>
<td></td>
<td>Pegasus 1</td>
<td></td>
<td>Synthetic</td>
<td>0,48</td>
<td>7,0</td>
<td>132,0</td>
<td>13,6</td>
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<tr>
<td></td>
<td>Pegasus 605</td>
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<td>7,4</td>
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<tr>
<td></td>
<td>Pegasus 705</td>
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<td>Mineral</td>
<td>0,49</td>
<td>5,3</td>
<td>122,0</td>
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</tr>
<tr>
<td></td>
<td>Pegasus 805</td>
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<td>Mineral</td>
<td>0,50</td>
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<tr>
<td></td>
<td>Pegasus 905</td>
<td>40</td>
<td>Mineral</td>
<td>0,50</td>
<td>6,2</td>
<td>115,0</td>
<td>12,7</td>
</tr>
<tr>
<td>FUCHS Europe</td>
<td>Fuchs Titan GM LA</td>
<td>40</td>
<td>Mineral</td>
<td>0,43</td>
<td>5,7</td>
<td>156,0</td>
<td>14,5</td>
</tr>
<tr>
<td>Kuwait Petroleum</td>
<td>Q 8 Mahler MA</td>
<td>40</td>
<td>Mineral</td>
<td>0,50</td>
<td>5,5</td>
<td>141,2</td>
<td>13,9</td>
</tr>
<tr>
<td>Petro-Canada</td>
<td>Sentinel 445</td>
<td>40</td>
<td>Hydro. Tr</td>
<td>0,40</td>
<td>4,7</td>
<td>127,0</td>
<td>13,2</td>
</tr>
<tr>
<td>Repsol</td>
<td>Extra Gas 40</td>
<td>40</td>
<td>Mineral</td>
<td>0,40</td>
<td>6,0</td>
<td>130,0</td>
<td>13,5</td>
</tr>
<tr>
<td>Roloil</td>
<td>Mogas / 40</td>
<td>40</td>
<td>Mineral</td>
<td>0,50</td>
<td>5,5</td>
<td>141,2</td>
<td>13,9</td>
</tr>
<tr>
<td>Shell</td>
<td>Mysella LA</td>
<td>40</td>
<td>Mineral</td>
<td>0,45</td>
<td>5,0</td>
<td>138,0</td>
<td>13,8</td>
</tr>
<tr>
<td></td>
<td>Mysella XL</td>
<td>40</td>
<td>Mineral</td>
<td>0,50</td>
<td>4,5</td>
<td>131,0</td>
<td>14,1</td>
</tr>
<tr>
<td>TOTAL FINA ELF</td>
<td>ELF Nateria MH 40</td>
<td>40</td>
<td>Mineral</td>
<td>0,35</td>
<td>4,6</td>
<td>133,8</td>
<td>13,8</td>
</tr>
<tr>
<td></td>
<td>ELF Nateria MH 40</td>
<td>40</td>
<td>Mineral</td>
<td>0,45</td>
<td>5,2</td>
<td>139,0</td>
<td>13,9</td>
</tr>
<tr>
<td></td>
<td>FINA Gasmotorenöl 505</td>
<td>40</td>
<td>Mineral</td>
<td>0,48</td>
<td>5,5</td>
<td>155,0</td>
<td>15,1</td>
</tr>
<tr>
<td>TEXACO</td>
<td>GEOTEX LA</td>
<td>40</td>
<td>Mineral</td>
<td>0,45</td>
<td>5,5</td>
<td>129,4</td>
<td>13,3</td>
</tr>
<tr>
<td></td>
<td>GEOTEX PX</td>
<td>40</td>
<td>Mol. conv</td>
<td>0,50</td>
<td>5,4</td>
<td>88,0</td>
<td>13,2</td>
</tr>
<tr>
<td>WIPA Chemicals</td>
<td>Ecosyn GE 4004</td>
<td>40</td>
<td>Ester</td>
<td>0,40</td>
<td>6,0</td>
<td>155,0</td>
<td>13,7</td>
</tr>
</tbody>
</table>

© 2003
<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Type of lube oil</th>
<th>Viscosity class SAE</th>
<th>Base oil</th>
<th>Sulphate ash weight per cent</th>
<th>Total base number (TBN) mgKOH/g</th>
<th>Viscosity at 40 °C</th>
<th>Viscosity at 100 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caltex</td>
<td>Geostar LF 40</td>
<td>40</td>
<td>Mineral</td>
<td>0,99</td>
<td>8,0</td>
<td>138,0</td>
<td>14,0</td>
</tr>
<tr>
<td>Kuwait Petroleum</td>
<td>Q8 Mahler HA</td>
<td>40</td>
<td>Mineral</td>
<td>0,90</td>
<td>7,9</td>
<td>141,2</td>
<td>14,1</td>
</tr>
<tr>
<td>Mobil</td>
<td>Pegasus 610</td>
<td>40</td>
<td>Mineral</td>
<td>0,96</td>
<td>9,5</td>
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</tr>
<tr>
<td>Roloil</td>
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<td>40</td>
<td>Mineral</td>
<td>0,90</td>
<td>7,9</td>
<td>141,2</td>
<td>14,1</td>
</tr>
<tr>
<td>Texaco</td>
<td>Geotex LF 40</td>
<td>40</td>
<td>Mineral</td>
<td>0,99</td>
<td>8,0</td>
<td>138,0</td>
<td>14,0</td>
</tr>
</tbody>
</table>
Engine corrosion protection

This Technical Circular applies for all DEUTZ medium and large engines and for the DEUTZ gas engine TCG 2015

1 General
2 Corrosion protection for engines which have been in operation
   2.1 Interior corrosion protection
   2.2 Exterior corrosion protection
   2.3 Storage and packaging
3 Subsequent corrosion protection of engines
   3.1 Interior corrosion protection
   3.2 Exterior corrosion protection
   3.3 Storage and packaging
4 Removal of corrosion protection
   4.1 Removal of interior corrosion protection
   4.2 Removal of exterior corrosion protection
5 Corrosion protection agents / cleaning agents
1 General

New engines and replacement parts are protected against corrosion before being shipped from the plant. The duration of protection against corrosion depends on the type of corrosion protection, the packaging and the storage conditions at the place of installation. Corrosion protection may be guaranteed for 12 months or 24 months depending on what the customer wants.

In engines a distinction is made between

- interior corrosion protection and
- exterior corrosion protection

All engines have both kinds of corrosion protection.

The following corrosion protection measures after taking the engine out of operation or subsequent corrosion protection of engines which have not yet been installed meet the requirements for 12 months full protection.

At the end of the corrosion protection work the crank drive may no longer be turned so that the corrosion protection agent in the bearings, bearing liners and cylinder liners is not scraped off.

2 Corrosion protection for engines which have been in operation

2.1 Interior corrosion protection

Interior corrosion protection is always provided by wetting of the walls with the implemented corrosion protection agent (see section 5) in a corrosion protection running of the engine.

Fuel system

This includes the injection valves, fuel filter, fuel pump, overflow valve, fuel lines and tank.

Engines operated with a mixed fuel must be switched over to distilled fuel at least 3 hours before shutting down.

- Fill the fuel tank with a mixture of
  - 85% distilled fuel
  - 15% corrosion protection oil SAE 30W-30
- Perform a corrosion protection run with the engine in no-load (together with corrosion protection run for the lube oil system), duration approx. 10 minutes

Lube oil system

This includes oil tray, lube oil pump, lube oil cooler, oil pressure control valve, oil filter, main oil channels, crankshaft, con-rod and camshaft bearings, tappets and tappet chambers, cylinder liners, valve springs and toggle levers.

- Drain lube oil from warm engine.
- Thoroughly clean engine compartment, oil tray, cylinder head with toggle levers, valves, valve springs with distilled fuel or cleaning agent.
- Fill the engine with corrosion protection oil SAE 30W-30 and perform a corrosion protection run (together with corrosion protection run for fuel system, duration approx. 10 minutes) so that all bearings and bearing liners are wetted,
  or
  wet all components with corrosion protection oil and pump corrosion protection oil through the engine with a separate pump until all bearings and bearing liners are wetted.

In additional devices with their own oil filling (these include turbochargers, governors, injection pumps etc.) drain lube oil and fill with new lube oil according to manufacturer specifications.
Coolant system

If a coolant with corrosion protection properties is poured into the engine, no further action is necessary after draining the coolant.

If this is not the case, the coolant must be drained and a corrosion protection run performed with a mixture of corrosion protection agent with corrosion protection properties (see section 5) and fresh water so that a coating forms on the interior surfaces of the cooling system.

The duration of the corrosion protection run and the concentration of the corrosion protection agent are specified by the manufacturer of the corrosion protection agent.

Then drain the coolant.

Combustion chamber

The injection valves and spark plugs must be removed at the end of the corrosion protection run. The respective piston must be set to LT.

The accessible part of the cylinder liner should be coated with corrosion protection oil with a spray lance through the opening.

+ Oil drips on the piston are not permissible and must be sucked off if necessary.

Receiver pipe and starter air line

Spray corrosion protection oil 30 W-30 into the receiver pipe and the main starter line.

+ Oil drips in lines are not permissible and must be sucked off if necessary.

2.2 Exterior corrosion protection

The engine must be cleaned thoroughly with a cleaning agent before exterior corrosion protection. Any signs of corrosion and damage to the paintwork must be removed. See section 5 for corrosion protection agents and cleaning agents.

Bare exterior surfaces and parts

All bare surfaces must be coated or sprayed with a corrosion protection agent.

Brush the crankshaft flange with corrosion protection agent and wrap tightly or cover with foil or packing cloth.

Control rods and joints

Coat control rods and joints with protective grease.

Rubber parts

Rub rubber parts with talcum powder.

+ Rubber parts must not come into contact with oil, grease and paint.

Engine openings

All engine openings must be fitted with air-tight, water-tight covers to delay the liquefication process of the corrosion protection agents.

Air should be locked out to avoid ventilation of the engine (chimney effect).
2.3 Storage and packaging

After being protected against corrosion, the engine must be stored in a dry, ventilated hall or suitably covered. The cover must be placed loosely over the engine so that the air can circulate around it to prevent condensation from forming. Use a dessicant if necessary.

3 Subsequent corrosion protection of engines

If the maximum duration of corrosion protection has been reached and the engine is to stay in storage, it must be subjected to subsequent corrosion protection. The subsequent corrosion protection protects the engine for another 12 months. Subsequent corrosion protection must be provided accordingly for stored replacement parts.

Mark the position of the flywheel or crankshaft flange. Deposits may form on the cylinder liner in the area of the piston rings. For this reason, the pistons must be set to a different position each time corrosion protection is carried out.

The engine packaging and the covers over the engine openings must be removed.

3.1 Interior corrosion protection

Fuel system

This includes the injection valves, fuel filter, fuel pump, overflow valve, fuel lines and tank.

- Fill the fuel tank with a mixture of
  - 85% diesel fuel
  - 15% corrosion protection oil SAE 30W-30
- Pump fuel with a separate pump or fuel hand pump until the fuel system is full.

Lube oil system

This includes oil tray, lube oil pump, lube oil cooler, oil pressure control valve, oil filter, main oil channels, crankshaft, con-rod, camshaft bearings, tappets and tappet chambers, cylinder liners, valve springs and toggle levers.

- Clean the engine compartment and oil tray with diesel fuel if necessary.
- Spray cleaned compartments with corrosion protection oil SAE 30W-30.
- Pump corrosion protection oil into the lube oil circuit with separate pump or pre-lubrication hand pump. Turn the engine manually or with electric turning gear so that all bearings and bearing liners are coated. The engine can also be turned with the starter without starting.
- Remove the cylinder head cover and spray valves, valve springs and toggle levers with corrosion protection oil SAE 30W-30.

In additional devices with their own oil filling (these include turbochargers, governors, injection pumps etc.) drain lube oil and fill with new lube oil according to manufacturer specifications.
Coolant system

Fill up the coolant system with a mixture of corrosion protection agent with corrosion protection properties (see section 5) and fresh water and circulate with an external pump so that a new coating forms on the interior surfaces of the cooling system.

The duration of the corrosion protection run and the concentration of the corrosion protection agent are specified by the manufacturer of the corrosion protection agent.

Then drain the coolant.

Combustion chamber

Remove the cylinder head cover and dismantle the injection valves and spark plugs. The pistons must be set to LT.

The accessible part of the cylinder liner should be coated with corrosion protection oil with a spray lance through the opening.

$\Rightarrow$ Oil drips on the piston are not permissible and must be sucked off if necessary.

Then turn the engine until the piston is in the UT position and spray the cylinder liner with corrosion protection oil from below.

Suction intake and starter air system, receiver pipe

Spray corrosion protection oil 30 W-30 into the receiver pipe and the main starter line.

$\Rightarrow$ Oil drips in lines are not permissible and must be sucked off if necessary.

3.2 Exterior corrosion protection

The engine must be cleaned thoroughly with a cleaning agent before new corrosion protection. Any signs of corrosion and damage to the paintwork must be removed.

Bare exterior surfaces and parts

All bare surfaces must be coated or sprayed with a corrosion protection agent.

Coat the crankshaft flange with corrosion protection agent and wrap tightly or cover with foil or packing cloth.

Control rods and joints

Coat control rods and joints with protective grease.

Rubber parts

Rub rubber parts with talcum powder.

$\Rightarrow$ Rubber parts must not come into contact with oil, grease and paint.

Engine openings

All engine openings must be fitted with air-tight, water-tight covers to delay the liquefication process.

Air should be locked out again to avoid ventilation of the engine (chimney effect).
3.3 Storage and packaging

After being subsequently protected against corrosion, the engine must be stored again in a dry, ventilated hall or suitably covered. The cover must be placed loosely over the engine so that the air can circulate around it to prevent condensation from forming. Use a dessicant if necessary.

4 Removal of corrosion protection

The corrosion protection must be removed from the engine before starting. The packaging must be removed as well as all covers from the sealed openings. Any signs of corrosion and damage to paintwork must be removed. See section 5 for cleaning agents.

4.1 Removal of interior corrosion protection

Fuel system
- If there is a mixture of diesel fuel/corrosion protection oil in the fuel tank, drain it.
- Fill the fuel tank and fuel system with the proper fuel.

Lube oil system
- If there is corrosion protection oil in the oil tray, drain it or pump it out.
- Fill the engine with the lube oil intended for operation. A purge is not necessary.
- In additional devices with their own oil filling (these include turbochargers, governors, injection pumps etc.) drain lube oil and fill with new lube oil according to manufacturer specifications.

Coolant system
- If the implemented corrosion protection agent is compatible with the coolant to be used, this can be filled directly into the coolant system as specified.
- If it is uncertain whether the implemented corrosion protection agent is compatible with the coolant, the cooling system should be purged with fresh water for about 15 minutes before filling.

4.2 Removal of exterior corrosion protection

- Wash all surfaces and components coated with corrosion protection agent with distilled fuel or a suitable cleaning agent.
- Wash out grooves of V-belts if necessary.

5 Corrosion protection agents / cleaning agents

Below we list some reference products for the corrosion protection agents or cleaning agents with which the best results have been achieved. Equivalent products can be used whereby the supplier must guarantee the suitability of the product for the application.
<table>
<thead>
<tr>
<th>Name</th>
<th>Purpose</th>
<th>Product name</th>
</tr>
</thead>
</table>
| Distilled fuel              | - Cleaning of engine parts  
- Filling the fuel system 85% distilled fuel                          | Diesel acc. to DIN EN 590    |
| Corrosion protection oil    | - Protect lube oil system  
- Protect additional devices with own oil filling  
- 15% to distilled fuel for protecting fuel system                     | Corrosion protection oil SAE30W-30  
BP-ME 80  
BP-Deutschland Hamburg                                                  |
| Corrosion protection agent  | - Protect coolant system                                                | Puriton 3956  
Kuhbier Chemie GmbH  
58566 Kierspe  
or ODACON Z  
Reicon Chemie  
04103 Leipzig                                                            |
| Corrosion protection agent  | - Protect bare exterior surfaces and parts                               | Gelserol Super  
Deutsche Castrol  
76829 Landau                                                            |
| wax-like                    |                                                                         |                               |
| Protective grease           | - for control rods and joints                                           | Renolit MP2  
Fuchs Europe GmbH  
68169 Mannheim                                                          |
| Talcum                      | - for rubber parts                                                      | Talcum fine, white  
Silbermann GmbH & Co. KG  
86456 Gablingen                                                         |
| Cleaning agent              | - to remove corrosion protection agent protection agent                 | Eskapon S 255  
Haug-Chemie GmbH  
74889 Sinsheim                                                          |
| Cleaning agent/thinner      | - Thin and remove corrosion protection agent wax-like                    | Renopal B 150  
Fuchs Europe GmbH  
68169 Mannheim                                                          |
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DEUTZ Gas Engines - Fuel gas

1. General

Fuel gas is the term used to describe gas mixtures of varying composition, calorific value and anti-knock index which are suitable for use in gas engines.

The knock rating is given by the methane number (MN), where

\[
MN = 100 \text{ (antiknock)} \quad \text{is defined for methane (CH}_4\text{) and}
\]
\[
MN = 0 \text{ (high level of knocking)} \quad \text{is defined for hydrogen (H}_2\text{).}
\]

In the case of gases with variable or low methane numbers there is a risk of knocking and hence the risk of extreme mechanical and thermal stress with possible consequential damage.

The methane number of combustion gas mixtures is influenced by several components. Thereby the main components are:

- Methane - CH\(_4\) - as the most significant component of the standard gas engine combustion gas, particularly in the case of the diverse natural gases.
- Hydrogen - H\(_2\) - which significantly reduces the methane number of the gas mixture. It is mainly present in combustion gases such as coke oven, blast furnace and low-temperature carbonization gases.
- Higher levels of hydrocarbons - C\(_n\)H\(_m\) with n>1 and m>4 - in other words more hydrocarbons than methane, which are often very unstable and therefore tend much more to knocking.
- Inert N\(_2\) and CO\(_2\) - which do not take an active part in the combustion process, but instead increase the methane number in a gas mixture, thereby CO\(_2\) has three times the effect of N\(_2\).

For the assessment of a gas with respect to its suitability as a combustion gas the attendant materials in the gas are of great importance. It is true that they have (mostly) no influence on the actual combustion process, but with respect to the reliable operation of the engine and plant in general these attendant gas materials must always be taken into account.

These attendant gas materials are released when the gas is generated in sewage treatment works, landfill sites or biogas plants. They consist of minerals, halogens, metals, heavy metals etc., which form a link with the hydrocarbons. Depending on the quantity and the damaging effect these attendant gas materials must be filtered out of the combustion gas in front of the engine. The limiting values of the significant attendant gas materials, which are known of at present, are listed in Table 2.
2. Classification into gas groups

The possible combustion gases are classified into different groups according to their abrasive properties. In this way the respective maintenance plan in the operation manual can be assigned to the engine.

Engines, which we have supplied, may only be operated with the combustion gas for which they were planned according to the scope of supply. If you wish to change the combustion gas then please contact DEUTZ first.

<table>
<thead>
<tr>
<th>Gas group 1</th>
<th>Gas group 2 (bio-gases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural gas</td>
<td>sewage gas</td>
</tr>
<tr>
<td>Pit gas</td>
<td>methane gas</td>
</tr>
<tr>
<td>Liquified gas</td>
<td>Wood gas</td>
</tr>
<tr>
<td>- propane, butane, LNG (liquid natural gas)</td>
<td>other bio-gases</td>
</tr>
<tr>
<td>Attendant petroleum gas (petroleum gas)</td>
<td></td>
</tr>
<tr>
<td>Gases with a hydrogen content, H₂ &gt; 30 Vol%, e.g. coke oven gas</td>
<td></td>
</tr>
</tbody>
</table>

Table 1 Classification into gas groups

3. Minimum properties of combustion gases for gas engines

Please note:

- The minimum properties for which an engine operation is still possible are given. However, the max. possible power of the engine is not given in all cases,
- For the engine-specific requirements of the respectively approved combustion gases see Table 3.
- The given minimum properties are only valid for the engine. For plant parts the respective manufacturer's documentation should be followed, see also Table 4.

<table>
<thead>
<tr>
<th>Property</th>
<th>Desc.</th>
<th>Unit</th>
<th>Limit</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calorific value (lower cal. val.)</td>
<td>Hₜ</td>
<td>[kWh/m₃]</td>
<td>≥ 4</td>
<td></td>
</tr>
<tr>
<td>Rate of increase Hₜ</td>
<td></td>
<td>[%/min]</td>
<td>&lt; 5</td>
<td></td>
</tr>
<tr>
<td>CO₂/Hₜ</td>
<td>CO₂/Hₜ</td>
<td>[Vol%/kWh/m₃]</td>
<td>&lt; 10</td>
<td></td>
</tr>
<tr>
<td>Sulphur content (total)</td>
<td>S</td>
<td>[mg/m₃ CH₄]</td>
<td>&lt; 2200</td>
<td>Due to corrosion in the engine</td>
</tr>
<tr>
<td>or H₂S content</td>
<td>H₂S</td>
<td>[Vol%/m₃ CH₄]</td>
<td>&lt; 0,15</td>
<td></td>
</tr>
<tr>
<td>Chlorine content (total)</td>
<td>Cl</td>
<td>[mg/m₃ CH₄]</td>
<td>&lt; 100</td>
<td></td>
</tr>
<tr>
<td>Fluorine content (total)</td>
<td>F</td>
<td>[mg/m₃ CH₄]</td>
<td>&lt; 50</td>
<td></td>
</tr>
<tr>
<td>Sum of chlorine and fluorine</td>
<td>(Cl+F)</td>
<td>[mg/m₃ CH₄]</td>
<td>&lt; 100</td>
<td></td>
</tr>
<tr>
<td>Ammonia</td>
<td>NH₃</td>
<td>[mg/m₃ CH₄]</td>
<td>&lt; 30</td>
<td></td>
</tr>
<tr>
<td>Dust content</td>
<td></td>
<td>[mg/m₃ CH₄]</td>
<td>&lt; 10</td>
<td></td>
</tr>
<tr>
<td>Grain size</td>
<td></td>
<td>[µm]</td>
<td>3 - 10</td>
<td></td>
</tr>
<tr>
<td>Oil gases &gt; C5 &lt; C10</td>
<td></td>
<td>[mg/m₃ CH₄]</td>
<td>&lt; 3000</td>
<td>No condensation in gas control system and the suction pipe</td>
</tr>
<tr>
<td>Oil gases &gt; C10</td>
<td></td>
<td>[mg/m₃ CH₄]</td>
<td>&lt; 250</td>
<td></td>
</tr>
<tr>
<td>Silicon (organic)</td>
<td>Si</td>
<td>[mg/m₃ CH₄]</td>
<td>&lt; 10</td>
<td></td>
</tr>
<tr>
<td>Humidity (relative)</td>
<td>ϕ</td>
<td>[%]</td>
<td>&lt; 80</td>
<td>At lowest air temperature</td>
</tr>
</tbody>
</table>

In general no condensation is permitted in the gas control system and the suction pipe.
<table>
<thead>
<tr>
<th>Property</th>
<th>Desc.</th>
<th>Unit</th>
<th>Limit</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static pre-pressure upon entry to gas control system</td>
<td>min</td>
<td>[mbar]</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Static pre-pressure upon entry to gas control system</td>
<td>max</td>
<td>[mbar]</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Gas pressure fluctuations</td>
<td>[%]</td>
<td>± 10</td>
<td>of the set value at the variation frequency &lt; 10/h</td>
<td></td>
</tr>
</tbody>
</table>

Different values apply to gases with a hydrogen content H₂ > 30 Vol%, e.g. coke oven gas:

<table>
<thead>
<tr>
<th>Property</th>
<th>Desc.</th>
<th>Unit</th>
<th>Limit</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static pre-pressure on entry to the gas control system</td>
<td>[mbar]</td>
<td>&gt; 60</td>
<td>of the set value at the variation frequency &lt; 3/min</td>
<td></td>
</tr>
<tr>
<td>Gas pressure fluctuations</td>
<td>[%]</td>
<td>± 10</td>
<td>of the set value at the variation frequency &lt; 3/min</td>
<td></td>
</tr>
</tbody>
</table>

Gas temperature [°C] < 50
Gas temperature [°C] > 10
due to lack of gas constituents, e.g. Naphthalene

Gas temperature [°C] > 35
due to lack of gas constituents, e.g. Naphthalene

Gas temperature [°C] > 25
due to lack of gas constituents, e.g. Naphthalene

Variations in the composition of gases with a hydrogen content H₂ > 30 Vol%, e.g. coke oven gas

| Hydrogen | H₂ | [%] | ± 3 | |
| Methane | CH₄ | [%] | ± 3 | |
| Rest | [%] | ± 5 | |

Limit values for attendant materials for gases with a hydrogen content H₂ > 30 Vol%, e.g. coke oven gas:

| Naphthalene | [mg/10kWh] | < 200 | |
| Benzene | [mg/10kWh] | < 25000 | |
| Tar | [mg/10kWh] | < 0.5 | |

Table 2 Minimum properties of combustion gases for gas engines

4. Engine-specific requirements of combustion gases

The gas types released according to the engine data sheet are listed in Table 3. It also shows the engine-specific limits required for different gases at maximum engine power.

<table>
<thead>
<tr>
<th>Application</th>
<th>Composition</th>
<th>MN, min</th>
<th>Hu, min [kWh/m₃]</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine TCG 2015</td>
<td>Natural gas</td>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sewergas</td>
<td>65 % CH₄ / 35 % CO₂</td>
<td>5,0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landfill site gas</td>
<td>50 % CH₄ / 27 % CO₂ / Rest N₂</td>
<td>5,0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine TBG 616</td>
<td>Natural gas</td>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sewergas</td>
<td>65 % CH₄ / 35 % CO₂</td>
<td>5,0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landfill site gas</td>
<td>50 % CH₄ / 27 % CO₂ / Rest N₂</td>
<td>5,0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Application</td>
<td>Composition</td>
<td>MN, min</td>
<td>Hu, min [kWh/m³]</td>
<td>Remark</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------------</td>
<td>---------</td>
<td>------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Engine TCG 2016</td>
<td>Natural gas</td>
<td>80</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sewer gas 65 % CH₄ / 35 % CO₂</td>
<td></td>
<td>5,0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Landfill site gas 50 % CH₄ / 27 % CO₂/ Rest N₂</td>
<td></td>
<td>5,0</td>
<td></td>
</tr>
<tr>
<td>Engine TBG 620</td>
<td>Natural gas</td>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sewer gas 65 % CH₄ / 35 % CO₂</td>
<td></td>
<td>5,0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Landfill site gas 50 % CH₄ / 27 % CO₂/ Rest N₂</td>
<td></td>
<td>5,0</td>
<td></td>
</tr>
<tr>
<td>Engine TCG 2020</td>
<td>Natural gas</td>
<td>80</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sewer gas 65 % CH₄ / 35 % CO₂</td>
<td></td>
<td>5,0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Landfill site gas 50 % CH₄ / 27 % CO₂/ Rest N₂</td>
<td></td>
<td>5,0</td>
<td></td>
</tr>
<tr>
<td>Engine TCG 2032</td>
<td>Natural gas</td>
<td>80</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Data for special gases and two-gas operation upon request or in the case of engines, which have already been delivered, according to the supplier documentation.</td>
</tr>
</tbody>
</table>

5. Project-related requirements

- If the required minimum properties of the combustion gas are not met or if it is contaminated with non-specified components the service life of the engine and its components will be reduced. The scheduled maintenance times given in the scheduled maintenance plan for the proper specified engine operation are often substantially fallen short of and hence lose their relevance completely.

- If the planned combustion gas does not meet the minimum properties given here or if the combustion gas contains additional by-products, which are not specified, and without the actual combustion gas analysis having been released in writing by DEUTZ, then any guarantee claims against DEUTZ or any form of liability by DEUTZ will be invalid.

- At the time of commissioning, a gas analysis must be submitted (not older than 2 weeks) and the commissioning report must be attached. After commissioning, a gas analysis is to be carried out 3 times a year and a check made to see if the minimum properties are being complied with. In the event of a warranty claim, these gas analyses must be presented.

- The respective manufacturer’s documentation should be followed for other plant parts. See also:
  - “The design of power plants with gas and diesel engine operation” (Planning and installation advice) of DEUTZ AG
  - “Project Manual” of DEUTZ AG

- If catalysers and/or exhaust gas heat exchangers are used the respective manufacturer’s information should be followed with respect to the permitted gas composition and exhaust gas temperature.
6. Sampling and gas analysis

Sampling and gas analyses are to be carried out according to the relevant standards and guidelines.

We recommend Tedlar bag sampling. This process is calibrated and suitable for determining Si compounds, chlorine, fluorine, sulphur, chlorinated hydrocarbons/chlorofluorocarbons and aromatic compounds from a sample. The sample can be used without problems affecting the pressure side of the compressor.

Sampling using the methanol impinger method (washing bottle method) or sampling on activated carbon (Draeger method) is only possible for Si compounds or, with limitations, also for chlorinated hydrocarbons/chlorofluorocarbons. Not all Si compounds remain stable and/or conversion processes occur. In addition to this, the gas volume must be determined exactly, which requires the corresponding equipment on site.

A selection of the analysis parameters is given here:

<table>
<thead>
<tr>
<th>Analysis parameters</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main components (O₂, CO₂, N₂, CH₄)</td>
<td>DIN 51872-04-A</td>
</tr>
<tr>
<td>Total chlorine, fluorine, sulphur using the Wickbold method</td>
<td>DIN EN 38409 H8 (Wickbold combustion)</td>
</tr>
<tr>
<td>Total silicon/org. Silicon compounds in appendix VDI 3865, sheet 4</td>
<td>DIN EN ISO 10304-1 (Ion chromatography)</td>
</tr>
<tr>
<td>Ammonia</td>
<td>VDI 2461, sheet 2, Nessler process</td>
</tr>
<tr>
<td>Hydrogen sulphide</td>
<td>DIN 51855-4; VDI 3486, Sheet 2</td>
</tr>
</tbody>
</table>

Table 5 Sampling and gas analysis

Si compounds which must also be analyzed with gas chromatography as a minimum requirement:

<table>
<thead>
<tr>
<th>Landfill sites:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Trimethylsilanol</td>
<td></td>
</tr>
<tr>
<td>Hexamethyldisilanol (L2)</td>
<td></td>
</tr>
<tr>
<td>Octamethylcyclotetrasilanol (D4)</td>
<td></td>
</tr>
<tr>
<td>Decamethylcyclopentasilanol (D5)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sewage treatment works also:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hexamethylicotrisilanol (D3)</td>
<td></td>
</tr>
</tbody>
</table>

Table 6 Si compounds

7. Examples for the methane number (MN) for selected gases

<table>
<thead>
<tr>
<th>Gas</th>
<th>MN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biogas</td>
<td>&gt; 120</td>
</tr>
<tr>
<td>Pit gas</td>
<td>105</td>
</tr>
<tr>
<td>Methane</td>
<td>100</td>
</tr>
<tr>
<td>Natural gas</td>
<td>65 - 95</td>
</tr>
<tr>
<td>Propane</td>
<td>33</td>
</tr>
<tr>
<td>Butane</td>
<td>10</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>0</td>
</tr>
</tbody>
</table>

DEUTZ AG
Service-Technology

- Sonntag -
- Boos -
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1 General Safety Regulations

This document has been published in various languages. In case of possible uncertainties or interpretative difficulties the German version is always decisive.

Each country (state) has its own safety regulations. No matter under which work and local conditions you are working - compliance with all private or public safety regulations of the respective country (state) and liability association is mandatory.

The safety regulations in this brochure must not be considered as being final for the complete unit (combustion engine and powered machine), because the assembly and interaction of combustion engine and powered machine requires further safety relevant measures.

The safety regulations issued by the machine manufacturer must therefore also be observed. Furthermore, the safety regulations on the respective worksheets in our operating instructions and workshop manuals must also be complied with.

1.1 Selection and qualification of personnel

Work on or with the combustion engine as well as on the complete machine must only be carried out by authorized specialists.

A legally specified minimum age must be observed.

Responsibilities for operation, set-up work, maintenance and repair must be clearly determined.

1.2 Organizational measures

The operating instructions must be handed out to the operating personnel. These must be always at hand at the operating location of the combustion engine, or, if this is not possible, in any other way accessible for the operating personnel.

With the help of the operating instructions the operating personnel must be instructed in the handling of the combustion engine, whereby all safety relevant information must be explained in particular. This is especially valid for persons who work on the machine only occasionally, e.g. for set-up or maintenance work.

In addition to the operating instructions all generally valid legal or country specific regulations for the avoidance of accidents and the protection of the environment must also be complied with at the operating location.

Unauthorized changes to the engine can have an adverse effect on safety. The manufacturer will not assume liability for any damage resulting from this. Manipulations on the injection and governor system may also affect the performance and exhaust emission characteristics, so that compliance with legal environmental regulations can no longer be assured.

Only genuine DEUTZ parts may be used.

All notes and warning stickers attached to the engine must be observed and maintained in legible condition.

1.3 Intended use

The combustion engine is solely intended for the contractually determined purpose of use. Any other use or any use for applications exceeding the intended use is considered as unintended use. The manufacturer will not assume liability for any damage resulting from this. The user is the sole bearer of any risk.

Observing the operating instructions and compliance with the maintenance instructions is also part of the intended use.
1.4 Symbols used

The following warning, prohibitive, order signs and notes may be attached with various symbols. These have the following meaning:

- **Warning sign**
  - This symbol is used for all safety regulations the negligence of which will cause danger to health and life of the persons involved.
  - Warning of combustible materials
  - Warning of caustic substances
  - Warning of dangerous electrical voltage
  - Warning of harmful or irritating substances
  - Warning of dangers caused by batteries
  - Warning of hot surface

- **Prohibitive signs**
  - Fire, naked light and smoking prohibited!

- **Order signs**
  - Wear eye protection
  - Wear a hard hat
  - Wear ear defenders
  - Wear safety gloves
  - Wear safety clothes

- **Notes**
  - This symbol is used for all notes the negligence of which causes the risk of damage to material, malfunction and damage to the environment.
Stickers

Stickers are used on the engine to give instructions and to highlight possible special danger sources which could lead to physical damage. Damaged or illegible stickers must be replaced immediately.

There are many possible danger sources during operation, set-up, inspection, repair or other work. Unfortunately it is not possible to fight all these dangers by attaching warning signs. It is therefore of utmost importance to have the engine operated and serviced by trained personnel concentrated on their work.

Note symbols and warning stickers are in compliance with the technical status at the date of delivery of the engine.

Due to technical and legal changes the safety regulations for the handling of combustion engines and the signs to be attached may also change. It is therefore very important to keep an eye on the latest technical developments.

2 Safety Regulations for Medium and Large Size Engines

2.1 Transport

- Use only transport devices specified by the manufacturer.
- Use only lifting gear recommended by the manufacturer.
- Use only the lifting points specified by the manufacturer.
- Transport the engine only in „as installed“ position.
- For transport lash the engine down only at the points specified by the manufacturer.
- After a transport distance of 50 km check the fastening for tight fit, retighten if necessary.

2.2 Operation

Check before or during commissioning:

- Safety installations for completeness and function!
- Lines, hoses and fittings for leaks!
- Intake and exhaust system for function and compliance with the installation specifications of the engine manufacturer!
- Run combustion engines only in appropriately ventilated rooms, if necessary use a fume extraction system. Ensure sufficient ventilation before starting in closed rooms!
- Never bridge the contacts of ignition switches, battery or starter. This can cause severe injury and/or damage to property.
- Before starting make sure that no persons are in the danger area of the engine!
- Due to the high risk of an explosion engines with compressed air starting system must not be started with the help of combustible gases and oxygen, even in cases of emergency!
- Start the engine only from the operator’s stand.
- After a starting fault crank the engine without fuel injection!
- Do not perform several cold starts within a short period of time.
- Be extremely careful in the vicinity of rotating, moving and hot parts.
- In the vicinity of the running engine wear ear defenders.
- Please remember that wearing ear defenders will affect the perception of possible warning sounds. Watch out more intensely for visual alarm signals.
- During operation keep an eye on control lights and gauges.
- In case of deviation from the normal values, e.g. overheating, shut the engine down immediately and perform trouble shooting. If necessary contact the customer service department. Do not perform any temporary repairs yourself.
- Inspect the engine at least once every day, even better once per shift, for externally visible deficiencies and damage! In case of malfunction of the engine have the fault corrected immediately! This applies particularly for malfunctions which could impair the safety, shut the engine down!
- Make sure the engine does not overshoot after being shut down!

2.3 Fuels and lubricants

- **Diffusion fluids for flaw detection tests**
  - Danger of poisoning when working with trichloroethylene!
  - Wear goggles and safety gloves!
  - Avoid contact with skin and eyes!
  - Ensure sufficient ventilation!
  - Extract fumes, do not inhale!

- **Various cleansing agents**
  - Observe the safety instructions of the individual manufacturers.
  - Observe the waste disposal regulations, see also para.2.5.

- **Liquid nitrogen**
  - Observe the safety instructions of the manufacturer.
  - Wear goggles and safety gloves.
  - Risk of perfrigeration.
  - Disposal of fluid residues according to the instructions of the manufacturer, see also para. 2.5.

- **Fuel (liquid fuel or gas)**
  - Fuel fumes and gases are harmful, do not inhale.
  - Fuel fumes and gases are highly inflammable, do not smoke, do not use open fire, no formation of sparks.
  - Do not refuel in closed rooms. However, if this cannot be avoided ensure an adequate supply of fresh air.
  - Refuel only with the engine shut down.
  - Catch running out fuel. Do not let it seep into the ground!
  - Clean the engine from spilled fuel. Risk of combustion on hot engine parts.
- Always keep the tank tightly closed
- Do not lay cleaning cloths soaked in fuel on hot engine parts, risk of ignition.
- Ensure strict cleanliness.
- Do not open any components under pressure, e.g. injection lines or similar.
- When checking the injection jet keep your hands away from the fuel jet.
- Dispose of replaced filter cartridges environmentally.
- Observe the waste disposal regulations, see also para. 2.5.
- Work on injection pumps and on the control linkages between speed governor and injection pump are only permitted in emergencies and must be checked and, if necessary, readjusted by the DEUTZ service as soon as possible.

### Lubrication oil

- Oils in engine, transmission or hydraulic system can be under pressure or very hot after operation of the engine. Before starting work or inspections in such systems the pressure should be relieved by following the instructions of the manufacturer and safety gloves and goggles should be worn to avoid burning or scalding.
- Before starting work on oil circuits apply appropriate measures to collect possibly leaking out oil.
- Always ensure strict cleanliness.
- Before disassembling shut down the engine as specified in the operating instructions.
- Laboratory tests revealed that the permanent contact with engine oil will cause cancer. After work all skin areas in contact with engine oil should be thoroughly cleaned with water and soap.
- Do not lay oily cleaning cloths on hot engine parts, risk of ignition.
- Dispose of oily rags, filters etc. environmentally.
- Wipe up any spilled oil from the floor or any other walk-along areas immediately. Danger of slipping.
- Make sure that oil does not get in contact with rubber or plastic parts of the engine. Such components could be destroyed by oil and cause severe material damage or bodily injury during later operation.
- Dispose of any oil dropping down while taking oil samples or oil filter service environmentally together with the filter cartridge.
- Service the lubrication oil centrifuge only when the engine is stopped. Dispose of dirt and lubrication oil environmentally.
- Dispose of dirty lubrication oil environmentally.
- Dispose of oily air filter elements environmentally.
- Observe the waste disposal instructions, see para. 2.5.
Coolant
- Wear safety gloves and goggles.
- Let the coolant cool down before opening the cooling system.
- The coolant is under pressure.
- Open the radiator cap slowly, danger of scalding by coolant squirting out or steam.
- Do not touch any engine components or coolant pipes. These are also very hot, danger of burning.
- Coolant additives are partly toxic, therefore avoid contact with skin and eyes, if necessary wash off immediately.
- Do not drink any coolant, danger of poisoning.
- Dispose of drained off or spilled coolant as specified by the manufacturer, see also para 2.5. Do not let it seep into the ground.

Coolant pre-heating
- Observe the documentation issued by the manufacturer of the coolant pre-heating system.

With coolant pre-heating system in operation
- Hot coolant, danger of scalding, coolant system is under pressure.
- During pre-heating and engine operation the shut-off valves before and after the pre-heating unit must always be open, do not close!
- Do not touch any coolant conducting components, danger of burning.
- Before starting maintenance work switch the coolant pre-heating system off and make sure that it is not started again unintentionally. Switch of the power supply to the unit.

With coolant pre-heating system switched off
- The coolant system is under pressure.
- Before opening the coolant system the coolant must have cooled down.
- Close the shut-off valves at the coolant feed and discharge ports only before disassembling.
- During disassembly catch running out coolant, reuse it or dispose of environmentally, see also para 2.5.

2.4 Maintenance, inspection and repair
- Maintenance, inspection and repair work must generally be performed after the engine has been switched off and cooled down.
- With the engine in operation there is a risk of being injured by rotating and hot parts.
- The maintenance work specified in the operating instructions and in the workshop manual must be performed as scheduled and completely. This ensures problem free, secure and environmental operation of the engine.
- Compliance with all legal and engine specific accident prevention instructions and safety regulations is mandatory.

- The work described in the operating instructions and in the workshop manual require, among others, the replacement of parts as well as fuels and lubricants. These replaced parts / fuels and lubricants must be stored, transported and disposed of as prescribed.

- Secure the engine against unintended starting, if necessary disconnect the battery or close the shut-off valve on the pressure vessel.

- Attach a warning sign to the operator’s platform, e.g. „Do not start - maintenance work“.

- Have maintenance, inspection and repair work only performed by specially trained personnel.

- Clean engine and area around the engine thoroughly before starting work.

- Allow engine and machine components to cool down before starting work, if necessary wear safety gloves.

- Perform adjustments only with the engine shut down.

- If certain work is specified to be carried out with the engine running, all related safety regulations must be strictly followed.

- If the engine is installed in a vehicle, the respective vehicle must be parked on solid ground before starting work. The vehicle must additionally be secured against rolling.

- All tools needed for work must be clean and in perfect condition. Do not use tools misappropriately and do not make any temporary tools yourself.

- Use only the specified special tools.

- Use only the prescribed lifting gear and lifting tackle to remove assemblies or components.

- Place removed parts down well secured against tipping over, support if necessary.

- Use only liquid cleansers approved by the manufacturer to clean components or engine and dispose of these after use as specified by the manufacturer of the cleanser, see also para. 2.5.

- Do not use fuels or other combustible liquids for cleaning.

- Repair and cleaning work on fuel tanks must only be performed by specially trained personnel in compliance with all special safety regulations applicable for this purpose.

- When working on the fuel or gas system do not use open fire, do not smoke, no formation of sparks.

- Take care when disconnecting fluid conducting lines, the fluid may be hot and under pressure. Therefore relieve the pressure beforehand and apply preventive measures against scalding.

- Always wear safety gloves when checking for leaks in fluid systems. Fluid jets penetrating the skin can cause severe bodily injury.

- Route and fasten lines for fluids and electrical system in a professional manner. Length, fittings and quality of the line must comply with the requirements.

- Before starting welding or torch cutting work disconnect the engine from ground, disconnect possibly available engine control modules.
- Do not perform any repairs on safety valves. Replace defective parts immediately!

- Before resuming operation make sure that all guards and safety installations, that had probably been removed, have been reinstalled.

- Make sure that there are no unauthorized persons near the engine when resuming operation.

- **Electrics / electronics, general**
  
  - Before starting work in the electrics/electronics de-energize the system, pull the ignition switch off. Compliance with the accident prevention instructions for electrical systems, e.g. VDE-0100/-0101/-0104/-0105 electrical precautions against dangerous contact voltages - is mandatory.
  
  - Do not touch any current conducting parts!
  
  - Mind the high electric voltage on ignition systems.
  
  - When cleaning with fluids all electrical and electronic components must be tightly covered.
  
  - Return electronic scrap to a specially set up collecting place, see also para. 2.5. Do not dispose off together with the domestic waste.

- **Battery**
  
  - When working with or on the battery the following regulations must be observed:
  
  - Always wear protective clothing when working with or on batteries. Wear at least goggles and safety gloves.
  
  - The battery electrolyte contains acid. Contact with skin, eyes and clothes must be strictly avoided. However, in case of any contact with skin and clothes neutralize the acid drops immediately with an acid converter or soap suds and rinse off with lots of water.
  
  - In case of eye contact rinse out immediately with clear water for at least 15 minutes and consult a physician immediately.
  
  - If acid has been drunk call for medical help immediately.
  
  - Do not lay any tools on the battery (short circuit and danger of explosion).
  
  - Avoid the sparking when handling cables and electrical equipment.
  
  - Avoid short circuits.
  
  - During transport secure batteries against slipping and tipping over, insulate the plus pole.
  
  - When charging batteries open the individual cells, if this is possible, so that the the gases developing during the charging process can escape. These gases are harmful and explosive, therefore always ensure sufficient ventilation and avoid sparking and smoking.
  
  - Do not tip the battery over, acid may seep out of the degassing openings.
  
  - Be extremely careful when connecting and disconnecting the battery charger. Strictly comply with the operating instructions of the manufacturer of the battery charger.
  
  - Return old and defective batteries to the to the supplier or a specially set up collecting place, see also para. 2.5. Do not dispose of together with domestic waste.
2.5 Waste disposal / recycling / waste material

- **Waste disposal**

  Waste disposal includes measures and technical methods for the disposal of residues (e.g. metal, plastic material, rubber), fuels and lubricants (e.g. lubrication oil, coolant, fuel), other fluids (e.g. cleansing agents, degreasing agents) as well as waste material (e.g. sealing and screw retention agents, grease, glue).

  In this context recycling (reuse) of these residues, fuels and lubricants as well as waste materials has priority.

  Details concerning waste disposal and its monitoring are controlled by regional, national and international laws and regulations, which must be observed by the operating company in their own responsibility.

  It is recommended to file any evidence on the disposal of wastes that require special monitoring.

- **Recycling**

  Recycling is a general term for the material recovery of residues, fuels and lubricants as well as waste materials.

- **Waste materials**

  Waste materials are all mobile objects the owner wants to or hast to get rid of. Objects which arise during production or service work, as well as objects the owner no longer has any use for.

  The avoidance of waste material has priority.

  Unavoidable wastes should, as far as possible, be recovered materially or energetically.

  Waste to be disposed of is waste that cannot be recovered.