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.

Engine manufacturer:
Motoren-Werke Mannheim AG
(DEUTZ MWM)
Carl-Benz-Str. 5
D-68167 Mannheim

Tel.  (06 21) 3 84-0
Tx.  462341
Fax  (06 21) 3 84-83 86
This documentation is intended for the following engine.

● Engine type: 

● Application: 

● System name: 

● Rating: kW

● Speed: / min

● Commissioning on: 19

Please enter the relevant data. This will make it easier for us to help you in questions involving repairs, spare parts and after-sales service in general.

This documentation package is to be presented to the Service Partner responsible every time a service job is carried out.
Please read all the information contained in this manual, and follow the instructions carefully. You will avoid accidents, retain the manufacturer’s warranty, and will be able to use a fully functional and operational engine.

This engine has been built solely for the purpose appropriate to the scope of delivery concerned, as defined by the equipment manufacturer (intended use). Any other use shall be construed as not intended. The manufacturer shall not be liable for any damage resulting therefrom; all risks involved shall be borne solely by the user.

The term „intended use“ shall also include compliance with the operating, maintenance and repair conditions specified by the manufacturer. The engine may be used, maintained and repaired only by persons who are familiar with the work concerned and who have been properly informed of the risks involved.

Make sure that these operating instructions are available to everyone involved in operating, maintaining, and repairing the engine, and that they have all understood the contents.

Non-compliance with these operating instructions may result in engine malfunctions and even damage or injury to persons; the manufacturer will accept no liability in such cases.

Proper maintenance and repair work depends on the availability of all requisite equipment, tools and special implements, all of which must be in perfect condition.

Engine parts like springs, brackets, elastic holding rings, etc., involve increased risk of injury if not handled properly.

The relevant accident prevention regulations and other generally recognized rules relating to safety engineering and health and safety at work must all be complied with.

Maximized cost-efficiency, reliability and long lifetime are assured only if original parts from DEUTZ AG are used.

Engine repairs must correspond to the intended use. In the event of modification work, only parts approved by the manufacturer for the purpose concerned may be used. Unauthorized changes to the engine will preclude any liability of the manufacturer for resultant damage.
Dear customer,

The engines of the DEUTZ MWM brand have been developed for a broad spectrum of applications. A comprehensive range of different variants ensures that special requirements can be met for the individual case involved.

Your engine has been equipped to suit your own particular installation, and accordingly not all of the devices and components described in these operating instructions will actually be fitted to your engine.

We have endeavoured to present the differences involved as clearly as possible, to make it easier for you to find the operating and maintenance instructions you need for your own particular engine.

Please read this manual before you start up your engine, and follow the operating and maintenance instructions meticulously.

If you have any questions, just get in touch with us, and we will be pleased to answer them for you.

Yours sincerely,
DEUTZ AG
DEUTZ MWM engines
are the culmination of long years filled with research and development work. The in-depth know-how
thus acquired, in conjunction with high standards of quality, is your guarantee for engines manufactured
for long lifetime, high reliability and low fuel consumption. And of course, stringent criteria of
environment-friendliness are met as well.

Care and maintenance
are crucial factors in ensuring that your engine satisfactorily meets the requirements involved.
Compliance with the specified maintenance intervals and meticulous performance of care and
maintenance work are therefore absolutely essential. Special attention must be paid to any more
critical operating conditions deviating from the norm.

DEUTZ AG
In the event of malfunctions, or if you need spare parts, please contact one of our responsible service
agencies. Our trained and qualified staff will ensure fast, professional rectification of any damage,
using original parts.
Original parts from DEUTZ AG have always been manufactured to the very latest state-of-the-art.
You will find details of our after-sales service at the end of these operating instructions.

Careful when the engine is running!
Carry out maintenance or repair jobs only when the engine is at a standstill. If you remove any
protective features, fit them back in position after completing your work. Always wear tight-fitting
clothing if you are working on the engine while it is running.

Safety
You will find this symbol next to all safety instructions. Follow these meticulously. Pass on all safety
instructions to your operating staff as well. In addition, comply with the statutory general safety and
accident prevention regulations applying in your country.

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

Asbestos
The seals and gaskets used in this engine are asbestos-free. Please use the appropriate spare
parts for maintenance and repair jobs.
This page intentionally left blank.
0 Introduction

Imprint, foreword, quick introduction, contents

1 Advice to users

1.1 General remarks
1.2 Safety instructions / Accident prevention
1.3 Operating instructions and Workshop manual
1.4 Job cards
1.5 Spare parts

2 Job Cards

2.1 Overviews
  2.1.1 Arranged alphabetically
  2.1.2 Arranged by Job Card Numbers
  2.1.3 Explanation of symbols
2.2 Job Cards arranged by Job Card Numbers

Service
Please note:

Operating instructions for DEUTZ MWM TEM System are a separate documentation and has to be ordered separately.
<table>
<thead>
<tr>
<th>1</th>
<th>Advice to users</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>General remarks</td>
</tr>
<tr>
<td>1.2</td>
<td>Safety instructions / Accident prevention</td>
</tr>
<tr>
<td>1.3</td>
<td>Operating instructions and Workshop manual</td>
</tr>
<tr>
<td>1.4</td>
<td>Job cards</td>
</tr>
<tr>
<td>1.5</td>
<td>Spare parts</td>
</tr>
</tbody>
</table>
1 Advice to users

1.1 General remarks

The maintenance and servicing jobs specified in this manual must be carried out punctually and completely.

The maintenance and servicing staff must possess the necessary technical knowledge required for doing their jobs properly. Any safety and protective features which had to be removed during maintenance and servicing work must be fitted back in place after completion.

![Warning symbol]

The accident prevention and safety regulations must by always be complied with throughout all maintenance and servicing work.

Also note the special safety instructions for the various servicing groups which are listed in detail as job cards in the Chapter „Job Cards“ see also Chapter 1.2).

The maintenance and servicing intervals are given in the maintenance and servicing schedule, which also provides information on the jobs required.

The job cards (Chapter 9) give technical instructions on how to actually perform the jobs.

1.2 Safety instructions / Accident prevention

For various servicing groups, detailed safety advice has have been drawn up in the form of job cards; they are listed before the job cards of the respective servicing groups.

The statutory accident prevention regulations have to be complied with (obtainable from professional associations or in specialized bookshops). They depend on the installation site, the operating mode and the expendables and auxiliary materials used.

Special protective arrangements dependent on the particular jobs are indicated and marked in the job description.

In general, the following applies:

- for the personnel:
  - Only trained personnel may operate or maintain the engine. Unauthorized persons are not allowed to enter the machine room.
  - When the engine is in operation, wear only tight-fitting clothes and ear muffs in the machine room.
  - Use only professionally qualified staff for repair work.

- for the machine room:
  - Ensure sufficient ventilation (do not cover air shafts).
  - Provide first-aid kit and suitable fire extinguishers and check their contents and serviceability at regular intervals.
  - Only store combustible materials in the machine room if they are necessary for the operation of the system.
  - Smoking and open flames are not allowed in the machine room.

- for operation and maintenance of the engine:
  - Only start the engine when all protective devices have been installed and the turning device has been removed. Make sure that there is nobody in the danger area.
  - Only carry out any cleaning, maintenance and repair work when the motor is shut down and secured against starting.
1.3 Operating instructions and Workshop manual

In order to provide a user-specific information structure, the service documentation has been divided into the Operating Instructions and the Workshop Manual.

The Operating Instructions include a general description as well as instructions for all necessary maintenance jobs.

In detail, they contain the following chapters:

0 General remarks, Getting started, Contents
1 Advice for the user
2 Engine description
3 Operating the engine, with
   - Work routines before initial start-up and after every inspection
   - Work routines before start-up
   - Start-up
   - Operational monitoring
   - Shutting down the engine
   - Emergency operation if components fail (if necessary and possible).
4 Instructions for expendables
5 Maintenance and servicing, with
   - Tools and equipment overview
   - Maintenance and servicing schedules
6 Operational malfunctions, their causes and how to correct them
7 Engine conservation
8 Technical particulars
9 Job Cards, arranged by Job Card Numbers
10 Sundry other instructions (if not included in the appendix or in separate files)
   After-sales service
      • Global service directory.

The Workshop Manual presupposes knowledge of the contents of the Operating Instructions. This particularly applies to the safety instructions. It describes easy repair jobs and emergency measures on components, which are more elaborate to perform, and require appropriately qualified professional staff.

It contains the following chapters:

0 General remarks, Getting started, Contents
1 Advice for the user
2 Job Cards, arranged by Job Card Numbers
   After-sales service
      • Global service directory.

1.4 Job cards

The Job cards are divided into maintenance Job Cards of Operating instructions, for example B 1-1-1 and servicing Job Cards of the Workshop Manual, for example W 4-5-1.

For the numbering please refer to Fig. 101.

The structure of a Job Card is shown in Fig. 102.
Type of documentation

• The letter at the front signifies the type of documentation involved.
  ➞ B = Operating Instructions
  W = Workshop Manual

Maintenance Group (the same for all engines)

<table>
<thead>
<tr>
<th>Maintenance Group</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General remarks / cross-category jobs</td>
<td>Cylinder head</td>
<td>Drive mechanism</td>
<td>Crankcase</td>
<td>Engine control</td>
<td>Governor</td>
<td>Exhaust gas system / Charging</td>
<td>Fuel system</td>
<td>Lube oil system</td>
<td>Coolant system</td>
<td>Compressed air system</td>
<td>Monitoring system</td>
<td>Other components</td>
<td>Electrical system</td>
</tr>
</tbody>
</table>

Subsystem (component)

• The subsystems are distinguished by maintenance groups.
• Generally valid:
  ➞ 0 Cross-subsystem or Safety Regulations
  1 System parameters or general checks

Serial Number

• Counting per subsystem (component)
• Various jobs per subsystem (component)
• Version differences

B 3-3-3

Fig. 101 Numbering of the Job Cards
Fig. 102  Structure of the Job Cards

1  DEUTZ AG,  
editor of the service documentation
2  DEUTZ MWM, manufacturer, and  
engine type to which the Job Card refers  
3  Short title of the Job Card  
4  Number of the Job Card
5  Necessary tools, equipment, and  
spare parts
6  Reference to further Job Cards,  
instructions, etc.
7  Explanatory diagrams
8  Present page of total number of pages
9  Internal part number of the Job Card
10  Date of issue of the Job Cards
11  Sequence of operations, work procedure
12  Safety instructions and general hints
13  Full title of the Job Card

If you have any questions on the Job Card,  
please always state the engine type (2), the  
number (4), the page (8), the date of issue  
(10) or, as an alternative, the Internal part  
number (9).
1.5  **Spare parts**

You will receive spare parts from Messrs. DEUTZ AG. You will find a list of the spare parts in the engine's spare parts list.
2 Job Cards

2.1 Overviews
2.1.1 Arranged alphabetically
2.1.2 Arranged by Job Card Numbers
2.1.3 Explanation of symbols
2.2 Job Cards arranged by Job Card Numbers
## Job Cards

### 2.1 Overviews

#### 2.1.1 Arranged alphabetically

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<th>Job Card</th>
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<td>Bearing race (drive end): removing and installing</td>
<td>W 2-2-1</td>
</tr>
<tr>
<td>Bearing race (free end): removing and installing</td>
<td>W 2-2-3</td>
</tr>
<tr>
<td>Bearing shells: checking for wear and tear</td>
<td>W 2-1-3</td>
</tr>
<tr>
<td>Bearing spread: checking</td>
<td>W 2-1-1</td>
</tr>
<tr>
<td>Camshaft bearings: removing and installing</td>
<td>W 4-1-1</td>
</tr>
<tr>
<td>Camshaft: installing</td>
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</tr>
<tr>
<td>Camshaft: removing and checking</td>
<td>W 4-5-1</td>
</tr>
<tr>
<td>Connecting rod bearings: installing</td>
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<tr>
<td>Connecting-rod bearings and connecting rod: checking for roundness and conicity</td>
<td>W 2-3-1</td>
</tr>
<tr>
<td>Coolant preheater: removing and installing</td>
<td>W 9-9-1</td>
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<tr>
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<td>W 9-0-1</td>
</tr>
<tr>
<td>Crack inspection with the diffusion liquid procedure</td>
<td>W 0-3-2</td>
</tr>
<tr>
<td>Crankshaft sealing ring (drive end): removing and installing</td>
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<td>Crankshaft sealing ring (free end): removing and installing</td>
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<tr>
<td>Cylinder head: checking</td>
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<td>Cylinder head nuts: hydraulically loosing and tightening</td>
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<tr>
<td>Cylinder head: removing and fitting</td>
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<td>Foundation bolts: checking</td>
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<tr>
<td>Frequency generator: removing, installing and checking</td>
<td>W 5-3-13</td>
</tr>
<tr>
<td>Gear train: checking</td>
<td>W 4-8-1</td>
</tr>
<tr>
<td>Gear train: removing and installing</td>
<td>W 4-4-1</td>
</tr>
<tr>
<td>Hydraulic clamping device: filling and venting</td>
<td>W 0-0-1</td>
</tr>
<tr>
<td>Instructions for Work on the Electrical Equipment</td>
<td>W 13-0-1</td>
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<tr>
<td>Liquid Nitrogen: use of</td>
<td>W 0-3-1</td>
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<tr>
<td>Mixture cooler: cleaning on the air side</td>
<td>W 6-4-5</td>
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<tr>
<td>Mixture cooler: cleaning on the water side</td>
<td>W 6-4-4</td>
</tr>
<tr>
<td>Oil pressure control valve, removing, installing and checking</td>
<td>W 8-11-2</td>
</tr>
</tbody>
</table>
### Arranged alphabetically

<table>
<thead>
<tr>
<th>Jobs</th>
<th>Job Card</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piston cooling-oil jets: checking, removing and installing</td>
<td>W 2-15-1</td>
</tr>
<tr>
<td>Piston pin bush: removing and installing</td>
<td>W 2-12-2</td>
</tr>
<tr>
<td>Piston pin: removing and installing</td>
<td>W 2-12-4</td>
</tr>
<tr>
<td>Piston: removing and installing</td>
<td>W 2-9-3</td>
</tr>
<tr>
<td>Piston ring grooves and piston rings: checking</td>
<td>W 2-10-3</td>
</tr>
<tr>
<td>Piston rings: removing and installing</td>
<td>W 2-10-1</td>
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<tr>
<td>Sparking plug guard sheath: removing and installing</td>
<td>W 1-10-2</td>
</tr>
<tr>
<td>Torsional vibration damper: removing and fitting</td>
<td>W 12-1-4</td>
</tr>
<tr>
<td>Valve actuator bridges, guide bolts: removing and installing</td>
<td>W 1-2-3</td>
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<tr>
<td>Valve guides: checking, removing and installing</td>
<td>W 1-6-1</td>
</tr>
<tr>
<td>Valve lifter and valve lifter bracket: removing, checking and installing</td>
<td>W 1-2-2</td>
</tr>
<tr>
<td>Valve mechanism, bottom: removing, installing and checking</td>
<td>W 4-2-1</td>
</tr>
<tr>
<td>Valve rotating device: removing, checking, and installing</td>
<td>W 1-3-1</td>
</tr>
<tr>
<td>Valve seat ring: removing and installing</td>
<td>W 1-7-3</td>
</tr>
<tr>
<td>Valve seats: endoscoping</td>
<td>W 1-7-2</td>
</tr>
<tr>
<td>Valves and valve seat rings: checking</td>
<td>W 1-7-1</td>
</tr>
<tr>
<td>Valves: removing and installing</td>
<td>W 1-5-1</td>
</tr>
</tbody>
</table>
## 2.1.2 Arranged by Job Card Numbers

<table>
<thead>
<tr>
<th>Job Card</th>
<th>Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>W 0-0-1</td>
<td>Hydraulic clamping device: filling and venting</td>
</tr>
<tr>
<td>W 0-1-3</td>
<td>Engine: running in</td>
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<td>W 1-2-2</td>
<td>Valve lifter and valve lifter bracket: removing, checking and installing</td>
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<td>Cylinder head: checking</td>
</tr>
<tr>
<td>W 1-4-4</td>
<td>Cylinder head: removing and fitting</td>
</tr>
<tr>
<td>W 1-5-1</td>
<td>Valves: removing and installing</td>
</tr>
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<td>W 1-6-1</td>
<td>Valve guides: checking, removing and installing</td>
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<td>W 1-10-2</td>
<td>Sparking plug guard sheath: removing and installing</td>
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<tr>
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<td>Drive mechanism: Safety Instructions</td>
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<td>W 2-0-2</td>
<td>Deep-groove bearing: Replacement criteria</td>
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<td>W 2-3-1</td>
<td>Connecting-rod bearings and connecting rod: checking for roundness and conicity</td>
</tr>
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<td>W 2-5-1</td>
<td>Connecting rod bearings: removing</td>
</tr>
<tr>
<td>W 2-5-2</td>
<td>Connecting rod bearings: installing</td>
</tr>
<tr>
<td>W 2-9-3</td>
<td>Piston: removing and installing</td>
</tr>
<tr>
<td>W 2-10-1</td>
<td>Piston rings: removing and installing</td>
</tr>
<tr>
<td>W 2-10-3</td>
<td>Piston ring grooves and piston rings: checking</td>
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<tr>
<td>W 2-12-2</td>
<td>Piston pin bush: removing and installing</td>
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<td>W 2-12-4</td>
<td>Piston pin: removing and installing</td>
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<tr>
<td>W 2-15-1</td>
<td>Piston cooling-oil jets: checking, removing and installing</td>
</tr>
<tr>
<td>W 3-3-1</td>
<td>Cylinder liner: measuring</td>
</tr>
<tr>
<td>W 3-3-2</td>
<td>Cylinder liners: endoscoping</td>
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<tr>
<td>W 3-3-3</td>
<td>Cylinder liner: removing</td>
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<tr>
<td>W 3-3-4</td>
<td>Cylinder liner: installing</td>
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<tr>
<td>W 3-7-1</td>
<td>Foundation bolts: checking</td>
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</tbody>
</table>
### Arranged by Job Card Numbers

<table>
<thead>
<tr>
<th>Job Card</th>
<th>Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>W 4-1-1</td>
<td>Camshaft bearings: removing and installing</td>
</tr>
<tr>
<td>W 4-2-1</td>
<td>Valve mechanism, bottom: removing, installing and checking</td>
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<tr>
<td>W 4-4-1</td>
<td>Gear train: removing and installing</td>
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<tr>
<td>W 4-5-1</td>
<td>Camshaft: removing and checking</td>
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<tr>
<td>W 4-5-2</td>
<td>Camshaft: installing</td>
</tr>
<tr>
<td>W 4-8-1</td>
<td>Gear train: checking</td>
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<tr>
<td>W 5-3-13</td>
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<td>W 8-11-2</td>
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<td>W 9-0-1</td>
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<td>Instructions for Work on the Electrical Equipment</td>
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</tbody>
</table>
2.1.3 Explanation of symbols
You will find there are various symbols used on the Job Cards, in order to designate information not relating directly to the actual work sequence involved.

**Tools:**
- The tools normally required are listed against this symbol.

**Equipment:**
- Things like pressure gauges, lube oil and hydraulic oil

**Spare parts:**
- Seals, locking parts, etc.

**Cross-references:**
- Documents, reports or Job Cards to which reference is made in the Job Card concerned.

2.2 Job Cards arranged by Job Card Numbers
Filling and venting the hydraulic clamping device

Safety instructions for the hydraulic clamping device.

- Before fitting the hydraulic clamping device, clean and lubricate the threads and contact areas.
- Lubricant: tallow / red lead or lube oil (Molykote forbidden).
- Before commencing any work on the pressurized hydraulic clamping device, check all pressurized hoses and seals.
- When working on the pressurized hydraulic clamping device wear face protection and gloves, since hydraulic oil escaping from leaks would penetrate under the skin due to the high pressure involved.
- Repairs to the hydraulic clamping device are forbidden.
- Because of the accident risk, all parts of the hydraulic clamping device, particularly the high-pressure hoses, must be in perfect condition.
- Do not kink, sharply bend or pull the high-pressure hoses.

Equipment:
- Hydraulic oil 6.088.801.1011.8

For the hydraulic clamping device to operate properly, the entire piping/hose system must be air-free.
But carry out a venting procedure only when necessary, since normally the automatically closing safety coupling halves will prevent oil escaping and air penetrating.

For safety reasons, always close off unconnected but pressurized hoses with closure nipple.

1. Components of the clamping device

1. High-pressure pump
2. Oil tank
3. Pump lever
4. Filling aperture with threaded plug
5. Handwheel for return valve
6. Pressure gauge
7. High-pressure hose
8. Manifold
9. Safety coupling half
10. Hydro tension element
11. Safety coupling half (mating component)
12. Venting aperture with grub screw
13. Closure nipple

Fig. 1 High-pressure pump
2. How the clamping device works

With the aid of high-pressure pump 1, oil pressure is passed via high-pressure hoses 7 into the hydro tension elements 10.

The oil pressure is limited by a safety valve.

The oil pressure specified for tightening the screw connection is read off at pressure gauge 6. To reduce the oil pressure in the piping/hose system, turn handwheel 5 in its opening direction.

The high-pressure hoses 7 are connected to the hydro tension elements 10 and the manifold 8 via safety coupling halves 9 and 11.

If fewer than four hydro tension elements are connected at the same time, the coupling halves 9 located at the unused hoses will close these in a pressure-tight configuration (see also the instructions on Page 1).

The normal operating configuration of the high-pressure pump 1 is horizontal, but it can also run in a vertical position, with the hose connection facing downwards.
3. Filling and venting the clamping device

- Fill the high-pressure pump 1 only with hydraulic oil 6.088.801.1011.8, or if this is not available, with one of the hydraulic oils listed below:
  - BP Energol Hydraulic 50
  - Mobil Hydraulic-Oil L
  - BV High-Performance Oil (Hochleistungsöl) E 100
  - Shell Oil AB 1
  - Esso Zerice 36
  - Shell Tellus Oil 15
  - Gasolin Special AS
  - Viscobil Oil Sera I
  - Viscobil Oil CL40

- Using other oils may cause malfunctions due to swelling of the seals.

- Completely unsuitable substances include brake fluid, shock-absorber oil, diesel oil, kerosene and petrol.

- Filter the oil from time to time. When you do this, flush out the oil tank as well.

5. Malfunctions

In the event of malfunctions at the hydraulic clamping device, e.g. no or inadequate pressure build-up or pressure drop, proceed as follows:

- If the high-pressure pump 1 is in a vertical position (hose connection facing downwards), operate pump lever 3 rapidly several times, while alternately opening and closing the return valve by means of handwheel 5.

- Vent high-pressure hoses and hydro tension elements.

- When necessary, you should check that pressure gauge 6 is indicating accurately by comparing it with a calibrated pressure gauge. The reserve pressure gauge is fitted with a safety coupling half 11 for connection to one of the high-pressure hoses 7.

4. Work sequence

- Place high-pressure pump in a horizontal position.

- At the fill opening 4 of the oil tank 2, fill high-pressure pump 1 with not less than 1.5 litres of hydraulic oil.

- Connect high-pressure pump 1, pressure gauge holder 6, manifold 8 and hydro-tension elements 10 to the high-pressure hoses.

- Unscrew grub screw 12 of the hydro tension elements 10, and operate pump lever 3 until hydraulic oil exits without bubbles from vent aperture 12.

- During this procedure, the hydro tension elements 10 should be positioned at a higher level than high-pressure pump 1 and held at an angle to vent aperture 12, in order to make sure the annular compartment in the hydro tension element 10 is vented completely.

- Tighten grub screw 12.
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Running in the engine

The engines have been run in at the manufacturer’s facility, therefore any further running-in instructions can be dispensed with. If maintenance work has been performed on bearings, pistons, cylinder liners, or any of these have been replaced, then the engine must be run in anew.

Cross-references:
- Operating instructions, Chapter 4, “Technical Circular 0199 - 99 - 2105”

Running in the engine

- After starting the engine, perform a visual and acoustic inspection. In the event of leaks, loose or defective components, the engine must be shut down and the appropriate repair routine performed.

Perform the running-in routine in three stages

To reduce wear on the engine, we recommend performing load changes not abruptly but allowing for a transitional period of 2 to 3 minutes between the individual running-in stages for increasing the power.

- Stage 1 30 min.  50 % power
- Stage 2 15 min.  75 % power
- Stage 3 15 min.  100 % power

- During Stage 3 of the running-in program, check the engine’s operational values, and compare them with the acceptance test report. In the event of major deviations, find the causes and eliminate them.

- For lube-oil analysis and/or lube oil change, see Operating Instructions, Chapter 4, “Technical Circular 0199 - 99 - 2105”.

For lube-oil analysis and/or lube oil change, see Operating Instructions, Chapter 4, “Technical Circular 0199 - 99 - 2105”.
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Endoscopy is a method enabling you to examine the combustion compartment (piston, cylinder liner, cylinder head, valves) for its wear-and-tear status without having to remove the cylinder head beforehand. This means you can exploit the wear limits more effectively, and thus cut your maintenance costs.

When handling the endoscope, always follow the manufacturer’s instructions!

The endoscope image may be laterally transposed or upside down, depending on how you are looking into the lens.

Examining the combustion compartment

- In the case of diesel engines, remove the injection valve, see Job Card B 7-7-2.
- In the case of gas engines, remove the sparking plugs, see Job Card B 13-5-1.
- Place the piston of the cylinder you want to examine in its bottom dead centre position.
- Connect the endoscope, switch it on, and insert it cautiously through the injection valve or the sparking plug borehole.
- Carry out your examination using the eyepiece and the cold light source.

To enable the inlet and exhaust valves to be checked, the engine has to be turned appropriately. Be very careful to ensure that the endoscope is not damaged. Light reflections may lead to faulty diagnoses. You will also find it helpful to swivel the endoscope during your examinations, and tilt it alternatively from side to side, making sure that the fibre-optic cable is not damaged.

Tools:
- Endoscope

Cross-references:
- Job Cards B 7-7-2, W 7-7-6, B 13-5-1
If you find clearly recognizable damage (e.g. break-outs, notches, scoring), remove the cylinder head.

Always be on the lookout for drip formation at the bottom of the cylinder head. This indicates a possible leak at the seal of the injection valve or the sparking plug guard tube.

Evaluation of normal wear phenomena, and specification of the next endoscoping date can be performed only by properly trained experts.

Carefully take out the endoscope.

In the case of diesel engines, install the injection valve, see Job Card B 7-7-2 and Installation Instructions W 7-7-6.

In the case of gas engines, install the sparking plugs, see Job Card B 13-5-1.

Fig. 1  Checking with an endoscope
Use of Liquid Nitrogen

⚠️ Never touch liquid nitrogen and undercooled parts:
Risk of injury!

For occasional work of short duration, place two concentric containers into each other and fill the clearance between the two containers with glass wool, cork meal or sand.

Pour the nitrogen from the containers, in which it is delivered, into the special basin and then dip the metal parts into this liquid. The start of the undercooling process is indicated by heavy "boiling". Bubbles will form until the metal parts have assumed the nitrogen temperature (-196 °C). Once no more bubbles form, the parts are ready for installation.

Quantity of Nitrogen needed
Under normal conditions, one kilogram of metal to be cooled from +15°C to -196°C requires the following quantity of liquid nitrogen:

- 0.60 l for steel
- 0.66 l for cast iron
- 0.45 l for bronze, copper, brass
- 0.96 l for aluminium
Crack inspection with the diffusion liquid procedure

**Aids:**
- Cleaning agent (trichloroethylene)
- Diffusion liquid (red)
- Developer (white)
- Dry cloth
- Protective goggles
- Protective gloves
- Extractor device

---

**Cleaning the components**
- Wear protective goggles and protective gloves!
- Make sure the room is properly ventilated!
- Make sure the vapours are extracted. Never inhale them!
- Use cleaning agent to degrease the component.
- Allow the cleaning agent to act for 10 - 15 minutes.
- Rub down the surface you want to check with a dry cloth. This will get rid of all the grease residues which might otherwise fill in and cover up any cracks present, see Fig. 1.

**Applying the diffusion liquid**
- Apply diffusion liquid, see Fig. 2. Use a spray can, a spray gun, or a brush to do this, or immerse the component in the diffusion liquid.
- Allow the liquid to act for the time period specified by the manufacturer.
- Clean the component with water, until the diffusion liquid has been washed off the surface, and remains only in the cracks, see Fig. 3.
- Rub the surface thoroughly with a cloth to dry it.
- Allow the component to finish drying.

**Applying the developer**
- Use a spray gun or a brush to apply a thin film of developer. (Avoid applying twice to the same area).
- Allow the developer to dry for 1 - 2 minutes.

Due to the “blotting paper” effect of the developer, the diffusion liquid is sucked out of the crack, and thus becomes visible, see Fig. 4.
Assessment

- It may happen that very thin cracks do not become visible until several hours have passed.

- Due to the diffusion liquid being sucked upwards, red points will form in the white developer coating wherever there are cracks or other surface irregularities.

- Red lines indicate cracks.

- Red dots indicate pitting and porosity.

- A dotted red line will appear in the case of:
  - very fine cracks,
  - metal fatigue,
  - an only partial rupture.
Valve lifter and valve lifter bracket: removing, checking and installing

Removing the valve lifter and the valve lifter bracket

- Use the special pliers to withdraw the sparking plug connector, and remove the cylinder head hood.
- Turn the engine so that the tappet of the valve mechanism at the cylinder unit concerned is destressed, and the valves are closed, i.e. are positioned at ignition TDC.
- Unscrew fixing nut 3 of the valve lifter bracket 2, and lift off the valve lifter bracket together with the valve lifters 5 and 1.

Checking the valve lifter and the valve lifter bracket

The inspection routine for the removed parts covers checking free passage of the lube oil ways in the valve lifter bracket and in the valve lifters themselves (clean them if necessary), checking proper fit of the screw plugs for these lube oil ways, checking for wear and tear at the contact areas of the clamping screws 4, and checking the radial clearance between bearing journal and valve lifter bore (see table 1). Replace parts if necessary.

<table>
<thead>
<tr>
<th>[mm]</th>
<th>New clearance</th>
<th>Max. perm. clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearance between</td>
<td>0.050 … 0.091</td>
<td>0.130</td>
</tr>
<tr>
<td>bearing journal and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>valve lifter bore</td>
<td></td>
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</tbody>
</table>

Table 1 Clearance

Installing the valve lifter and the valve lifter bracket

- Place the valve lifter bracket on the cylinder head, positioning it by means of the centering bush and the dowel pin.
- Screw on fixing nut and tighten .
- Adjust valve clearance, see Job Card B 1-1-1.

Tools:
- Normal tools
- Special pliers for sparking plug connector
- Feeler gauge
- Caliper gauge

Cross-references:
- Job Card B 1-1-1
- Operating Manual, Chapter 8, Tightening instructions
Fig. 1  Valve actuator, parts
Valve actuator bridges, guide bolts: removing and installing

Check valve actuator bridges for zero-tilt mounting. If there is perceptible play, replace valve actuator bridges and/or guide bolts.

Tools:
- Normal tools
- Extractor

Aids:
- Nitrogen (liquid)

Cross-references:
- Job Card W 0-3-1, B 1-1-1, W 1-2-2

Removing the guide bolts for valve actuator bridges

- Remove valve lifter and valve lifter bracket, see Job Card W 1-2-2.
- Take off valve actuator bridges 2 with shims 3. Clean the parts.
- Check valve actuator bridges, shims and guide bolt 1 for wear and tear and traces of scoring. Replace any damaged parts.
- Bore the damaged guide bolt 1 inside to 8.5 mm. Cut an M10 thread, and withdraw guide bolt 1.

Installing the guide bolts for valve actuator bridges

- Supercool the bolt in liquid nitrogen (approx. -190°C), and insert it without using any force.
- The top edge must lie 46.0 mm above the adjoining cylinder head surface.
- Oil all the components of the valve mechanism.
- Fit valve actuator bridge onto the guide bolt with a shim.
- Install valve lifter and valve lifter bracket, see Job Card W 1-2-2.
- Adjust valve clearance, see Job Card B 1-1-1.

Fig. 1 Valve actuator

Never touch liquid nitrogen and undercooled parts: Risk of injury!
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Valve rotating device: removing, checking, and installing

**Tools:**
- Normal tools

**Cross-references:**
- Job Card W 1-5-1

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**Removing the valve rotating device**
- Remove valves, see Job Card W 1-5-1.
- Take out valve rotating device.

**Checking the valve rotating device**
- Clean the valve rotating device.
- Make a visual inspection to check for wear and tear.
- Check by hand that it moves freely.

⚠️ If you find no defects after this check routine, you can continue to use the valve rotating device. Otherwise replace the valve rotating device.

**Installing the valve rotating device**
- Insert the valve rotating device.
- Install valves, see Job Card W 1-5-1.
Cylinder head nuts: hydraulically loosening and tightening

The hydraulic clamping device makes it easier for you to loosen and tighten the cylinder head nuts.

**Tools:**
- Special tools
- Hydraulic clamping device

**Aids:**
- Lube oil

**Cross-references:**
- Job Card W 0-0-1

---

**Preparations**

- Fill and vent the hand pump, see Job Card W 0-0-1.
- Oil the anti-fatigue stud bolts 4; do not lubricate with Molykote.
- When mounting the cylinder head, tighten cylinder head nuts 5 in diagonally opposite sequence until they are hand-tight.
- Fit support tubes 3. They must be easy to turn, and must not be supported on the adjoining cylinder heads.
- Fit socket wrenches 2 onto cylinder head nuts 5. The marking rings 7 must be flush with the upper edges of the arbors 1 and the bores of socket wrenches 2.
- Fit tension elements 8. Check the centering support by turning it.
- Screw the puller bolts 6 onto the stud anti-fatigue bolts.

---

Fig. 1 Hydraulic element
Tightening and loosening

- Tighten the puller bolts hand-tight.
- When **tightening** the nuts, turn the puller bolts back by 90°.
- When **loosening** the nuts, turn the puller bolts back by 180°.

By tightening and then turning back the puller bolts, you will prevent the puller bolts and the cylinder head nuts locking each other when the pressure is bled off in the clamping device.

- Connect clamping devices 1 to hand pump 2 via high-pressure hoses, see Fig. 2.
  - **Do NOT operate** the hand pump before the high-pressure hoses have been properly secured!
  - **Never** place yourself in the direction of pull **behind or above** the hydraulic preclamping device, for as long as it is under pressure!

- Bring piston 9 of the tension elements into its starting position, see Fig. 1.
- Open vent screw 3 by one turn, see Fig. 2.
- Close drain plug 4, see Fig. 2.
- Operate pump lever 1, until 150....160 bar have been reached, see Fig. 2.
- Use arbor 1 to tighten all socket wrench and cylinder head nuts hand-tight, see Fig. 1.
- Slowly open drain plug 4, reduce pressure down to 0 bar, see Fig. 2.
- Close the drain plug.
- Operate pump lever until 720....730 bar have been reached.
- Use the arbor to tighten all socket wrench and cylinder head nuts hand-tight, see Fig. 1.

This hand-tight tightening procedure means 3...3.5 holes which can be turned further. If this is not the case, find and eliminate the cause (e.g. thread damaged, soiled with paint, erection error, device defective, etc.).

- Slowly open the drain plug, reduce pressure to 0 bar.
- Remove clamping devices.
Cylinder head: checking

The inspection intervals for cylinder heads can vary widely, depending on the engine’s operating conditions and loading, and on the quality of the fuel and the lube oil quality.

Tools:
- Normal tools
- Endoscope

Cross-references:
- Job Card W 0-3-2, W 1-3-1, W 1-4-1, W 1-5-1, W 1-6-1, W 1-7-1, W 1-7-2

Checking the cylinder head
- Make your inspection in conjunction with an endoscope, see Job Card W 1-7-2.
  - If you don’t have an endoscope available, you will have to remove a cylinder head. (Don’t choose one from the end of a cylinder row).
- Inspect the cylinder head with the worst-looking combustion compartment, following the procedure described below.
- Remove the cylinder head, see Job Card W 1-4-1.
- Check the combustion-compartment side of the cylinder head for cracks, see Job Card W 0-3-2.
- Check the screw plug for leaks.
- Flush the coolant compartment with cold cleaning agent; if there are significant scale deposits, use scale-dissolving agents to remove them (follow the manufacturer’s instructions).
- Remove valves, see Job Card W 1-5-1.
- Check valve lifter mounting for wear and tear.
- Check valve rotating device, see Job Card W 1-3-1.
- Check valve guide, see Job Card W 1-6-1.
- Check valves and valve seat rings, see Job Card 1-7-1.
  - If previous inspections have proved positive, the inspection routine for the other cylinder heads can be postponed for another combustion-compartment check interval. When this interval has elapsed, check the combustion compartments once more as detailed above.
  - If everything is again in order, then you can postpone inspection of all cylinder heads once more for another combustion compartment inspection interval.
  - If, however, you find excessive wear and tear at the cylinder head which you check, then you must check all the other cylinder heads as well, and repair them as necessary.
  - The number of operating hours run by the engine up to the date when all cylinder heads have to be checked for the first time is defined as the inspection interval for the cylinder heads.
- Install valves, see Job Card W 1-5-1.
- Fit cylinder head, see Job Card W 1-4-1.
Cylinder head: removing and fitting

Add-on pieces fitted to the engine will vary, depending on the options the client chooses, and the particular application concerned. This will, for example, apply to the exhaust gas system, the turbocharger equipment, and the electrics. These features may entail additional work. The procedures involved are not described here.

The safety instructions for work on the drive mechanism must be complied with as detailed in Job Card W 2-0-1.

Removing the cylinder head

- Drain off the coolant, see Job Card W 9-0-1.
- Remove all requisite covers.
- Take off air intake pipe, coolant drain pipe, exhaust gas collecting pipe, oil pressure line (if any), and oil return line, and use special pliers to withdraw the sparking plug connector.
- Remove combustion-compartment temperature probe from cylinder head.
- Remove valve lifter and valve lifter bracket, see Job Card W 1-2-2.
- Take off valve lifter actuator bridges.
- Remove fixing nuts for cylinder head. When using a hydraulic clamping device, see Job Card, W 1-4-0.
- Screw mounting device for lifting off the cylinder head onto the bolt of the valve lifter bracket mounting.
- Use the mounting device to carefully lift off the cylinder head.
- Take special care to ensure that the stud bolts do not get damaged.
- Once you have removed the cylinder head, place it on a wooden board.

Tools:
- Normal tools
- Mounting device for lifting off the cylinder head
- Rail for aligning the cylinder heads

Aids:
- Lube grease

Cross-references:
- Job Card W 1-2-2, W 1-4-0, W 2-0-1, W 9-0-1, W 1-4-2
Fitting the cylinder head

- Clean the cylinder head completely. Remove any remains of seals.
- Check cylinder head for damage, see Job Card W 1-4-2.
- Check threads of the four stud bolts along their entire length for faultless condition and easy nut movement.
- Check nuts and washers, replace if necessary.
- Clean the sealing surface on the cylinder liner.
- Clean the contact areas and seat surfaces for sealing rings and round sealing rings on the cylinder.
- Grease all the round sealing rings before fitting them.
- Fit a new cylinder head gasket, Fig. 1.
- Fit the two coolant transfer fittings 1 with new round sealing rings. Remember the flow direction of the coolant (chamfer), Fig. 2.
- Fit two new round sealing rings for the shock-absorber rod casing (if any) into the turned groove of the cylinder head. Don’t forget the grease!
- Also fit new (greased!) round sealing rings into the lower grooves of the shock-absorber rod casings.
- Insert casing with round sealing ring into the tappet bore of the crankcase.
- Fit the mounting device.
- Place cylinder head onto the stud bolts.
  
  ! Be careful not to damage the stud bolt threads. Insert the shock-absorber rod casings (with the shock-absorber rods inside them!) carefully from below into the fitted round sealing rings in the cylinder head.
- Lower the cylinder head slowly and carefully onto the crankcase.
- Screw on by hand all four cylinder head nuts (smooth side facing downwards, marked side facing upwards), with washers, and tighten them evenly by hand in a diagonally opposite sequence.
- Remove the mounting device.

 Align the cylinder head with the flange surface for the air collecting pipe. When more than one cylinder head is being mounted (or the entire row), you have to use a rail or this alignment procedure. If you are mounting only one or two cylinder heads, use the air collecting pipe for alignment purposes. Do not align on the exhaust pipe.
- Tighten the cylinder head nuts
  - With hydraulic clamping device,
    see Job Card W 1-4-0.

The cylinder head must lie completely evenly flush against the sealing ring.

To check, measure the gap dimension between the cylinder head and the crankcase, see Fig. 3.

Gap dimension: 0.6 to 1.25 mm

(same dimension ± 0.05 mm over the entire circumference of a cylinder head).

- Fit valve lifter actuator bridges.
- Install valve lifter and valve lifter bracket,
  see Job Card W 1-2-2.
- Fit combustion compartment temperature probe at cylinder head.
- Fit oil pressure line (if any), oil return line, exhaust gas collecting pipe, air intake pipe and coolant drain pipe, and attach the sparking plug connector.
- Fill with coolant.
- Fit covers.
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Valves: removing and installing

When working on the valve mechanism, you must take special care to keep everything absolutely clean. Never use magnetic tools.

**Tools:**
- Normal tools
- Removal and installation lever for valve springs

**Aids:**
- Wooden board
- Lube oil

**Cross-references:**
- Job Card W 1-2-2, W 1-4-4, W 1-7-1

---

**Removing valves**

- Remove cylinder head, see Job Card W 1-4-4.
- Place cylinder head with combustion-compartment side on something soft (e.g. wood).
- Remove valve lifters and valve lifter brackets, see Job Card W 1-2-2.
- Take off valve actuator bridges.
- Screw the removal lever for valve springs onto the bolt for the valve lifter bracket mounting.

**Accident risk!**

Springs are under tension.

- Fit shim on valve.
- Press down the valve spring.
- Remove the valve clamping cone.
- Destress the valve spring.
- Take out the valve spring disk, the valve spring and the valve rotating device.
- Lay the cylinder head lengthways.
- Pull the inlet and exhaust valves out of the valve guides.
- Check valves and valve seat rings, see Job Card W 1-7-1.
Installing the valves

- Replace the valve springs, clamping cones and valve spring disks.
- Oil the valve stem and valve guide.
- Insert valves 1 carefully, making sure that the round sealing ring in the valve guide does not get damaged.
- Fit valve rotating device, valve spring and valve spring disk 3.
- Place supports underneath the cylinder head so that the valve disks are flush.
- Fit shim 5 onto valve spring disk 3.
- Press down the valve spring 4.
- Insert the valve clamping cone 2.
- Destress valve spring 4.

Never destress the valve spring disk upwards while the valve spring is still tensed, if the valve clamping cones 2 are not clamping properly in the specified configuration (X = wrong, Y = right).

The valve clamping cones 2 must slide into the inside cone of the valve spring disk, and are then fixed in position, see Fig. 3.

- Use a plastic hammer to tap briefly on the end surface of the valve stem.

Don’t tap the valve spring disk itself.

- In order to check whether the valve cone pieces are properly fitted, press the valve spring disk downwards with the shim.

The spring disk must resist being detached from the valve cone pieces, and when it does come free, this must happen with a jerk, since the valve cone pieces clamp into the valve stem (bead into the groove). Then destress the valve spring disk again, and tap on the end surface of the valve stem briefly once more with a plastic hammer.

If the valve spring disk can be easily detached from the valve clamping cones easily and without a jerk, this means the cones were not fitting properly into the valve stem, and have to be replaced.

- Fit valve actuator bridge.
- Install valve lifter and valve lifter bracket, see Job Card W 1-2-2.
- Fit the cylinder head, see Job Card W 1-4-4.
Valve guides: checking, removing and installing

When a cylinder head is being repaired, the valve guides must be checked for wear and tear.

If the inside diameter of the valve guides is greater than 11.11 mm, they must be replaced. Likewise if there is excessive scoring.

Removing the valve guides

- Removing the valves, see Job Card W 1-5-1.
- Use a press and a press-out mandrel to press out the valve guides.

After pressing out the guide, check the location hole in the cylinder head. If the hole is larger than 18.018 mm or is damaged, the cylinder head must be reworked in a DEUTZ MWM Service to ensure the correct overdimension. (At a hole diameter of > 19.018 mm, the cylinder head must be replaced.)

Installing the valve guides

- Supercool the valve guides in liquid nitrogen (approx. -190 °C). Insert them dry (i.e. without oil), using no force, into the location hole of the cylinder head, with the end stepped by 1 mm in diameter going first. Use a press-in mandrel for guidance.
- Make sure the protruding dimension $C = 23.0 \pm 0.200$ mm above the contact area of the valve rotating device is correct.
- Working with liquid nitrogen, see Job Card W 0-3-1.
- To check, test whether a long mandrel moves freely in the valve guide.
- If it does not move freely, you must rework with a single-stroke honing tool. NEVER ream it!
- Wet new round sealing ring 2 with engine oil, and insert in valve guide 1.
- Install valves, see Job Card W 1-5-1.

Tools:
- Normal tools
- Digital caliper gauge
- Press-out mandrel
- Press-in mandrel
- Single-stroke honing tool
- Inside calipers

Aids:
- Engine oil
- Nitrogen (liquid)

Cross-references:
- Job Card W 1-5-1, W 0-3-1

Fig. 1 Valve guide
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Valves and valve seat rings: checking

Defective engine condition, poor fuel and cooling water conditioning, and inadequate preheating, impermissible torque operation (speed drop with ongoing engine block), etc., may cause premature failure of valves.

Tools:
- Normal tools
- Digital caliper gauge
- Magnifying glass (at least 4-fold magnification)

Aids:
- Distillate fuel

Cross-references:
- Job Card W 1-5-1

Checking the valves and valve seat rings
- Remove the valves, see Job Card W 1-5-1.
- Clean the seat surface to remove any residues.
- Use a scraper to remove any coking on the valve disks and seat rings, and wash down with distillate fuel.

To make it easier to remove water-soluble residues with a sulphur content, the run valve cones can be placed in water for a few hours.

Checking the valves
The valve cones can continue to be used, provided the following preconditions are met:
- seat surface without any burn-outs, blow-throughs, cracks, or impact traces,
- no damage to the chrome layer,
- no corrosion scars,
- stem diameter min. 10.93 mm,
- no damage to the clamp cone groove.

The seat surface of the valve cone must be repaired if:
- the cleaned seat surface is not free of coke impacts, blow-throughs, pittings and other damage (check with a magnifying glass).

Checking the valve seat rings
The valve seat rings can continue to be used, provided the following preconditions are met:
- seat surface without burn-outs, blow-throughs, cracks or impact traces.

If the valve seat rings exhibit coke impacts, scoring, stepping or corrosion, etc., the seat surfaces of the valve seat rings must be repaired in their installed state.
- Install valves, see Job Card W 1-5-1.

Reworking of the valve seat rings may be carried out only by an authorized workshop.
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Valve seat ring: removing and installing

If the damage involved cannot be eliminated within the permissible reworking limits, or if the maximum permissible residual dimension between bottom edge of valve and the bottom of the cylinder head cannot be complied with, even when new valves are fitted, then the valve seat rings must be replaced.

**Tools:**
- Normal tools
- Electric welding unit
- Inside calipers
- Digital caliper gauge
- Press

**Aids:**
- Nitrogen (liquid)

**Cross-references:**
- Job Card W 1-5-1, W 1-7-1, W 0-3-1

Removing the valve seat rings

- Remove the valves, see Job Card W 1-5-1.
- Check valves and valve seat rings, see Job Card W 1-7-1.
- Place a Ø 2 mm electric welding electrode at 130 A around the valve seat ring. The deformation will cause the valve seat ring to drop out.

Do not set a higher current, otherwise you may damage the cylinder head.

Check reference dimensions for valve seat ring.
- Location hole in the cylinder head, table 1.

<table>
<thead>
<tr>
<th>[mm]</th>
<th>Inlet</th>
<th>Exhaust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve seat ring</td>
<td>Ø  60 +0.019 -0</td>
<td>Ø  58 +0.019 -0</td>
</tr>
<tr>
<td>Hole depth</td>
<td>15 +0.02 +0.05</td>
<td>15 +0.02 +0.05</td>
</tr>
</tbody>
</table>

Table 1 Dimensions

Installing new valve seat rings:

- Supercool inlet and exhaust valve seat rings in liquid nitrogen (approx. -190°C) and insert them without applying any force. Use a press to press in the valve seat rings, using a force of 12000 N (approx. 1200 kp), and maintaining this pressure force for not less than 15 seconds.
- Newly fitted valve seat rings must be ground in together with the associated valves.
- Install valves, see Job Card W 1-5-1.
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Removing and installing the sparking plug guard sheath

Comply with the tightening instructions given in the Operating Manual, Chapter 8, „Technical Data“.

Tools:
- Normal tools
- Special nut for removing the bottom guard sheath

Aids:
- Screw-locking compound

Cross-references:
- Job Card W 1-2-2
- Operating instructions, Chapter 8, tightening instructions

Removing the guard sheath
- Remove valve lifter and valve lifter bracket, see Job Card W 1-2-2.
- Take off valve actuator bridges.
- Remove sparking plug.
- Unscrew top guard sheath 1.
- Remove bottom guard sheath.

Installing the guard sheath
- Clean the bottom guard sheath, fit new seals, apply screw-locking compound, insert sheath in the cylinder head, and tighten.
- Screw the top guard sheath into the cylinder head, with screw-locking compound, and tighten.
- Install sparking plug.
- Fit valve actuator bridges.
- Install valve lifter and valve lifter bracket, see Job Card W 1-2-2.

Fig. 1 Sparking plug guard sheath

Comply with the tightening instructions given in the Operating Manual, Chapter 8, „Technical Data“.
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Safety rules for working on the drive mechanism

⚠️ When you are performing any work on the drive mechanism, you MUST always comply with the following rules.

⚠️ Danger of burst!

Before starting work
- Shut down the engine, and secure it against being started up again.
- If necessary, drain off lube oil and/or coolant, and collect it for re-use. Caution: risk of scalding!
- With diesel engines, open the indexing cocks. With gas engines, remove the spark plugs.
- If it is fitted on your engine, open the inspection hole cover 10 minutes at the earliest AFTER the engine has been shut down, and after oil circulation has been interrupted.
- Do not perform any other work on the drive mechanism until the engine has cooled down sufficiently. The engine must have cooled down enough to ensure that there is no longer any risk of burns.
- When working on the exhaust gas system, remember that in spite of long cooldown ties some components may still be hot. Heat guard plates can have sharp edges, so wear protective gloves.
- Do not start the work until a sufficient ventilation period has elapsed.
- Make sure that the environment is clean in which the engine is going to be opened up.

During the work
- Make sure that no dirt can penetrate into the drive compartment.
- Before turning the crankshaft, check that:
  - the turning device has engaged properly,
  - there are no persons working in or at the engine,
  - no tools are impeding the crankshaft from turning and might thus cause damage,
  - the drive mechanism is not being put out of equilibrium by the removal of drive mechanism parts.
- Make sure that the engine cannot turn unintentionally.

After finishing work
- Before you close the engine, check whether you have removed all tools, cleaning cloths, etc. from the crank compartment.
- Fit inspection hole cover (if any), with new seals.
- Before starting up, turn the engine with open indexing cocks or (in the case of gas engines) with spark plugs not installed.
- With diesel engines, close indexing cocks. With gas engines, install spark plugs.
- Fill with lube oil. Top up coolant, vent cooling system, and check for leaks.
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Drive mechanism: checking

The safety instructions for work on the drive mechanism must be complied with as detailed in Job Card W 2-0-1.

Tools:
- Normal tools
- Turning device

Cross-references:
- Job Card W 2-0-1, W 2-15-1

When you are doing this work, take care to ensure that the spray jets of the piston cooling systems do not get bent, see Job Card W 2-15-1.

- Feel the bearing covers at the crankshaft and connecting rods, to check whether they are exhibiting a uniform temperature.
- Check the drive mechanism for soiling. Pay special attention to checking for bearing metal in the oil pan, and for corrosion and water leaks.
- Make a careful check of the cylinder liner contact surface on the liner seals on the drive compartment side. Note that when you do this the pistons must be at TDC.
- Carry out a lubrication check:
  - Operate and check the prelubrication pump, to see whether lube oil exits visibly at every bearing.
  - Take off the cylinder head hood. Carry out a corresponding check at the valve lifter bearings.
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Checking the bearing spread

The bearing shell must exhibit a positive spread, so that it is properly flush against the acceptance bore when it has been installed.

All new bearing shells exhibit a positive spread, unless they have been incorrectly handled (e.g. in transit).

Tools:
- Slide gauge

1. Definition
Positive spread:
Measured at room temperatures, Dimension „a“ is greater than Dimension „D“.

Negative spread:
Dimension „a“ smaller than Dimension „D“.

Crankshaft bearing: Dimension „D“ etched into the end fact of the bearing shell,

Connecting-rod bearing: must be measured directly at the bearing cover.

2. Assessment
If a used bearing shows negative spread, this may (if no other reasons can be detected) be an indication that the bearing has undergone plastic deformation due to overheating and has thus lost its initial tension.

Bearing shells with a negative spread must no longer be used.

Do not attempt to correct with any tool, since there is a risk that the bearing metal will become detached from the support shell, or that the bearing will be deformed. This sort of damage can lead to serious operational malfunctions.

3. Setpoint values

<table>
<thead>
<tr>
<th>[mm]</th>
<th>Conn. rod b.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spread „a“</td>
<td>135.025 +0.4</td>
</tr>
</tbody>
</table>
Visual inspection of the bearing shells

Please take the precise point in time when to inspect the connecting-rod and crankshaft bearings from the operating instructions, “Maintenance and Servicing”.

Tools:
- Magnifying glass, 5-fold magnification

Cross-references:
- Job Cards W 2-1-1, W 2-7-2, W 2-9-1, W 2-9-3
- Operating instructions

How to proceed:

You must check the bearing shells by means of a visual inspection and by checking the bearing shell spread.

Under a basic overhaul routine (for precise intervals see operating instructions “Maintenance and servicing”), connecting-rod and crankshaft bearings must always be replaced.

Removing the bearing shells

- Remove piston with connecting rod, see Job Card W 2-9-1 and/or W 2-9-3.
- Remove main bearing, see Job Card W 2-7-2.
- Check bearing spread, see Job Card W 2-1-1

Visual inspection of the slide bearings

Running pattern of the bearing shells

Material: steel/aluminium alloy

Depending on the number of operating hours and on the operating conditions involved, used bearing shells will exhibit different running patterns. The essential differences can often be recognized only by a properly trained and specialized expert. If in doubt, we recommend you to consult DEUTZ service for the assessment of the bearing shells concerned.

If the inspection reveals a poor running pattern on the connecting-rod bearings and/or deep dirt scoring or a lot of embedded dirt, then you must additionally check a crankshaft bearing.
The contact pattern is evenly formed over the entire width of the bearing. As practical experience has shown, the dirt scoring caused by a foreign body in the lube oil has no significant effect on the slide bearing's further operational dependability.

The bearing shell’s contact pattern is faultless.

This bearing shell can be re-used. Fig. 1.
The contact pattern is evenly formed over the entire width of the bearing.

The bearing shell’s contact pattern is impeccable.

This bearing shell can be re-used. Figs. 2 and 3.
The contact pattern is evenly formed over the entire width of the bearing. The radial-configuration scoring is caused by fine solid particles contained in the lube oil.

If the depth of this scoring can neither be measured nor felt, the bearing shell in question may be re-used. If the depth of such scoring reaches or even exceeds the lube-oil film's order of magnitude, the bearing shell must be replaced. Figs. 4 and 5.
Fig. 6 Bearing shell, cannot be re-used

The contact pattern shows a marked edge carrier with traces of scoring in the slide layer made of aluminium alloy.

You must find out what caused this slide-bearing damage, and eliminate the cause. Fig. 6.

This bearing shell cannot be re-used.
Drive mechanism
Job Card
W 2-1-6
DEUTZ MWM
Gas engines

Fig. 7  Bearing shell, cannot be re-used

The contact pattern exhibits large-area damage with varying degrees of scoring.
You must find out what caused this slide-bearing damage, and eliminate the cause. Fig. 7.
This bearing shell cannot be re-used.

The loaded area of the bearing shell exhibits broken-off bearing metal pieces. Some broken-off pieces are lying around loose in the fatigue zone.
These have been caused by fatigue in the slide layer of the aluminium alloy. The surface structure at the bottom of the break-out indicates good bonding between steel and aluminium alloy.
This bearing shell cannot be re-used. Fig. 8.

Fig. 8  Bearing shell, cannot be re-used
This bearing shell exhibits broken-off bearing metal pieces.

These have been caused by fatigue in the slide layer of the aluminium alloy. The surface structure at the bottom of the break-out indicates good bonding between steel and aluminium alloy.

This bearing shell cannot be re-used. Fig. 9.
Visual inspection of the deep-groove bearings

Running pattern of the bearing shells

Material: steel/aluminium alloy

In its as-new condition, the contact surface exhibits approx. 75 % electroplated contact layer and approx. 25 % of light metal.

- Use a magnifying glass to assess the wear-and-tear status of the contact surface (magnification at least 5-fold). Contact surface is visible as the dark zone and the light-metal rib as the light-coloured zone.

- Crucial for wear-and-tear status:
  - Ratio of width of light-metal rib and width of groove, plus
  - Extent of the worn surface.

- Each time you are assessing groove states, you must adduce the contact surface in the less loaded area (in most cases groove status as new) as a comparison.

A distinction must be made between the following cases:

**Case 1 (Fig. 10):**

Definition of the contact-surface areas

1. Max. 30 % of the shell’s circumference
2. Max. 70 % of the width
3. Max. 50 % of the shell’s circumference
4. Max. 35 % of the width
5. Wear-and-tear 1 : 1

Assessment

In places, the bearing is worn to such an extent that the bearing metal ribs and the grooves in the contact layer have reached a ratio of 1 : 1. The width of the bearing metal ribs has increased from 25 % (as-new condition) to 50 %. There is still some contact layer left in the grooves.

If a wear-and-tear status as described in Case 2 below must be anticipated within the next inspection interval, then the bearing must be replaced.
Case 2 (Fig. 11):

Definition of the contact-surface areas

1. Max. 20 % of the width
2. Max. 5 % of the shell’s circumference
3. Max. 10 % of the width
4. Max. 35 % of the shell’s circumference
5. Max. 10 % of the width
6. Comb wear
7. Wear and tear 1 : 1
8. Bearing metal ribs worn

Assessment
The bearing metal ribs are worn in places.
When this wear-and-tear status has been reached, the bearing must be replaced.
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Removing and installing the bearing race (drive end)

The safety instructions for work on the drive mechanism must be complied with as detailed in Job Card W 2-0-1.

Comply with the tightening instructions given in the Operating Manual, Chapter 8, „Technical Data“.

Tools:
- Normal tools
- Sealant Hylomar

Cross-references:
- Job Card W 2-0-1, W 2-2-2, W 12-6-1
- Operating Instructions, Chapter 8, Tightening Instructions

After a lengthy period of running, a lead-in groove on the bearing race 2 will form underneath the sealing lip of the shaft sealing ring 1. Provided the shaft sealing ring is not replaced, this will in most cases not impair the sealing effect.

Install a new shaft sealing ring, see Job Card W 2-2-2, in the end wall cover, axially offset by approx. 3 mm, so that it effectively seals next to the old lead-in groove. In the case of the end wall cover at the coupling-end, this is possible only if the distance between the old groove and the free end of the bearing race is not less than 7.5 mm. Otherwise (and if the shaft sealing ring has already been repositioned once) you will have to replace the bearing race.

Removing and fitting the flywheel
see Job Card W 12-6-1.

Removing the bearing race
- Remove flywheel flange 3.
- Apply a thin welding bead or individual welding spots at regular intervals on the bearing race.
- Take off bearing race.
- If necessary, cut through the bearing race with a flat chisel, in the longitudinal direction of the crankshaft. Take care not to damage the crankshaft.
- Remove the residues of the old sealant, to ensure an absolutely clean surface.

Installing the bearing race
- Apply sealant.
- Press the new bearing race on, with the larger diameter at the front (the inner diameter of the bearing races is slightly conical).
- Press the ring on, evenly and without tilting it (use a “soft” interlayer). The shoulder of the flywheel flange must be evenly flush all the way round.

Fig. 1, X: flush with the worked outer surface

After pressing on:
- Check that the lead-in bevel for the shaft sealing ring is in faultless condition.
- Fit the flywheel flange, and tighten the anti-fatigue bolts 4 as specified in the Operating Instructions, Chapter 8, Tightening Instructions.
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Removing and installing the crankshaft sealing ring (drive end)

The safety instructions for work on the drive mechanism must be complied with as detailed in Job Card W 2-0-1.

Tools:
- Normal tools
- Sealant Loctite 574

Cross-references:
- Job Card W 2-0-1, W 2-2-1, W 12-6-1

Different shaft sealing rings are fitted at the flywheel and vibration-absorber ends, and you must be careful not to mix them up. The ones at the free end (= vibration-absorber end) have a right-hand twist, and the those at the drive end (= vibration-absorber end) have a left-hand twist.

Removing and fitting the flywheel

see Job Card W 12-6-1.

Take note of the markings

There is a directional arrow and letters reading “Schwungradseite” (flywheel end) and “Schwingungsdämpferseite” (vibration-absorber end) outside on the dust lip.

Removing the crankshaft sealing ring

Replace shaft sealing ring 1 only if there is a leak or (after dismantling operations) if there is visible wear and tear at the sealing lip (width greater than 1 mm).

- Check contact surface of the shaft sealing ring on the bearing race 2; replace the bearing race if necessary, see Job Card W 2-2-1.
- After installing the bearing race, check that the lead-in bevel for the shaft sealing ring is in faultless condition.

Fig. 1 Crankshaft sealing ring
Installing the crankshaft sealing ring

- Oil the shaft sealing rings thoroughly before fitting them.
- Install only original DEUTZ-MWM shaft sealing rings, so as to ensure a reliable sealing effect. Always install the shaft sealing ring with the open side facing inwards.

Installation position for the shaft sealing ring

- Seal the outer surface with Loctite 574.

![Diagram](https://example.com/diagram.png)

When you press the shaft sealing ring into the end wall cover, do it **evenly** and **without tilting** (use a help device if necessary).

When you are installing sealing rings with a 3 mm axial offset, always use a suitable, stepped device (journal diameter of device 214 mm).

Fig. 1, X: flush with worked outer surface
Removing and installing the bearing race (free end)

The safety instructions for work on the drive mechanism must be complied with as detailed in Job Card W 2-0-1.

Tools:
- Normal tools
- Sealant Hylomar

Cross-references:
- Job Card W 2-0-1, W 2-2-4, W 12-1-4
- Operating Instructions, Chapter 8, Tightening Instructions

Under unfavourable operating conditions, and after a lengthy period of running, lead-in grooves on the bearing race 2 may form underneath the sealing lip of the shaft sealing ring 1. Provided the shaft sealing ring is not replaced, this will in most cases not impair the sealing effect.

Install a new shaft sealing ring, see Job Card W 2-2-4, offset by approx. 3 mm, so that it effectively seals next to the old lead-in groove. If the shaft sealing ring has already been repositioned once, you must replace the bearing race.

Removing and fitting the torsional vibration absorber.

see Job Card W 12-1-4

Removing the bearing race

- Remove torsional vibration absorber flanges 3.
- Apply a thin welding bead or individual welding spots at regular intervals on the bearing race.
- Take off bearing race.
- If necessary, cut through the bearing race with a flat chisel, in the longitudinal direction of the crankshaft. Take care not to damage the crankshaft.
- Remove the residues of the old sealant, to ensure an absolutely clean surface.

Installing the bearing race

- Press the new bearing race on, with the larger diameter at the front (the inner diameter of the bearing races is slightly conical).
- Press the ring on, evenly and without tilting it (use a "soft" interlayer). The race must be evenly flush with the hub all the way round.

Fig. 1, X: flush with the worked outer surface

After pressing on:

- Check that the lead-in bevel for the shaft sealing ring is in faultless condition.
- Mount vibration-absorber hub and fit vibration absorber. Tighten anti-fatigue bolts 4 as specified in the Operating Instructions, Chapter 8, Tightening Instructions.
This page intentionally left blank.
Removing and installing the crankshaft sealing ring (free end)

The safety instructions for work on the drive mechanism must be complied with as detailed in Job Card W 2-0-1.

**Tools:**
- Normal tools
- Sealant Loctite 574

**Cross-references:**
- Job Card W 2-0-1, W 2-2-3

At the flywheel and vibration absorber ends, you will find different shaft sealing rings, and you must be very careful not to get these mixed up. The one at the free end (vibration absorber end) has a right-hand twist, and the one at the drive end (flywheel end) has a left-hand twist.

**Check the identifiers**
Sense-of-rotation arrow and labelling “Schwungradseite” (= “flywheel end”) or “Schwingungsdämpferseite” (= vibration absorber end) outside on the dust lip.

**Removing the crankshaft sealing ring**
- Replace the shaft sealing ring 2 only if there is a leak or (after removal) you find visible wear and tear at the dust lip (width greater than 1 mm).
- Check the contact surface of the shaft sealing ring on the bearing race 1; replace the bearing race if necessary, see Job Card W 2-2-3.
- After installing the bearing race, check that the lead-in bevel for the shaft sealing is in faultless condition.
Installing the crankshaft sealing ring

- Before fitting them oil the shaft sealing rings thoroughly.
- Install only original DEUTZ-MWM shaft sealing rings, to ensure a reliable sealing effect. Always make sure the open side of the shaft sealing ring is facing inwards.

Installation position for the shaft sealing ring

- Seal the outer surface with Loctite 574.

⚠️ When pressing the shaft sealing ring into the end wall cover, make sure you do so evenly and without tilting (use the help device if necessary).

When installing shaft sealing ring with a 3 mm axial offset, you must always use a suitable, stepped device (device's journal diameter 214 mm).

Fig. 1, X: flush with worked outer surface
Checking connecting-rod bearings and connecting rod for roundness and conicity

The connecting-rod bearing shells must be measured in the associated, removed and already-measured connecting rod before being installed in your engine.

Tools:
- Normal tools
- Two-step measuring instrument
- Caliper gauge

Cross-references:
- Job Card W 2-1-1, W 2-1-3, W 2-5-2

Checking the connecting-rod bearing shells in their installed condition

- Assess the bearing shells, see Job Card W 2-1-3.
- Check the bearing shells’ spread dimension, see Job Card W 2-1-1.
- Install bearing shells, and attach connecting-rod bearing covers.
  Use the measured values obtained to determine the roundness (out-of-roundness) and conicity W 2-5-2.
- Carry out the following check in the centre of the bearing:
  - measure diameters “a”, “b” and “c”.
- Use the measured values obtained to determine out-of-roundness and conicity.
  If the limit values specified below are exceeded, remove the bearing shells and the bearing covers, and clean the gearing again thoroughly.
- Carry out check routine as described above.

Tools:
- Normal tools
- Two-step measuring instrument
- Caliper gauge

Cross-references:
- Job Card W 2-1-1, W 2-1-3, W 2-5-2

Designation: Nominal dimension in mm: Limit values in mm:

<table>
<thead>
<tr>
<th>Designation</th>
<th>Nominal dimension in mm:</th>
<th>Limit values in mm:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conn. rod head, with bearing shells fitted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Normal</td>
<td>125.099 - 125.155</td>
<td>max. 125.190</td>
</tr>
<tr>
<td>- Rep. Stage 3</td>
<td>123.899 - 123.955</td>
<td>max. 123.990</td>
</tr>
<tr>
<td>- Roundness (out-of-roundness) / conicity</td>
<td>max. 0.04</td>
<td>max. 0.065</td>
</tr>
<tr>
<td>Bearing clearance (Bearing shells / crankshaft)</td>
<td>0.095 - 0.185</td>
<td>max. 0.230</td>
</tr>
</tbody>
</table>

Fig. 1 Bearing shell diameters
If the bearing shells pass all the above-mentioned checks, they can be re-used.
If the permissible values are not reached, you have to measure the connecting-rod head borehole.

**Checking the connecting-rod head borehole (conn. rod foot / conn. rod bearing cover)**

- Assemble connecting-rod stem and connecting-rod bearing covers **without bearing shells**, as described in Job Card W 2-5-2.
- Carry out the following check in connecting-rod head’s bearing centre:
  - measure diameters “a”, “b” and “c”.
- Enter your measured values in a record sheet, stating the operating hours, the date, and the No. of the connecting rod you have checked.
- Use the measured values obtained to determine the roundness (out-of-roundness) and conicity

  ![Fig. 2 Connecting-rod head borehole](image)

  If the values detailed below are exceeded, replace the connecting rod concerned.

<table>
<thead>
<tr>
<th>Designation</th>
<th>Rated dimension in mm:</th>
<th>Limit values in mm:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Conn. rod head, without bearing shells fitted</td>
<td>135.000 - 135.025</td>
<td>134.980 - 135.060</td>
</tr>
<tr>
<td>- Conn. rod head bore</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Conicity</td>
<td>max. 0.012</td>
<td>max. 0.020</td>
</tr>
<tr>
<td>- Roundness (Out-of-roundness)</td>
<td>max. 0.012</td>
<td>max. 0.040</td>
</tr>
</tbody>
</table>
Connecting rod bearings: removing

The safety instructions for work on the drive mechanism must be complied with as detailed in Job Card W 2-0-1.

Tools:
- Normal tools

Cross-references:
- Job Card W 2-0-1, W 2-1-3, W 2-9-1

With piston removal

- Turn the crankshaft so that connecting rod screws 1 can be loosened.
- Prop up the connecting rod bearing cover 2.
- Unscrew the connecting rod screws completely.
- Lift the connecting rod bearing cover out of the crankcase.
- Take the bottom bearing shell out of the connecting rod bearing cover.
- If you are removing the piston (see Job Card W 2-9-1), take the top bearing shell out of the connecting rod.
- Protect the crankshaft journal against soiling in the oil bore with adhesive tape (not with transparent sellotape), and wrap with a clean cloth or oiled paper.

Without removing the piston

The top bearing shell can be removed even while the piston is still installed.

- Remove the connecting rod bearing cover 2 as described under "Work sequence with piston removal".
- Slowly turn the piston with the crankshaft, until the connecting rod is hanging free.
- Take off the top bearing shell.

Assessing the bearing shells

see Job Card W 2-1-3.
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Connecting rod bearings: installing

The safety instructions for work on the drive mechanism must be complied with as detailed in Job Card W 2-0-1.

Comply with the tightening instructions given in the Operating Manual, Chapter 8, „Technical Data“.

Assess bearing shells as described in Job Card W 2-1-3, and replace if necessary. Be careful not to get the bearing shells and bearing covers mixed up. Piston, connecting rod foot and bearing cover are all identified with the cylinder number involved. Check the condition of the lift journal. Permissible run-out is 0.020 mm. Consult DEUTZ Service before initiating any rework if this becomes necessary.

Preparation

Clean all parts thoroughly. Check the surface condition of the lift journal meticulously, and smooth out any impact points with an oil stone.

When the piston has been removed

- Insert top bearing shell into the connecting rod, and install piston as described in Job Card W 2-14-1.

Top and bottom shells are identical. Make sure that run bearing shells are fitted back into their original positions, and that the groove coincides with the fixing pin.

- Lower the connecting rod with piston slowly onto the lift journal.

When the piston is still fitted

- Insert the bearing shell into the connecting rod foot, in the same way as when the piston has been removed. Turn the lift journal slowly into the connecting rod foot.

- Insert bearing shell into the bearing cover. Oil the contact surface of the bearing shell.

- Make sure that the rear of the bearing and the partition lines are free from oil and grease.

- Fit the connecting rod cover, making sure that the fixing pin pressed into the connecting rod cover is correctly positioned.

- Oil the thread and the contact areas, tighten connecting rod screws in accordance with Tightening Instructions.

- Check clearance between crankshaft and connecting rod bearing, max. 0.095...0.230 mm.
Removing and installing the piston

When you replace a piston or the piston rings, you must also replace the cylinder liner at the same time if its wear limits have been exceeded. Cylinder liners which still have the right dimensions have to be re-honed.

Tools:
- Normal tools
- Lifting tackle
- Lift-out plate
- Piston support device
- Tightening strap or mounting pliers

Aids:
- Wooden wedges
- Engine oil

Cross-references:
- Job Card W 0-1-3, W 1-4-1, W 2-12-4

Removing the piston

- Remove cylinder head, see Job Card W 1-4-1.
- Remove inspection hole cover at the height of the cylinder concerned on the opposite row of cylinders.
- Using a scraper, carefully remove the oil carbon deposits at the top of the cylinder liner.
- Move the piston to its TDC position.
- Scrape free the cylinder number (if any) on the bottom of the piston.
- If there is no cylinder number on the piston, mark the piston for identification before you remove it.
- Mark the connecting rod-cover with the cylinder number.
- Unscrew the connecting-rod screws, and take off the loose connecting-rod cover.
- Screw the lift-out plate onto the piston, detach the connecting-rod from the crankshaft, and push it upwards.
- With the lift-off plate, pull out the piston and connecting rod upwards.
- Withdraw the piston carefully, taking care not to damage the connecting rod, the cylinder liner and the piston cooling spray jet.

Comply with the tightening instructions given in the Operating Manual, Chapter 8, „Technical Data“.
Storing removed pistons

When you have removed the piston, either place it inverted with the connecting rod using two wooden wedges (Fig. 1 left), or store it suspended in a wooden rack (Fig. 1 right).

Installing the piston

- Coat piston, cylinder liner and connecting-rod bearing shells with a generous amount of engine oil.

⚠ You must put each piston back into the same cylinder you took it out of.

- Before installing piston, check whether the bottom edge of the piston has been mounted with its milled point on the side of the spray jet, see Job Card W 2-12-4.

- The joints of the piston rings must be offset against each other at installation by 180° or 90° respectively. Install the ring and spring joints of the narrow-land drain oil-control ring offset by 180°, Fig. 2.

Installation with a tightening strap

- Use a tightening strap to clamp together all three piston rings, Fig. 3.

- Carefully insert piston and connecting rod into the cylinder liner, until the tightening strap is flush against the top edge of the cylinder liner.

- Hold and guide the connecting rod from below, and press the piston slowly downwards from above, until the connecting-rod bearing shell is resting on the connecting-rod journal of the crankshaft.
**Installation with mounting pliers**

- Use the mounting pliers to clamp all three piston rings, Fig. 4.
- Carefully insert piston and connecting rod into the cylinder liner, until the mounting pliers are resting on the top edge of the cylinder liner.
- Hold and guide the connecting rod from below.
- Slightly loosen the mounting pliers at the tommy screw, and press the piston slowly downwards from above, until the connecting-rod bearing shell is resting on the connecting-rod journal of the crankshaft.

![Fig. 4 Piston installation with mounting pliers](image)

⚠️ The connecting rod must not be allowed toouch the spray nozzles, nor must it knock against the crankshaft. This would damage the bearing journals, and bend the spray jets.

- Fit the connecting-rod bearing cover, making sure the fixing pin located in the connecting-rod bearing cover is correctly positioned.
- Oil the thread and the contact areas.
- Tighten the connecting-rod screws, with tightening torques as follows:
  - Step 1: 150 Nm
  - Step 2: 250 Nm
  - Step 3: 30°
  - Step 4: 30°

- Check clearance between crankshaft and connecting-rod bearing:
  - max. 0.095...0.230 mm.
- Fit inspection hole cover with new seal to the crankcase.
- Fit cylinder head, see Job Card W 1-4-1.

⚠️ When new pistons have been installed with rings and/or cylinder liners, you must run in your engine anew, see Job Card W 0-1-3.
This page intentionally left blank.
Removing and installing the piston rings

Every time a piston is removed, you must replace the piston ring set. Only in exceptional cases, and after meticulous checking may you re-install piston ring sets.

**Tools:**
- Piston ring pliers

**Cross-references:**
- Job Card W 2-9-3, W 2-10-3

---

**Removing the piston rings**

- Remove piston, see Job Card W 2-9-3.
- Take off piston rings, using piston ring pliers, Fig. 1.
- Check piston ring groove and piston rings, see Job Card W 2-10-3.

**Installing the piston rings**

- Use piston ring pliers to insert the piston rings.
  "Top" on the piston ring flanks facing upwards, Fig. 2.
- Insert hose spring 4 of the narrow-land oil control ring 3 in the piston ring groove, Fig. 2.
- Fit piston rings in the sequence 3, 2, 1, Fig. 2.
- Install ring and spring joints of the narrow-land drain oil control ring offset by 180°.

---

![Fig. 1 Piston ring pliers](image1)

![Fig. 2 Piston ring configuration](image2)
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Checking the piston ring grooves and piston rings

Tools:
- Feeler gauge
- Micrometer

Cross-references:
- Job Card W 2-9-3, W 2-10-1

Checking the axial clearance

- Remove the piston, see Job Card W 2-9-3.
- Take the old piston rings off the piston, using a pair of piston ring pliers.
- Clean the piston ring groove.
- Fit new piston rings, see Job Card W 2-10-1.
- Check the axial clearance of the piston rings every 45°, Fig. 1.
- When taking your measurements, press the piston ring against the bottom of the groove in the vicinity of the measuring point, Fig. 2.

If the permissible axial clearance is exceeded, then you have to replace the piston.

Fig. 1 Measuring points for measuring the axial clearance

Fig. 2 Measuring procedure for measuring the axial clearance

Dimensions for piston rings and piston ring grooves, see next page.
Checking the joint clearance

- Insert the piston ring in its mounting position in the cleaned, not-worn, top part of the cylinder liner.
- Make sure that the piston ring is not tilted.
- Use the feeler gauge to measure the joint clearance “X” between the two piston ring ends, Fig. 3.
- If the maximum permissible joint clearance is exceeded on a particular piston ring, you must replace the entire piston ring set concerned.

Dimensions for piston rings and piston ring grooves, see Page 2.

- Install piston, see Job Card W 2-9-3.

Piston ring set

1. Keystone ring
2. Tapered compression piston ring
3. Narrow-land drain oil control ring with hose spring

<table>
<thead>
<tr>
<th>Ring thickness and groove depth</th>
<th>Joint clearance</th>
<th>Axial clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>As-new dimension</td>
<td>As-new condition</td>
</tr>
<tr>
<td></td>
<td>(mm)</td>
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<tr>
<td>Ring</td>
<td>3.313 - 3.333</td>
<td>0.50 - 0.75</td>
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<tr>
<td>Groove</td>
<td>3.415 - 3.445</td>
<td>---</td>
</tr>
<tr>
<td>Ring</td>
<td>3.475 - 3.490</td>
<td>0.90 - 1.15</td>
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<tr>
<td>Groove</td>
<td>3.560 - 3.580</td>
<td>---</td>
</tr>
<tr>
<td>Ring</td>
<td>5.975 - 5.990</td>
<td>0.50 - 0.80</td>
</tr>
<tr>
<td>Groove</td>
<td>6.060 - 6.080</td>
<td>---</td>
</tr>
</tbody>
</table>

Fig. 3 Piston ring joint clearance
Removing and installing the piston pin bush

Tools:
- Normal tools
- Press
- Inside callipers
- Micrometer

Aids:
- Nitrogen

Cross-references:
- Job Card W 0-3-1, W 2-12-4

Checking the
- Remove piston pin, see Job Card W 2-12-4.
- Check that the piston pin bushes are firmly seated.
- Check that the position of the oil bores in the connecting-rod eye and the piston pin bush still coincide. (When a 6 mm test mandrel can no longer be inserted, replace the bush).
- Check piston pin bush for even contact pattern, surface quality and scoring.
- Measure piston pin bush.

Replace any scored, worn connecting-rod bushes, or any with a poor contact pattern.

<table>
<thead>
<tr>
<th>Tolerances</th>
<th>Nominal dimension in mm</th>
<th>Wear limit in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piston bush</td>
<td>D 65.056...65.099</td>
<td>D 65.140</td>
</tr>
<tr>
<td></td>
<td>Conicity after</td>
<td></td>
</tr>
<tr>
<td></td>
<td>installation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>65.060...65.120</td>
<td>65.140</td>
</tr>
<tr>
<td>Conn. rod</td>
<td>Clearance between</td>
<td></td>
</tr>
<tr>
<td></td>
<td>piston pin and piston</td>
<td></td>
</tr>
<tr>
<td></td>
<td>pin bush</td>
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<tr>
<td></td>
<td>0.056...0.107</td>
<td>0.120</td>
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<td></td>
<td>Axial clearance between</td>
<td></td>
</tr>
<tr>
<td></td>
<td>conn. rod and piston</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.180...0.740</td>
<td>1.000</td>
</tr>
</tbody>
</table>
Removing the piston pin bush
- Grind in a continuous groove approx. 2.5 mm deep on the long side of the bush (this will cause the bush to be detached).
- Use a press-out bush to press out the piston pin bush from the eye of the connecting rod, Fig. 1.

Installing the piston pin bush
- For how to work with liquid nitrogen, see Job Card W 0-3-1.
- Warm up the connecting rod.
- Supercool the piston pin bush in liquid nitrogen (temperature difference required is approx. 200°C).
- Without using force, insert the piston pin bush.

Make sure the bush is correctly positioned in relation to oil bores, oil pockets and lateral flushness at insertion.

The piston pin bushes are ready for installation, and must not be reworked after shrink-in.

- After installation, check the piston pin bushes.
- Install the piston pin, see Job Card W 2-12-4.
Removing and installing the piston pin

**Tools:**
- Normal tools
- Pliers for circlips
- Inside callipers
- Micrometer

**Aids:**
- Engine oil

**Cross-references:**
- Job Card W 2-9-3

---

**Removing the piston pin**
- Remove the piston, see Job Card W 2-9-3.
- Clean the sides of the piston pin bore to remove any oil carbon.
- Remove the circlip in the piston, Fig. 1.
- Push the piston pin out of the piston, if necessary tapping it lightly with a piece of wood or a hammer handle (no warm-up necessary).

**Checking the piston pin clearance in the piston**
- Use a micrometer to measure the diameter of the piston pin.
- Use inside callipers to measure the piston pin bore.

> The calculated clearance between piston pin and piston pin bore in the piston must not exceed 0.03 mm.

**Checking the piston pin clearance in the connecting-rod eye**
- Use a micrometer to measure the diameter of the piston pin.
- Use inside callipers to measure the connecting-rod eye.

> The calculated clearance between piston pin and connecting-rod eye bore must not exceed 0.12 mm.

If the permissible tolerances have been exceeded, the components concerned must be replaced.
Installing the piston pin

- Insert a circlip in the piston.

⚠️ Position the opening of the circlip facing upwards, and make sure that the circlip is firmly seated in the groove provided, Fig. 1.

- Oil all components abundantly.

⚠️ When assembling the piston and the connecting-rod together, take special note of the length of the recess for the spray jet at the bottom of the piston shaft. The recess for the spray jet 1 in Fig. 2 is located on the side of the “near-the-pin” connecting-rod, screw.

The arrow marking 2 in Fig. 2 on the piston points to the exhaust side.

- Insert the piston pin into the piston.

- Place the piston on the connecting rod, and push in the piston pin as far as the circlip.

- Insert the circlip for the piston pin on the other side of the piston.

⚠️ Position the opening of the circlip facing upwards, and make sure that the circlip is firmly seated in the groove provided, Fig. 1.

- Install piston, see Job Card W 2-9-3.

Fig. 2  Piston alignment against connecting rod.
Checking, removing and installing the piston cooling-oil jets

You have to remove the piston cooling-oil jets for any major overhauls or erection jobs, before all cylinder liners are removed. You must also remove them if there is severe soiling due to damage, or if the lube oil circuit is soiled. Removing these jets is not essential if you are only going to be removing and installing individual pistons, connecting rods and cylinder liners.

Removing the piston cooling oil jets

- Remove the piston, see Job Card W 2-9-3.
- Mark piston cooling-oil jets with the associated cylinder number.
- Make sure you do not get the piston cooling-oil jets mixed up.
- Unscrew the fixing screws of the piston cooling-oil jets.
- The fixing screws here are self-locking types, which are difficult to loosen. If the hexagon socket is damaged, the engine must be dismantled and the screw drilled out. Take care not to use any worn tools.
- Carefully remove the piston cooling oil jets.

Cleaning the piston cooling-oil jets

- Clean the piston cooling-oil jets with cleaning agent, and rinse them through.
- Clean and rinse out the main oil line in the crankcase (accessible from the drive end).

Installing the piston cooling-oil jets

- Insert the piston cooling-oil jets belonging to each cylinder into the locating bushes.
- Tighten the new fixing screws. 
Aligning the piston cooling-oil jets (with piston removed)

- Place monitoring device 4 on cylinder liner.

The top plate is positioned by the cooling water overspill hole 5 in the crankcase, and possesses a monitoring hole 3 for the test mandrel 2.

- Insert test mandrel 2 carefully into spray jets 1.

The upper side of the test mandrel must be freely inserted into monitoring hole 3.

![Fig. 1 Aligning the piston cooling-oil jets (with piston removed)](image-url)
Aligning the piston cooling-oil jets (with piston installed)

- Through the open inspection hole cover, carefully push test rod 2 into jet 1
- Turn the piston slowly downwards.
- Use the mirror and lamp whether the test rod is immersed in the cooling-oil entry hole of piston 3 without touching the piston.

Re-aligning the piston cooling-oil jets

- If you find any deviations, first check the mounting and position.
  
  Re-alignment is necessary only if the jets have been bent. Never use the test mandrel for this purpose. You have to use a pipe, so that the mouth of the jet will not be damaged.

- Re-align, using a suitable pipe pushed over the spray jet.
- Tighten the fixing screws of the piston cooling-oil jet.
- Install the piston, W 2-9-3.
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Measuring the cylinder liner

The safety instructions for work on the drive mechanism must be complied with as detailed in Job Card W 2-0-1.

Tools:
- Inside micrometer
- Turning device

Cross-references:
- Job Card W 1-4-4, W 2-0-1, W 3-3-3

Measuring the cylinder liner

- Remove the cylinder head, see Job Card W 1-4-4.
- Turn the crankshaft until the piston concerned is at its BDC position.
- Clean the cylinder liner to remove any combustion residues.
- Check the stop edge of the first piston ring.
  - If it can be clearly felt, this means there is excessive wear.
- Set the inside micrometer to the inside diameter of the cylinder liner.
- Take your measurements in accordance with the measurement sheet attached, in longitudinal and transverse directions, and in the different measuring levels.

<table>
<thead>
<tr>
<th>Nominal diameter</th>
<th>Ø 170 ±0.025 mm</th>
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<tbody>
<tr>
<td>max. perm. wear dimension</td>
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<tr>
<td>max. perm. out-of-roundness</td>
<td>0.051 mm</td>
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</table>

Table 1 Cylinder liner dimensions

Fig. 1 Stop edge of the first piston ring

If one of the max. permissible values is exceeded, you must replace the cylinder liner concerned, see Job Card W 3-3-3.

If the cylinder liner is only slightly worn, it may be possible to re-hone it. If you are considering this option, please contact your DEUTZ Service.

- Fit the cylinder head, see Job Card W 1-4-4.

Fig. 2 Measuring with an inside micrometer
**Measuremetn sheet for cylinder liners ø 170 +0.025 mm (nominal dimension)**

<table>
<thead>
<tr>
<th>Cylinder:</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>A4</th>
<th>A5</th>
<th>A6</th>
<th>A7</th>
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<td>Y</td>
<td>X</td>
<td>Y</td>
<td>X</td>
<td>Y</td>
<td>X</td>
<td>Y</td>
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<table>
<thead>
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<th>B2</th>
<th>B3</th>
<th>B4</th>
<th>B5</th>
<th>B6</th>
<th>B7</th>
<th>B8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meas. direction</td>
<td>X</td>
<td>Y</td>
<td>X</td>
<td>Y</td>
<td>X</td>
<td>Y</td>
<td>X</td>
<td>Y</td>
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<td>H in mm</td>
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</tr>
</tbody>
</table>
Removing the cylinder liner

The safety instructions for work on the drive mechanism must be complied with as detailed in Job Card W 2-0-1.

Tools:
- Normal tools
- Pull-out device for cylinder liners

Cross-references:
- Job Card W 2-0-1, W 2-9-3

You have to remove the cylinder liners if the wear and tear measured has exceeded the permissible limit dimensions, if the running path exhibits a poor contact pattern, or has suffered damage or is too smooth (no honing marks visible any more). If the piston or the piston rings are replaced, or if during intermediate and major overhauls the coolant compartments of the crankcase and the condition of the coolant-conveying outside of the liner are checked, you have to remove the cylinder liner as well.

When you are removing the cylinder liner, and installing it again, you must be very careful not to let any dirt from the cooling water compartments drop onto the crankshaft. This is why you have to cover up the drive compartment properly.

Removing the cylinder liner

- Remove the piston, see Job Card W 2-9-3.
- Carefully cover up the drive compartment.
- Use the pull-out device to withdraw the cylinder liner from the crankcase, Fig. 1.

Be careful not to damage the piston cooling oil jets.

Fig. 1 Removing cylinder liners
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Installing the cylinder liners

The safety instructions for work on the drive mechanism must be complied with as detailed in Job Card W 2-0-1.

Tools:
- Normal tools

Aids:
- Abrasive paste
- Acid-free grease

Cross-references:
- Job Card W 0-1-3, W 2-0-1, W 2-15-1, W 3-3-1

Installing the cylinder liner

- Check cylinder liners for wear and tear, see Job Card W 3-3-1.
- Clean the contact area of the cylinder liner in the crankcase before inserting the new cylinder liner, and check for any damage.
  When replacing a cylinder liner, you will find it best to replace the associated piston as well, but you must always replace the piston rings.
- Insert cylinder liner by hand without round sealing rings into the cleaned case, Fig. 1. It must be easy to insert, and you must be able to turn it by hand.
  Take care not to damage the piston cooling-oil jets.
- Grind in the contact area of the collar seat by hand with abrasive paste until there is an even contact pattern.
  If an even contact pattern is impossible to achieve, call in DEUTZ Service.
- Lift out the cylinder liner again.
- Moisten new round sealing rings with acid-free grease.
- Fit round sealing rings onto the cylinder liners.
  Do not roll the rings when doing this, and don’t twist them when inserting them in the grooves, Fig. 2.
• Insert the cylinder liner by hand as far as the contact area.

Every cylinder liner is punch-marked at the top collar with the DEUTZ-MWM lettering. Install the liner with this lettering facing the shock-absorber rod side, Fig. 3.

When you are installing the cylinder liner, take care not to damage the piston cooling-oil jets.

• Check the alignment of the piston cooling-oil jets, Fig. W 2-15-1.

• Use and installation device to push in the cylinder liners evenly with the round sealing rings, Fig. 4.

When you are installing the cylinder liners, there is a risk that the O-rings will jam or get twisted. So be very careful when installing the cylinder liners.

• Install the piston, see Job Card W 2-9-3.

• After installing new cylinder liners and/or pistons and piston rings, you must run in your engine anew, see Job Card W 0-1-3.
Foundation bolts

Since the foundation may alter, due to the effects of heat and distortion, you have to check the foundation bolts to see if they have worked loose. This is particularly important after the first few operating hours.

Tools:
- Normal tools

Checking the foundation bolts

- Check adapters in the case of a rigid mounting, or shims in the case of elastic mounting, by tapping (include the places where pipes above make access difficult).

When you tap, a metallic sound is an indication of a secure join.

- Tighten loose screws, following the manufacturer's tightening instructions.

- Check the alignment.

Make sure everything is kept meticulously clean; in particular, keep oil and water away from the foundation.
Removing and installing the camshaft bearings

The safety instructions for work on the drive mechanism must be complied with as detailed in Job Card W 2-0-1.

You must replace the camshaft bearings if after a visual inspection or taking measurements you discover wear and tear.

Tools:
- Normal tools
- Press-out device
- Two-step measuring instrument

Cross-references:
- Job Card W 2-0-1, W 4-5-1, W 4-5-2

Removing the camshaft bearings

- Remove the camshaft bearings, see Job Card W 4-5-1.

Checking the camshaft bearings

- Check bearing bushes for scoring and wear.

<table>
<thead>
<tr>
<th>Dimensions in mm</th>
<th>Nominal dimension</th>
<th>Wear limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location hole in crankcase</td>
<td>68,000...68,030</td>
<td>68.035</td>
</tr>
<tr>
<td>Camshaft bush pressed in, inner diameter</td>
<td>59.996...60.050</td>
<td>60.120</td>
</tr>
<tr>
<td>Brg clearance, camshaft - brg</td>
<td>0.064...0.156</td>
<td>0.240</td>
</tr>
</tbody>
</table>

Table 1 Nominal dimensions and wear limits

- Fit press-out device 1.
- Withdraw bearing bush 2 from crankcase 3.

Cleaning the components

- After removing scored or worn bearing bushes, clean all the oil boreholes very carefully, preferably with compressed air.

If, because of reworking at the crankcase or due to bearing damage, metal chips have penetrated into the oil circuit or into the crankcase, then you must remove the camshaft bearing bushes (even if there is nothing wrong with them), and clean the oil borehole and the oil grooves. It is then best to press in new bearing bushes.
If the permissible wear dimension for the location holes in the crankcase for the camshaft bearing bushes is exceeded after the bushes have been pressed out, please contact DEUTZ Service regarding a repair job.

Installing the camshaft bearings

The two outer camshaft bearings are 60 mm wide. Install these in such a way that the wider side is facing outwards from the oil groove, and that the bearing bush is protruding by 8 mm from each end of the casing. In all other bearing positions, install the bearing bushes, 40 mm wide, centrally (= flush) in the casing walls.

- Install all the bearing bushes in such a way that both oil boreholes 1 are facing downwards 3 towards the. The circumferential oil groove 2 must be precisely congruent with the oil borehole (you can check this with a piece of wire, for example).
- Push the bearing bushes into the housing borehole with the bevelled side facing forwards (make sure you don’t tilt the bearing bushes).
- Before pushing the bush in completely, remove any chips from pressing in at the outer oil groove.

After installing new bearing bushes, you must check the inner diameters with a two-step measuring instrument (see Table 1).

When installing, always consult:

- Installing the camshafts, see Job Card W 4-5-1.
Removing, installing and checking the bottom valve mechanism

The safety instructions for work on the drive mechanism must be complied with as detailed in Job Card W 2-0-1.

Tools:
- Normal tools

Cross-references:
- Job Card W 1-2-2, W 1-4-4, W 2-0-1

Removing the shock-absorber rods
- Remove valve lifter, see Job Card W 1-2-2.
- Take out shock-absorber rods upwards.

Checking the shock-absorber rods
- Check the shock-absorber rods for run-out by always turning two of them next to each other.
- Check shock-absorber rod head (ball socket) and shock-absorber rod foot (ball head) for wear and tear or damage (break-outs, etc.).

Installing the shock-absorber rods
- Insert the shock-absorber rods carefully from above.
- Install valve lifter, see Job Card W 1-2-2.
Removing the valve tappet
- Remove the cylinder head, see Job Card W 1-4-4.
- Take out the shock-absorber rods upwards.
- Remove the shock-absorber rod guard sheaths.
- Take out the valve tappet from the holes in the crankcase.

Checking the valve tappet
- Check the valve tappet’s contact area and inner seat pan for wear and tear.
- Check the holes at the bottom end of the tappet for free passage, Fig. 1.
  - If you find irregularities when you check the tappets, then check the camshafts and camshaft bearings as well.

Installing the valve tappet
- Insert valve tappet into the holes of the crankcase.
- Carefully install shock-absorber rod guard sheaths with new sealing rings.
- Insert shock-absorber rods carefully from above.
- Fit cylinder head, see Job Card W 1-4-4.
Removing and installing the gear train

Comply with the tightening instructions given in the Operating Manual, Chapter 8, “Technical Data”.

Tools:
- Normal tools
- Special tools

Cross-references:
- Job Card W 4-8-1
- Operating instructions, Chapter 8, Tightening instructions

Removing the gear train

- Check the gear train, see Job Card W 4-8-1.
  - If you find any faults, you must replace the gears concerned.
- Remove step idler gear 3, Fig. 1.
- Remove camshaft gears 1, Fig. 1.
- Take off crankshaft gear 4 either with a commercially available two-arm or three-arm extractor, or with an extractor which engages in the threads of the crankshaft gear.
  - When dismantling the gears, take care with the dowel pins.

Installing the gear train

- Clean the crankshaft gear and the contact surface on the crankshaft.
- On a hot plate, heat up the crankshaft gear to approx. 100°C.
- Taking care to position the dowel pin correctly, place the crankshaft gear onto the crankshaft.
  - To turn the crankshaft (e.g. for adjusting the marking), the crankshaft gear must be screwed to the crankshaft with not less than two fixing screws. This will prevent any damage to the dowel pin.
- Turn the crankshaft so that the marking (0) on the crankshaft gear is facing upwards, Fig. 3.
Fit camshaft gears 1 with new fixing screws, and turn until the markings reach the position shown in Fig. 3. Screw in the camshaft sensor in accordance with the punched-in cylinder number.

Fit step idler gear 2, making sure the markings are correctly positioned, Fig. 3.

Check all the markings at the step idler gear, Fig. 3.

Use torque wrench 1 in conjunction with a turning rod 2 to tighten the step idler gear as shown in Fig. 2.

For tightening instructions, see Operating Instructions Chapter 8.

Check the gear train, see Job Card W 4-8-1.

Fig. 2  Fitting the step idler gear

Fig. 3  Gear train markings
Removing, checking the camshaft

The safety instructions for work on the drive mechanism must be complied with as detailed in Job Card W 2-0-1.

You will not normally need to check the camshafts, their bearings and their drive mechanism until a major overhaul becomes due, unless a check on the valve tappets has discovered some irregularities.

Removing the camshafts

- Remove bottom valve mechanism, see Job Card W 4-2-1.
- Remove camshaft drive gears, see Job Card W 4-4-1.
- Remove guide plates of camshafts 1, Fig. 1.
- Fit removal mandrel to the camshaft, Fig. 2.
- Carefully withdraw camshaft from the crankcase.

Checking the camshaft bearings

- Give camshafts' bearing shells in crankcase a visual inspection. Replace any worn bearing shells, see Job Card W 4-1-1.

Tools:
- Normal tools
- Insertion and removal mandrels for camshaft
- Prism / dial gauge
- Micrometer

Cross-references:
- Job Card W 2-0-1, W 4-1-1, W 4-2-1, W 4-4-1

Fig. 1 Camshaft guide plates

Fig. 2 Removal mandrel for the camshaft
Checking the camshaft (with camshaft removed)

- Check diameters of camshaft bearings, Table 1.
- Check guide plates for wear and tear, Table 1.

<table>
<thead>
<tr>
<th>Dimensions in mm</th>
<th>Nominal dimension</th>
<th>Wear limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camshaft bearings</td>
<td>59.94...59.40</td>
<td>59.880</td>
</tr>
<tr>
<td>Axial clearance</td>
<td>0.120...0.210</td>
<td>0.300</td>
</tr>
<tr>
<td>Guide plate wear</td>
<td>17.840...17.880</td>
<td>17.770</td>
</tr>
</tbody>
</table>

Table 1 Tolerances for camshaft measurements

- Check camshafts' radial runouts, Table 2 and Fig. 3.
  - Support on prism at the penultimate outer bearing on each side
  - Measure the radial runout with a dial gauge at every other bearing

<table>
<thead>
<tr>
<th>Meas. point</th>
<th>V8</th>
<th>V12</th>
<th>V16</th>
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<tr>
<td>I</td>
<td>0.06</td>
<td>0.08</td>
<td>0.09</td>
</tr>
<tr>
<td>II</td>
<td>–</td>
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<td>0.06</td>
</tr>
<tr>
<td>III</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Table 2 Maximum values for camshaft's radial runout

Fig. 3 Radial runout measurement for the camshaft
Installing the camshaft

The safety instructions for work on the drive mechanism must be complied with as detailed in Job Card W 2-0-1.

Installing the camshaft

- Clean the components thoroughly.
- Moisten camshaft and camshaft bearings with lube oil.
- Fit insertion mandrel.
- Fit guide plates of camshafts 1 at one side of the casing, and screw them tightly in place, Fig. 2.

You can install the camshafts from either end of your engine. The two ends of each camshaft are differentiated by a dowel pin borehole and the threaded holes of the drive gear. Each camshaft has been identified by a punched-in “A” or “B” at the drive end, to correspond to Cylinder Row A or B.

- Insert the insertion mandrel with camshaft carefully through the bearings, Fig. 1.
- Fit guide plates of camshafts 1, Fig. 2.
- Fit camshaft drive gears, see Job Card W 4-4-1.
- Install bottom valve mechanism, see Job Card W 4-2-1.

Follow tightening instructions as specified in the Operating Instructions, Chapter 8.

Tools:
- Normal tools
- Insertion and removal mandrels for camshaft

Aids:
- Lube oil

Cross-references:
- Job Card W 2-0-1, W 4-2-1, W 4-4-1
- Operating Instructions, Chapter 8, Tightening instructions
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Checking the gear train

The safety instructions for work on the drive mechanism must be complied with as detailed in Job Card W 2-0-1.

Tools:
- Normal tools
- Feeler gauge
- Dial gauge

Cross-references:
- Job Card W 2-0-1, W 4-4-1, W 12-1-4

Checking the gear train

- Take off the built-in parts at the free side of the engine.
- Remove any vibration absorbers, see Job Card W 12-1-4.
- Remove the end wall cover.

Checking the gears

- Visually inspect all spur gears for face wear and pitting. If there is severe wear and tear (perceptible wear), major pitting, damage to teeth, cracks at the tooth root, etc., replace the spur gears involved. If you observe uneven contact patterns, check that the gear concerned is firmly secured, check that the flanged shafts are firmly secured in the case of idler gear mountings, and check for faultless concentricity (axial and radial runout).

Checking the face clearance

- Before removing the gears, and after finishing assembly, check the face clearance at all gears. Use the feeler gauge to do this, checking whether the face clearance exceeds the wear limit value.
- If the wear limit value has been exceeded, replace the gear(s) concerned, see Job Card W 4-4-1.
- Fit end wall cover.
- Fit any vibration absorbers, see Job Card W 12-1-4.
- Fit built-on parts to the free side of the engine.

<table>
<thead>
<tr>
<th>[mm]</th>
<th>Meas. point</th>
<th>Nominal dimension</th>
<th>Wear limit</th>
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</thead>
<tbody>
<tr>
<td>Face clearance</td>
<td>0.050...0.300</td>
<td>0.380</td>
<td></td>
</tr>
</tbody>
</table>

Step idler gear

<table>
<thead>
<tr>
<th>[mm]</th>
<th>Meas. point</th>
<th>Nominal dimension</th>
<th>Wear limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idler gear axle</td>
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<td>Ø 44.955</td>
<td></td>
</tr>
<tr>
<td>Radial clearance</td>
<td>0.035...0.091</td>
<td>0.100</td>
<td></td>
</tr>
<tr>
<td>Axial clearance</td>
<td>0.080...0.192</td>
<td>0.300</td>
<td></td>
</tr>
<tr>
<td>Lube oil pumps idler gear</td>
<td>Ø 34.959...34.975</td>
<td>Ø 34.955</td>
<td></td>
</tr>
<tr>
<td>Radial clearance</td>
<td>0.025...0.083</td>
<td>0.120</td>
<td></td>
</tr>
</tbody>
</table>

Table 1

The safety instructions for work on the drive mechanism must be complied with as detailed in Job Card W 2-0-1.

Tools:
- Normal tools
- Feeler gauge
- Dial gauge

Cross-references:
- Job Card W 2-0-1, W 4-4-1, W 12-1-4

Checking the gear train

- Take off the built-in parts at the free side of the engine.
- Remove any vibration absorbers, see Job Card W 12-1-4.
- Remove the end wall cover.

Checking the gears

- Visually inspect all spur gears for face wear and pitting. If there is severe wear and tear (perceptible wear), major pitting, damage to teeth, cracks at the tooth root, etc., replace the spur gears involved. If you observe uneven contact patterns, check that the gear concerned is firmly secured, check that the flanged shafts are firmly secured in the case of idler gear mountings, and check for faultless concentricity (axial and radial runout).

Checking the face clearance

- Before removing the gears, and after finishing assembly, check the face clearance at all gears. Use the feeler gauge to do this, checking whether the face clearance exceeds the wear limit value.
- If the wear limit value has been exceeded, replace the gear(s) concerned, see Job Card W 4-4-1.
- Fit end wall cover.
- Fit any vibration absorbers, see Job Card W 12-1-4.
- Fit built-on parts to the free side of the engine.

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Step idler gear

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<td>0.025...0.083</td>
<td>0.120</td>
<td></td>
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Table 1
Removing, installing and checking the frequency generator

If the distance between the frequency generator and the flywheel’s toothed rim is not adjusted correctly, or if there are chips of metal adhering to the permanent magnets, this will affect the pulses fed to the control electronics. The frequency generator has been set in the factory, and so you should never dismount it without a really good reason.

Tools:
- Normal tools
- Feeler gauge

Removing the frequency generator

- Loosen knurled nut 3 and disconnect the cable link.
- Loosen counternut 2, and unscrew frequency generator 1 by hand.
- Check frequency generator for any metal chips adhering and for soiling, and clean as necessary.

Installing the frequency generator

- Screw in frequency generator 1 by hand until it is just touching a tooth tip of the toothed rim 4 or the pulse protrusion of the flywheel, Fig. 1.
- To adjust the clearance “X”, turn the frequency generator back by 180° (1/2 a revolution), and tighten the counternut 2 (the position of the frequency generator must not change when you do this).
- Use a feeler gauge to check the clearance of the frequency generator: “X” 0.5 to 0.8 mm.
- Establish cable link with knurled nut 3.

Fig. 1 Screw in until it touches

Fig. 2 Distance X after turning backwards
Cleaning the mixture cooler on the water side

You can carry out this cleaning routine while the mixture cooler is still built on. If it is severely soiled, however, you have to remove it, and give it an additional cleaning as described in Job Card W 6-4-2. Replace all seals, round sealing rings and the spring washers.

Tools:
- Normal tools
- Round brush
- Wooden rod

Spare parts:
- Seals and spring washers

Cross-references:
- Job Card W 6-4-2, W 9-0-1
- Operating Instructions, Chapter 4

Cleaning the mixture cooler

- Drain the engine, see Job Card W 9-0-1.
- Close off all engine openings in the vicinity.
- Cover up all parts sensitive to water.
- Remove coolant lines to the mixture cooler.
- Remove covers 1 and 3.
- Use a brush or a wooden rod to clean the inside (cooler insert 2).
- After you have finished your cleaning routine, fit the covers.
- Fit the coolant lines.
- Fill up with coolant, see Operating Instructions Chapter 4.

Fig. 1 Mixture cooler
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Cleaning the mixture cooler on the air side

**Tools:**
- Normal tools
- Lifting tackle
- Cleaning agent

**Spare parts:**
- Seals and spring washers

**Cross-references:**
- Job Card W 6-4-1
- Operating Instructions Chapter 4

Cleaning the mixture cooler

- Take off the parts built onto the mixture cooler.
- Remove the mixture cooler.
- Clean the mixture cooler on the water side, see Job Card W 6-4-1.
- Use cleaning agent to wash out the mixture cooler on the air side, following the manufacturer’s instructions.
- Rinse with a powerful jet of water, and blow dry with compressed air.
- Assemble mixture cooler, with new seals, round sealing rings, and spring washers.
- Fill up with coolant, see Operating Instructions Chapter 4.
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Oil pressure control valve, removing, installing and checking

If the lube oil pressure drops, you must check the oil pressure control valve.

Tools:
- Normal tools
- Special wrench for removing the oil pressure control valve
- Measuring tools

Cross-references:
- Job Card W 4-4-1

Removing the oil pressure control valve

- Remove the gear train, see Job Card W 4-4-1.
- Remove mounting 1 of oil pressure control valve, Fig. 1.
- Use special wrench to unscrew oil pressure control valve.
- Remove clamping cone pieces 3, Fig. 2.
- Dismantle oil pressure control valve, and clean all components.

Always ensure absolute cleanliness when working on the lube oil system.

Checking the oil pressure control valve

- Check the condition of the valve disk, the valve seat in the housing, the clamping cone pieces, the spring plate, the valve stem and the valve spring. If you find any wear and tear, replace the parts concerned.

Opening oil pressure control valve: 4 ± 0.3 bar.
Spring length 2 (destressed): 100 mm.
Clearance between valve 1 and valve housing 4 max.: 0.085 mm.
Disc edge thickness of valve min.: 1.500 mm.
Spring power for an overall length of 58 mm: 28.2 ± 2.5 kp.

Installing the oil pressure control valve

- To install, proceed in the opposite sequence.

When re-assembling, make sure the clamping cone pieces are correctly fitted, Fig. 2.
Fig. 2   Oil pressure control valve
Draining the coolant system

For various jobs, such as those involving cylinder head, crankcase, heat exchanger and piping, it is necessary to drain off part or all of the coolant.

If no antifreeze has been added, then if your engine is going to be shut down for a lengthy period, and if there is a risk of frost, then all the coolant must be drained out of the engine and the built-on components.

If your engine is going to be shut down for a lengthy period, you must conserve it as detailed in the Operating Instructions, Chapter 7.

Tools:
- Normal tools

Aids:
- Collecting containers for coolant

Cross-references:
- Operating Instructions, Chapter 4
- Operating Instructions, Chapter 7

Draining off the coolant

- Shut off the coolant lines to and from your engine.
- Place collecting containers to catch the coolant.
- Open the drain plug at the lube oil heat exchanger.
- Open the preheater drain plug 1, Fig. 1.
- Open the coolant pipe drain plug 1, Fig. 2.
Coolant system
Job Card
W 9-0-1

DEUTZ MWM
TBG 620/TBG 620K

- Open crankcase drain plugs. Fig. 3 shows the drain plug 1 on the right-hand side.

- Open mixture cooler drain plugs 1.

After all the coolant has drained off, close the drain plugs, drain valves and pipes again. Use new seals and sealing rings. Re-use the coolant you have collected, or dispose of it in an eco-friendly manner.

Fig. 3  Crankcase drain plug

Fig. 4  Mixture cooler drain plugs
Removing and installing the coolant preheater

Depending on the type of engine involved, either one or two heating element assemblies are installed. If only these are to be cleaned, it is sufficient to remove them from the preheater housing.

**Tools:**
- Normal tools

**Aids:**
- Cleaning agent for removing scale
- Collecting container for coolant

**Removing the coolant preheater**

- Switch off the power supply to the heating element assembly 7.
- Disconnect the power cable from the heating element assembly.
- Close valves 1 and 3 in the lines to the crankcase's coolant compartment.
- Unscrew coolant drain plug 5, and collect the coolant.
- Detach hose links 2 and 4.
- Remove the fixing screws of the preheater 6, and take out the preheater unit.
- Remove the heating element assembly.

**Cleaning**

- Immerse the heating elements in a bath with a scale-dissolving agent, until the lime scale has become detached. Make sure the solvent concerned does not attack metal.
- NEVER use tools (e.g. scrapers) or force to detach these deposits.
- After you have cleaned them, rub the heating elements down, and rinse them in clean water, to ensure that no solvent gets into your engine's coolant system.

**Installing the coolant preheater**

- Insert the preheater, and install the fixing screws.
- Attach hose links 2 and 4.
- Screw in coolant drain plug 5 with a new seal.
- Open valves 1 and 3 in the lines to the crankcase's coolant compartment.
- Check the preheater for leaks.
- Check the coolant level, and top up with coolant if necessary.
Fig. 1 Preheater
Removing and fitting the torsional vibration damper

Check the exterior of the damper for oil leaks (radial traces of oil on the side plates!). Repair the damper of the leaks are being caused by worn round sealing rings. For any further repairs, you must call in DEUTZ Service or the manufacturer.

The safety instructions for work on the drive mechanism must be complied with as detailed in Job Card W 2-0-1.

Comply with the tightening instructions given in the Operating Manual, Chapter 8, „Technical Data“.

Removing the torsional vibration damper
- Remove the protective casing.
- Suspend the damper from the lifting tackle.
- Unscrew the fixing screws 5 to the crankshaft.
- Loosen the main connecting screws 8.
- Take off side plates 10 and 1.
  Note that the threads of the vent screws can be utilized as lift-out or extraction threads.
- Give all parts a thorough cleaning.

Fitting the torsional vibration damper
- Replace round sealing rings 4, 6 and 9.

To fit, proceed in the reverse sequence, noting the following points:
- Coat the inside of side plates 10 and 11 and the outer circumference of the inside star, and coat the latter’s driver grooves with Molykote or equivalent.
- Grease round sealing rings 4, 6 and 9 before installing them, make sure you do not twist them, and take care not to damage them on sharp edges.
- Secure screw heads with OMNIFIT 250M or equivalent, and seal.
- Side plates without a centering collar must be centered to a precision of $\pm 0.1$ mm in relation to the outer ring.

Tools:
- Normal tools
- Lifting tackle

Aids:
- Locking compound Omnifit 250M
- Acid-free grease
- Molykote or equivalent

Spare parts:
- Round sealing rings

Cross-references:
- Job Card W 2-0-1
- Operating Instructions, Chapter 8, Tightening Instructions
Removing and fitting the flywheel

The safety instructions for work on the drive mechanism must be complied with as detailed in Job Card W 2-0-1.

You have to remove the flywheel if the starter gear has to be replaced, or if the bearing race and the shaft sealing ring have to be replaced.

Removing the flywheel

- Remove the parts covering the flywheel.
- Unscrew two opposite flywheel fixing screws, and screw in the mounting mandrels instead of them (Fig. 1).
- Use lifting tackle to take the weight of the flywheel.
- Now remove the remaining fixing screws, and withdraw the flywheel carefully. We recommend you to lever off the flywheel carefully from two sides, using two turning rods.

Fitting the flywheel

To fit the flywheel, proceed in the reverse sequence, likewise using the two mounting mandrels. Follow Operating Instructions, Chapter 8, tightening instructions for flywheel fixing screws.

Tools:
- Normal tools
- Flywheel mounting mandrels
- Lifting tackle

Cross-references:
- Job Card W 2-0-1
- Operating Instructions, Chapter 8, tightening instructions

Flywheel flange and special-version flywheel

For certain applications, besides the standard version of the flywheel, there is a special version with 30 fixing screws.

Follow Operating Instructions, Chapter 8, Tightening Instructions.

- Before fitting the flywheel, clean all the flywheel’s locating surfaces.
- Check the seat surfaces and contact areas of the flywheel screws for faultless condition (friction traces).
Instructions for Work on the Electrical Equipment

⚠️ When working on the high-voltage ignition system:
- life-threatening risk!

⚠️ The gases emitted by the battery are explosive.
- Avoid sparks and open flames in the vicinity of the battery.
- Do not allow any acid to get on your skin or clothing.
- Wear protective goggles.
- Do not place any tools on the battery.

The following instructions must be observed when working on the electrical equipment:

Battery (if installed)
- Disconnect the negative lead!
- Dispose of batteries in a manner preventing environmental pollution!

Other power supply
- Interrupt the power supply to the engine!

Cable
- Observe cross sections and lengths in accordance with the generally accepted safety regulations.
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DEUTZ AG is represented in 150 countries throughout the world. Around 15,000 specialists provide competent servicing of DEUTZ and DEUTZ MWM engines at approximately 3,000 service bases. The service registers are adapted to the structure of the trading area or the regional situation.

As a result, quick updating is possible in the event of regional changes.

In detail, the following registers are available (see also the diagram below):

- **„World“**
  Order Nr. 0297 7099
  Total overview of the service network and Trading Area I.
  The Trading Area I is complemented by the regional registers
  - Germany - Great Britain
  - Italy - France
  - Spain - Russia

- **„North/Central America and Caribbean“**
  Order Nr. 0297 7101
  Trading Area II

- **„Asia Pacific“**
  Order Nr. 0297 7102
  Trading Area III
  The Trading Area III will be supplemented by the regional register
  - Japan

All of the service registers can be obtained from your local service agent or from DEUTZ in Cologne.

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