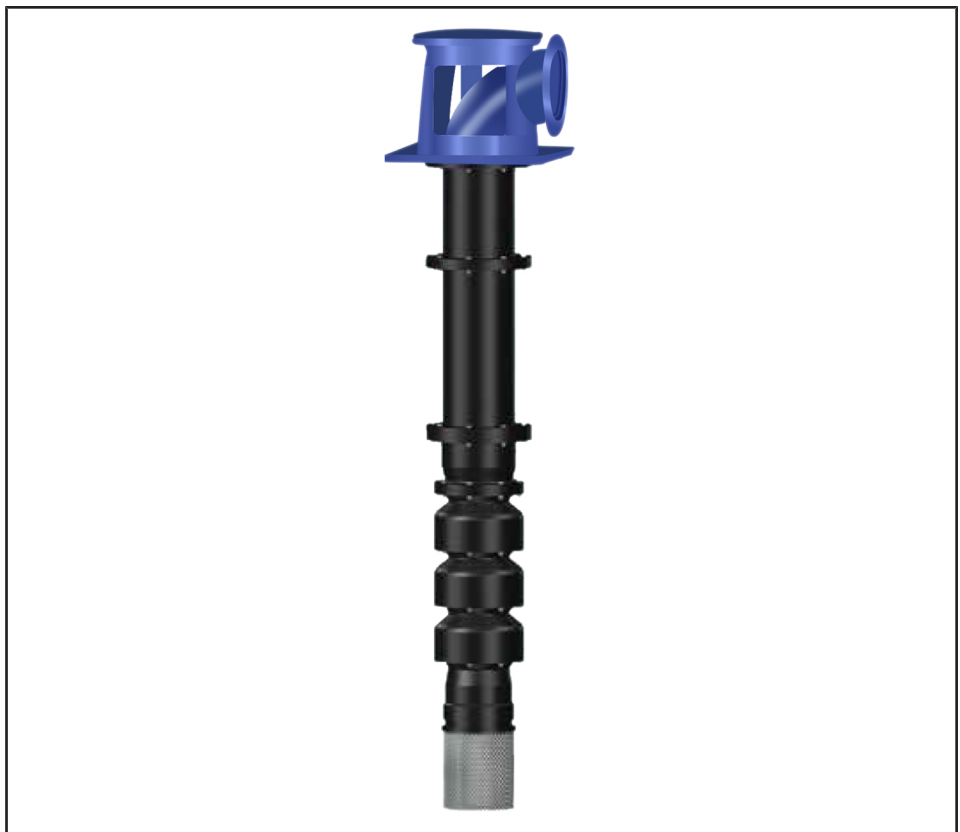


Vertical Turbine Pump

## B Pump

### Installation/Operating Manual



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Installation/Operating Manual B Pump

Original operating manual

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## Glossary

### **Certificate of decontamination**

A certificate of decontamination is enclosed by the customer when returning the product to the manufacturer to certify that the product has been properly drained to eliminate any environmental and health hazards arising from components in contact with the fluid handled.

### **Discharge line**

The pipeline which is connected to the discharge nozzle

### **Pump**

Machine without drive, additional components or accessories

### **Pump set**

Complete pump set consisting of pump, drive, additional components and accessories

### **Suction lift line/suction head line**

The pipeline which is connected to the suction nozzle

## 1 General

### 1.1 Principles

This operating manual is valid for the type series and variants indicated on the front cover.

The operating manual describes the proper and safe use of this equipment in all phases of operation.

The name plate indicates the type series and size, the main operating data, the order number and the order item number. The order number and order item number clearly identify the pump set and serve as identification for all further business processes.

In the event of damage, immediately contact your nearest KSB Service centre to maintain the right to claim under warranty.

### 1.2 Installation of partly completed machinery

To install partly completed machinery supplied by KSB refer to the sub-sections under Servicing/Maintenance.

### 1.3 Target group

This operating manual is aimed at the target group of trained and qualified specialist technical personnel. (⇒ Section 2.3, Page 9)

### 1.4 Other applicable documents

**Table 1:** Overview of other applicable documents

Document	Contents
Data sheet	Description of the technical data of the pump (set)
General arrangement drawing/ outline drawing	Description of mating dimensions and installation dimensions for the pump (set), weights
Drawing of auxiliary connections <sup>1)</sup>	Description of auxiliary connections
Hydraulic characteristic curve	Characteristic curves showing head, NPSH required and power input as a function of flow rate Q
General assembly drawing	Sectional drawing of the pump
Sub-supplier product literature <sup>1)</sup>	Operating manuals and other product literature describing accessories and integrated machinery components
Spare parts lists <sup>1)</sup>	Description of spare parts
Piping layout <sup>1)</sup>	Description of auxiliary piping
List of components	Description of all pump components
Installation instructions <sup>1)</sup>	Description of the installation of other types of installation and components




For accessories and/or integrated machinery components observe the relevant manufacturer's product literature.

### 1.5 Symbols

**Table 2:** Symbols used in this manual








Symbol	Description
✓	Conditions which need to be fulfilled before proceeding with the step-by-step instructions
▷	Safety instructions

1) If agreed to be included in the scope of supply

Symbol	Description
	Result of an action
	Cross-references
1. 2.	Step-by-step instructions
	Note Recommendations and important information on how to handle the product

## 1.6 Key to safety symbols/markings

Table 3: Definition of safety symbols/markings

Symbol	Description
	<b>DANGER</b> This signal word indicates a high-risk hazard which, if not avoided, will result in death or serious injury.
	<b>WARNING</b> This signal word indicates a medium-risk hazard which, if not avoided, could result in death or serious injury.
	<b>CAUTION</b> This signal word indicates a hazard which, if not avoided, could result in damage to the machine and its functions.
	<b>Explosion protection</b> This symbol identifies information about avoiding explosions in potentially explosive atmospheres in accordance with EU Directive 2014/34/EU (ATEX).
	<b>General hazard</b> In conjunction with one of the signal words this symbol indicates a hazard which will or could result in death or serious injury.
	<b>Electrical hazard</b> In conjunction with one of the signal words this symbol indicates a hazard involving electrical voltage and identifies information about protection against electrical voltage.
	<b>Machine damage</b> In conjunction with the signal word CAUTION this symbol indicates a hazard for the machine and its functions.



## 2 Safety

All the information contained in this section refers to hazardous situations.

In addition to the present general safety information the action-related safety information given in the other sections must be observed.

### 2.1 General

- This operating manual contains general installation, operating and maintenance instructions that must be observed to ensure safe operation of the system and prevent personal injury and damage to property.
- Comply with all the safety instructions given in the individual sections of this operating manual.
- The operating manual must be read and understood by the responsible specialist personnel/operators prior to installation and commissioning.
- The contents of this operating manual must be available to the specialist personnel at the site at all times.
- Information and markings attached directly to the product must always be complied with and kept in a perfectly legible condition at all times. This applies to, for example:
  - Arrow indicating the direction of rotation
  - Markings for connections
  - Type designation
- The operator is responsible for ensuring compliance with all local regulations not taken into account.

### 2.2 Intended use

- The pump (set) must only be operated in the fields of application and within the use limits specified in the other applicable documents.
- Only operate pumps/pump sets which are in perfect technical condition.
- Do not operate the pump (set) in partially assembled condition.
- Only use the pump to handle the fluids described in the data sheet or product literature of the pump model or variant.
- Never operate the pump without the fluid to be handled.
- Observe the minimum flow rates indicated in the data sheet or product literature (to prevent overheating, bearing damage, etc).
- Observe the maximum flow rates indicated in the data sheet or product literature (to prevent overheating, cavitation damage, bearing damage, etc).
- Do not throttle the flow rate on the suction side of the pump (to prevent cavitation damage).
- Observe the minimum water levels given in the product literature (to prevent cavitation and bearing damage).
- Consult the manufacturer about any use or mode of operation not described in the data sheet or product literature.

#### Prevention of foreseeable misuse

- Never open the discharge-side shut-off elements further than permitted.
  - The maximum flow rates specified in the product literature or data sheet would be exceeded.
  - Risk of cavitation damage
- Never exceed the permissible application and operating limits specified in the data sheet or product literature regarding pressure, temperature, etc.
- Observe all safety information and instructions in this manual.
- Observe the settings stated in the data sheet.



### 2.3 Personnel qualification and training

All personnel involved must be fully qualified to transport, install, operate, maintain and inspect the machinery this manual refers to.

The responsibilities, competence and supervision of all personnel involved in transport, installation, operation, maintenance and inspection must be clearly defined by the operator.

Deficits in knowledge must be rectified by means of training and instruction provided by sufficiently trained specialist personnel. If required, the operator can commission the manufacturer/supplier to train the personnel.

Training on the pump (set) must always be supervised by technical specialist personnel.

### 2.4 Consequences and risks caused by non-compliance with this manual

- Non-compliance with these operating instructions will lead to forfeiture of warranty cover and of any and all rights to claims for damages.
- Non-compliance can, for example, have the following consequences:
  - Hazards to persons due to electrical, thermal, mechanical and chemical effects and explosions
  - Failure of important product functions
  - Failure of prescribed maintenance and servicing practices
  - Hazard to the environment due to leakage of hazardous substances

### 2.5 Safety awareness

In addition to the safety information contained in this operating manual and the intended use, the following safety regulations shall be complied with:

- Accident prevention, health regulations and safety regulations
- Explosion protection regulations
- Safety regulations for handling hazardous substances
- Applicable standards, directives and laws

### 2.6 Safety information for the operator/user

- Fit protective equipment (e.g. contact guards) supplied by the operator for hot, cold or moving parts, and check that the equipment functions properly.
- Do not remove any protective equipment (e.g. contact guards) while the pump is in operation. The only exception is the guard of the packing chamber.
- Provide the personnel with protective equipment and make sure it is used.
- Contain leakages (e.g. at the shaft seal) of hazardous fluids handled (e.g. explosive, toxic, hot) so as to avoid any danger to persons and the environment. Adhere to all relevant laws.
- Eliminate all electrical hazards. (In this respect refer to the applicable national safety regulations and/or regulations issued by the local energy supply companies.)
- If shutting down the pump does not increase potential risk, fit an emergency-stop control device in the immediate vicinity of the pump (set) during pump set installation.

## 2.7 Safety information for maintenance, inspection and installation

- Modifications or alterations of the pump (set) are only permitted with the manufacturer's prior consent.
- Use only original spare parts or parts/components authorised by the manufacturer. The use of other parts/components can invalidate any liability of the manufacturer for resulting damage.
- The operator ensures that maintenance, inspection and installation are performed by authorised, qualified specialist personnel who are thoroughly familiar with the manual.
- Only carry out work on the pump (set) during standstill of the pump.
- Only perform work on the pump set when it has been disconnected from the power supply (de-energised).
- The pump (set) must have cooled down to ambient temperature.
- Pump pressure must have been released and the pump must have been drained.
- When taking the pump set out of service always adhere to the procedure described in the manual. (⇒ Section 6.3, Page 34)
- Decontaminate pumps which handle fluids posing a health hazard. (⇒ Section 7.3, Page 42)
- As soon as the work has been completed, re-install and re-activate any safety-relevant devices and protective devices. Before returning the product to service, observe all instructions on commissioning. (⇒ Section 6.1, Page 27)

## 2.8 Unauthorised modes of operation

Never operate the pump (set) outside the limits stated in the data sheet and in this manual.

The warranty relating to the operating reliability and safety of the supplied pump (set) is only valid if the equipment is used in accordance with its intended use. (⇒ Section 2.2, Page 8)

## 2.9 Explosion protection



**Always observe the information on explosion protection given in this section when operating the product in potentially explosive atmospheres.**

Only pumps/pump sets marked as explosion-proof **and** identified as such in the data sheet may be used in potentially explosive atmospheres.

Special conditions apply to the operation of explosion-proof pump sets to EU Directive 2014/34/EU (ATEX).

The explosion-proof status of the pump set is only assured if the pump set is used in accordance with its intended use.

Never operate the pump set outside the limits stated in the data sheet and on the name plate.

Prevent impermissible modes of operation at all times.

For information on application options of individual components (if any) in potentially explosive atmospheres, refer to the manufacturer's product literature.

### 2.9.1 Repair

Special regulations apply to repair work on explosion-proof pumps. Modifications or alterations of the pump set can affect explosion protection and are only permitted after consultation with the manufacturer.









Repair work at the flameproof joints must only be performed in accordance with the manufacturer's instructions. Repair to the values in tables 1 and 2 of EN 60079-1 is not permitted.


### 3 Transport/Temporary Storage/Disposal

#### 3.1 Checking the condition upon delivery

1. On transfer of goods, check each packaging unit for damage.
2. In the event of in-transit damage, assess the exact damage, document it and notify KSB or the supplying dealer and the insurer about the damage in writing immediately.


#### 3.2 Transport

	<div style="background-color: #e67e22; color: white; padding: 5px;"> <b>DANGER</b></div> <p><b>Lifting lugs of pump/motor overloaded</b>            Danger to life from falling parts!</p> <ul style="list-style-type: none"> <li>▷ Never transport the pump set components (pump/motor) in any way other than those illustrated in the section on transport options.</li> <li>▷ Refer to the weights of the individual components stated in the manufacturer's product literature.</li> </ul>
	<div style="background-color: #e67e22; color: white; padding: 5px;"> <b>DANGER</b></div> <p><b>The pump or individual components could slip out of the suspension arrangement</b>            Danger to life from falling parts!</p> <ul style="list-style-type: none"> <li>▷ Always transport the pump or components in the specified position.</li> <li>▷ Never attach the suspension arrangement to free shaft areas on the pump.</li> <li>▷ Refer to the weights and centre of gravity indicated for the individual components.</li> <li>▷ Observe the applicable local health and safety regulations.</li> <li>▷ Use suitable, permitted lifting accessories.</li> </ul>
	<div style="background-color: #e67e22; color: white; padding: 5px;"> <b>DANGER</b></div> <p><b>Improper transport</b>            Risk of injury from lifting heavy components!</p> <ul style="list-style-type: none"> <li>▷ Select lifting accessories which are suitable for the component weight.</li> <li>▷ Always use the attachment points provided for the lifting accessories.</li> <li>▷ Comply with the applicable health and safety regulations.</li> </ul>
	<div style="background-color: #e67e22; color: white; padding: 5px;"> <b>DANGER</b></div> <p><b>Pump set tipping over or rolling off</b>            Danger to life from parts tipping over or rolling off!</p> <ul style="list-style-type: none"> <li>▷ Always secure a pump set placed in vertical position against tipping over.</li> <li>▷ Always secure a pump set placed in horizontal position against rolling off.</li> </ul>




	<div style="background-color: #e67e22; color: white; padding: 5px;"><b>⚠ DANGER</b></div> <p><b>Risk of falling when working at a great height</b>            Danger to life by falling from a great height!</p> <ul style="list-style-type: none"> <li>▷ Use a sturdy scaffold.</li> <li>▷ Observe the applicable local occupational safety and accident prevention regulations.</li> </ul>
---	--

1. Refer to the weights of the individual components stated in the general arrangement drawing and/or the manufacturer's product literature.
2. Select suitable lifting equipment.
3. Transport the pump/pump set and individual components as illustrated.<sup>2)</sup>


### 3.3 Storage/preservation

	<div style="background-color: #f1c40f; color: black; padding: 5px;"><b>⚠ WARNING</b></div> <p><b>Installation on mounting surfaces which are unsecured and cannot support the load</b>            Personal injury and damage to property!</p> <ul style="list-style-type: none"> <li>▷ Use a concrete of compressive strength class C25/30 which meets the requirements of exposure class XC1 to EN 206-1.</li> <li>▷ The mounting surface must have set and must be completely horizontal and even.</li> <li>▷ Observe the weights indicated.</li> </ul>
---	---


If commissioning is to take place some time after delivery, we recommend that the following measures be taken:

	<div style="background-color: #f1c40f; color: black; padding: 5px;"><b>CAUTION</b></div> <p><b>Damage during storage due to humidity, dirt or vermin</b>            Corrosion/contamination of the pump (set)!</p> <ul style="list-style-type: none"> <li>▷ For outdoor storage cover the pump (set) or the packaged pump (set) and accessories with waterproof material.</li> </ul>
	<div style="background-color: #f1c40f; color: black; padding: 5px;"><b>CAUTION</b></div> <p><b>Wet, contaminated or damaged openings and connections</b>            Leakage or damage to the pump!</p> <ul style="list-style-type: none"> <li>▷ Clean and cover pump openings and connections as required prior to putting the pump into storage.</li> </ul>
	<div style="background-color: #f1c40f; color: black; padding: 5px;"><b>CAUTION</b></div> <p><b>Bearings in the same position for a prolonged period of time</b>            Damage to the bearings!</p> <ul style="list-style-type: none"> <li>▷ Manually rotate the shaft once a month with suitable tools.</li> <li>▷ Store the pump in a room isolated from vibrations.</li> </ul>

<sup>2)</sup> See other applicable documents for transport options.

	<div style="background-color: #FFD700; padding: 5px;"><b>CAUTION</b></div> <p><b>Pump stored too long or incorrectly</b> Damage to the pump!</p> <ul style="list-style-type: none"> <li>▷ Check especially the rolling element bearings and the lubricant. If any damage is suspected, replace the rolling element bearings.</li> </ul>
---	---

- Store the pump and supplied components under dry, vibration-free conditions, if possible in their original packaging.
  - Ambient temperatures for transport and storage: see data sheet
1. Manually rotate the pump shaft once a month with suitable tools.
  2. Spray the preservative through the suction and discharge nozzles.  
It is advisable to then close the pump nozzles (e.g. with plastic caps or similar).


	<div style="background-color: #0070C0; color: white; padding: 5px;"><b>NOTE</b></div> <p>Observe the manufacturer's instructions for application/removal of the preservative.</p>
---	---

### 3.4 Return to supplier

1. Drain the pump as per operating instructions. (⇒ Section 7.3, Page 42)
2. Flush and clean the pump, particularly if it has been used for handling noxious, explosive, hot or other hazardous fluids.
3. If the pump has handled fluids whose residues could lead to corrosion damage in the presence of atmospheric humidity or could ignite upon contact with oxygen also neutralise the pump and blow through with anhydrous inert gas to ensure drying.
4. Always complete and enclose a certificate of decontamination when returning the pump.  
Indicate any safety measures and decontamination measures taken.  
(⇒ Section 11, Page 56)

	<div style="background-color: #0070C0; color: white; padding: 5px;"><b>NOTE</b></div> <p>If required, a blank certificate of decontamination can be downloaded from the following web site: <a href="http://www.ksb.com/certificate_of_decontamination">www.ksb.com/certificate_of_decontamination</a></p>
---	--

### 3.5 Disposal

	<div style="background-color: #FFA500; padding: 5px;"><b>! WARNING</b></div> <p><b>Fluids handled, consumables and supplies which are hot and/or pose a health hazard</b> Hazard to persons and the environment!</p> <ul style="list-style-type: none"> <li>▷ Collect and properly dispose of flushing fluid and any fluid residues.</li> <li>▷ Wear safety clothing and a protective mask if required.</li> <li>▷ Observe all legal regulations on the disposal of fluids posing a health hazard.</li> </ul>
---	---

1. Dismantle the pump (set).  
Collect greases and other lubricants during dismantling.
2. Separate and sort the pump materials, e.g. by:
  - Metals
  - Plastics
  - Electronic waste
  - Greases and other lubricants
3. Dispose of materials in accordance with local regulations or in another controlled manner.

## 4 Description of the Pump (Set)

### 4.1 General description

Pump for use in water works, irrigation pumping systems and drainage pumping systems, power stations and industrial water supply.

### 4.2 Designation

Example: B 16 B/2 VN / V1

Table 4: Designation key

Code	Description
B	Type series
16	Borehole size in inches (16 = 16")
B	Hydraulic system (B impeller)
2	Number of stages of the hydraulic system
VN	Type of installation (VN = discharge nozzle above floor <sup>3)</sup> )
V1	Type of drive (V1 = direct drive by vertical electric motor <sup>3)</sup> )

### 4.3 Name plate

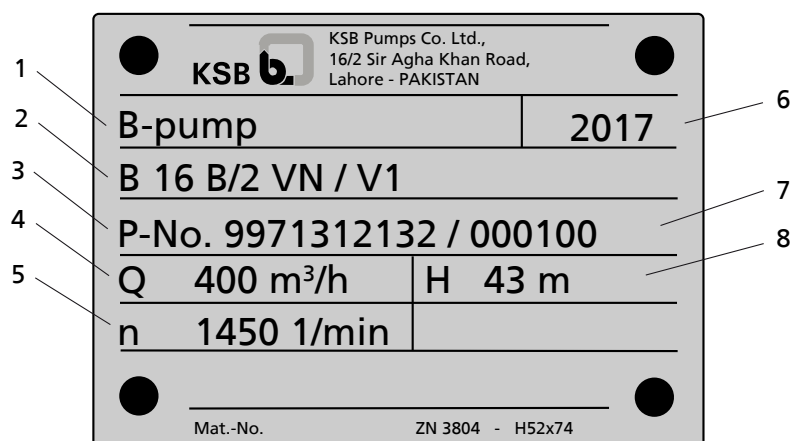


Fig. 1: Name plate (example)

1	Pump type	2	Designation of the pump set
3	Order number	4	Flow rate
5	Speed	6	Year of supply
7	Order item number	8	Head

### 4.4 Design details

#### Design

- Centrifugal pump
- Vertical installation
- Single-stage or multistage
- Pump shaft, intermediate shaft and top shaft connected via screwed coupling, conical coupling or split muff coupling

<sup>3)</sup> Refer to the general arrangement drawing/outline drawing

- Torque transmission from pump shaft to impeller and couplings via locking sleeves or keys
- Nominal discharge nozzle diameter: 80 mm - 500 mm
- Borehole diameter: 6 inches to 24 inches

### Pump casing

- Radially split relative to the shaft
- Suction casing
- Discharge casing
- Pump bowl
- Replaceable casing wear rings

### Impeller type

- Single-entry mixed flow impeller without hydraulic balancing
- Impeller wear rings (optional)
- Axially locked in position on the shaft via locking sleeves or stage sleeves

### Shaft seal

- Gland packing
- Mechanical seal

### Bearings

Shaft guide bearings:

- Product-lubricated plain bearings
- Pump shaft supported by bearing bush in each pump bowl
- Intermediate shaft supported by bearing spiders in bearing bushes installed between column pipes
- From size B14: shaft protecting sleeves (stage sleeves) in pump bowl and in all column pipe bearings

Thrust bearings:

- Grease-lubricated rolling element bearings
- Angular contact ball bearings in back-to-back arrangement
- Uncooled

## 4.5 Noise characteristics

Surface sound pressure level  $L_{pA}^{4)}$ : see data sheet for values.

## 4.6 Scope of supply

Depending on the model, the following items are included in the scope of supply:

- Pump
- Drive
- Base frame, supporting frame, foundation blocks, foundation rails, foundation ring
- Coupling and coupling guard
- Universal-joint shaft, guard
- Fasteners for pump and base frame

---

4) Spatial average; as per ISO 3744 and EN 12639; valid for pump operation in the  $Q/Q_{BEP} = 0.80 - 1.1$  range and for non-cavitating operation. If noise levels are to be guaranteed, add an allowance of +3 dB for measuring and manufacturing tolerances.

Optional accessories:

- Vibration monitoring equipment
- Temperature monitoring device (Pt100)
- Constant level oiler
- Pressure gauge
- Measuring nipple for shock pulse measurement
- Cyclone

### 4.7 Dimensions and weights

- For pump dimensions and weights, please refer to the pump data sheet.
- For motor dimensions and weights, please refer to the motor documentation.



#### NOTE





Some individual components weigh more than 25 kg. Refer to the indicated weights!



## 5 Installation at Site


### 5.1 Safety regulations

For all work involving assembly, reassembly and installation, observe the following safety information:

 	<p><b>⚠ DANGER</b></p> <p><b>Improper installation in potentially explosive atmospheres</b>  Explosion hazard!  Damage to the pump set!</p> <ul style="list-style-type: none"> <li>▸ Comply with the applicable local explosion protection regulations.</li> <li>▸ Observe the information in the data sheet and on the name plates of pump and motor.</li> </ul>
	<p><b>⚠ DANGER</b></p> <p><b>Improper transport</b>  Risk of injury from lifting heavy components!</p> <ul style="list-style-type: none"> <li>▸ Select lifting accessories which are suitable for the component weight.</li> <li>▸ Always use the attachment points provided for the lifting accessories.</li> <li>▸ Comply with the applicable health and safety regulations.</li> </ul>
	<p><b>⚠ DANGER</b></p> <p><b>Pump in a vertical position tipping over</b>  Danger to life from pump or components tipping over!</p> <ul style="list-style-type: none"> <li>▸ Attach the components to be installed to the hoisting tackle and keep them secured until the screwed connections have been fastened.</li> <li>▸ Always install the pump (set) in the sequence described.</li> <li>▸ Always place components in their centre of gravity position on a suitable surface to prevent them from tipping over.</li> </ul>


### 5.2 Checks to be carried out prior to installation

#### Place of installation

	<p><b>⚠ WARNING</b></p> <p><b>Installation on mounting surfaces which are unsecured and cannot support the load</b>  Personal injury and damage to property!</p> <ul style="list-style-type: none"> <li>▸ Use a concrete of compressive strength class C25/30 which meets the requirements of exposure class XC1 to EN 206-1.</li> <li>▸ The mounting surface must have set and must be completely horizontal and even.</li> <li>▸ Observe the weights indicated.</li> </ul>
---	--




1. Check the structural requirements.  
All structural work required must have been prepared in accordance with the dimensions stated in the outline drawing/general arrangement drawing.

### Suction head/suction lift line

	<b>WARNING</b>
	<p><b>Foreign objects in the intake/suction line</b> Personal injury and damage to property!</p> <ul style="list-style-type: none"> <li>▷ Make sure that the intake area (e.g.: intake chamber/intake channel) is clean and free from foreign objects.</li> <li>▷ Make sure that the suction line is clean and free from foreign objects.</li> <li>▷ Protect intake area leading into any existing suction line against ingress of foreign matter.</li> <li>▷ Any existing suction-side flow distribution equipment must be installed firmly and securely.</li> </ul>

1. Check suction-side conditions. No foreign objects must enter the pump.
2. Clean the intake or suction line as necessary.
3. Install suction strainer if required.





### 5.3 Installing the pump set

	<b>NOTE</b>
	See other applicable documents for the type of installation of the delivered design.
	<b>NOTE</b>
	See other applicable documents for other types of installation than those documented here.
	<b>NOTE</b>
	Depending on the design, the mechanical seal can be supplied fitted or not fitted (assembly instructions see (⇒ Section 9, Page 54) ).

Depending on the type of installation, carry out the relevant instructions:


- Prepare and install the base frame/supporting frame/foundation blocks/foundation rails/foundation ring.
- Install the pump and motor on the prepared base frame/supporting frame/foundation blocks/foundation rails/foundation ring.
- Check the alignment of pump and motor.
- Align the pump with the piping.
- Install and align the coupling.
- Connect the piping.
- Perform precision alignment of pump and motor, if this is possible with larger motors.
- Remove any transport locks.

### Installation on existing elements

	<div data-bbox="507 230 683 275" style="background-color: #f4a460; padding: 5px;"> <b>DANGER</b></div> <p><b>The pump or individual components could slip out of the suspension arrangement</b> Danger to life from falling parts!</p> <ul style="list-style-type: none"> <li>▷ Always transport the pump or components in the specified position.</li> <li>▷ Never attach the suspension arrangement to free shaft areas on the pump.</li> <li>▷ Refer to the weights and centre of gravity indicated for the individual components.</li> <li>▷ Observe the applicable local health and safety regulations.</li> <li>▷ Use suitable, permitted lifting accessories.</li> </ul>
	<div data-bbox="507 629 683 674" style="background-color: #f4a460; padding: 5px;"> <b>DANGER</b></div> <p><b>Incorrect installation</b> Risk of injury from lifting heavy components and placing them upright</p> <ul style="list-style-type: none"> <li>▷ Only transport and place the pump and individual components upright in the specified position.</li> <li>▷ Select a suitable lifting accessory according to the weight of the component and the installation requirements.</li> <li>▷ Always use the attachment points provided for the lifting accessories.</li> </ul>

- ✓ The relevant general arrangement drawing is available.
  - ✓ The foundation has the required strength and characteristics for the loads specified in the general arrangement drawing.
  - ✓ The foundation complies with the dimensions specified in the general arrangement drawing.
  - ✓ If the mechanical seal is already fitted in the pump, the assembly fixtures are intact. See (⇒ Section 9, Page 54) if the mechanical is supplied with the pump but not fitted.
1. Transport and place the pump (set) upright in accordance with the other applicable documents.
  2. Lower the pump onto the foundation elements provided.
  3. Align the pump with the piping and connect it to the foundation.
  4. Mount the motor and drive lantern as described in the motor manufacturer's operating instructions.
  5. Align the coupling as described in the coupling manufacturer's operating manual.
  6. Remove the assembly fixtures after pump rotor adjustment (see Section 5.3.1).

### 5.3.1 Checking and adjusting the pump rotor clearance

	<div data-bbox="507 1659 639 1697" style="background-color: #f4d03f; padding: 5px;"><b>CAUTION</b></div> <p><b>Incorrect setting of pump rotor</b> Damage to the pump/pump set components</p> <ul style="list-style-type: none"> <li>▷ Establish the permissible clearance by raising the pump rotor in axial direction.</li> </ul>
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The rotor must always be checked and re-adjusted after the first installation or following complete dismantling. It must always be checked and re-adjusted before the motor and the coupling plate are fitted.

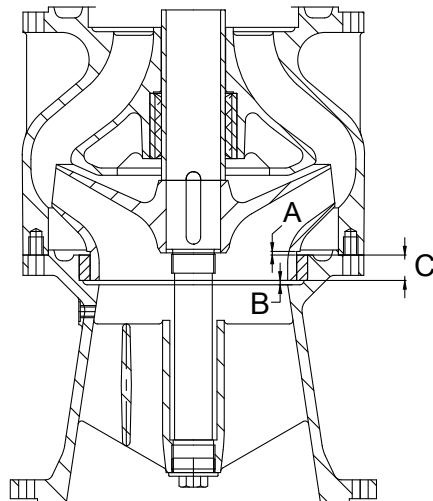


Fig. 2: Axial clearance

A	Axial clearance A	B	Axial clearance B
C	Height of casing wear ring		

Table 5: Axial clearance




Size	Axial clearance [mm]		Casing wear ring C
	A	B	
6B	3	3	8
7B	3	3	8
8B	3	3	12
8D	3	3	12
10B	3	4	15
10D	4	6	19
10F	3	5	18
12B	3	9	15
12D	3	4	20
12F	5	5	18
14B	3	4	18
14D	3	4	20
16D	4	5	22
18B	7	4	22
20B	5	6	35
22B	6	8	33
24B	6	7	35

- ✓ Suitably dimensioned lifting equipment and lifting accessories are available.
- ✓ The pump has been completely assembled.
- ✓ The drive has not been mounted.
- ✓ The hexagon nuts for re-adjusting the gland follower have been loosened.
- ✓ The pump rotor rests with the blades inside the wear ring.
- ✓ The pump has been correctly aligned.


1. Measure the distance from the contact face of the drive lantern to the end of the top shaft. Record the measured value.
2. Raise the pump rotor by turning the adjusting nut clockwise until the pump rotor has reached the value specified for the axial clearance "A" in the *Axial clearance* table.

3. After establishing the correct axial clearance, turn the adjusting nut further until the holes of the locking screws align with the next threaded holes. This slightly increases the permissible clearance.
4. Fit the locking screws of the adjusting nut.
5. Rotate the pump rotor by hand to check that it rotates freely. Rubbing contact is indicated by a higher rotational resistance.
6. If the assembly fixtures of the mechanical seal are still fitted, remove them.

#### 5.4 Connecting the piping


	<div style="background-color: #f4a460; padding: 5px;"><b>! DANGER</b></div> <p><b>Impermissible loads acting on the pump nozzles</b>            Danger to life from escaping hot, toxic, corrosive or flammable fluids!</p> <ul style="list-style-type: none"> <li>▷ Do not use the pump as an anchorage point for the piping.</li> <li>▷ Anchor the pipes in close proximity to the pump and connect them properly without transmitting any stresses or strains.</li> <li>▷ Observe the permissible forces and moments at the pump nozzles.</li> <li>▷ Take appropriate measures to compensate for thermal expansion of the piping.</li> </ul>
	<div style="background-color: #f4d03f; padding: 5px;"><b>CAUTION</b></div> <p><b>Incorrect earthing during welding work at the piping</b>            Destruction of rolling element bearings (pitting effect)!</p> <ul style="list-style-type: none"> <li>▷ Never earth the electric welding equipment on the pump or baseplate.</li> <li>▷ Prevent current flowing through the rolling element bearings.</li> </ul>
	<div style="background-color: #2980b9; color: white; padding: 5px;"><b>NOTE</b></div> <p>Installing check and shut-off elements in the system is recommended, depending on the type of plant and pump. However, such elements must not obstruct proper drainage or hinder disassembly of the pump.</p>

- ✓ Suction lift lines have been laid with a rising slope, suction head lines with a downward slope towards the pump.
  - ✓ A flow stabilisation section having a length equivalent to at least twice the diameter of the suction flange has been provided upstream of the suction flange.
  - ✓ The nominal diameters of the pipelines are at least equal to the nominal diameters of the pump nozzles. A hydraulically optimised elbow is provided between the suction lift line/suction head line and the pump.
  - ✓ To prevent excessive pressure losses, adapters to larger diameters have a diffuser angle of approx. 8°.
  - ✓ The pipelines have been anchored in close proximity to the pump and connected without transmitting any stresses or strains.
1. Thoroughly clean, flush and blow through all vessels, pipelines and connections (especially of new installations).
  2. Before installing the pump in the piping, remove the flange covers on the suction nozzles and discharge nozzles of the pump.
  3. If the owner/operator supplies an expansion joint, it has to be braced with external tie rods to prevent impermissible reaction forces.


	CAUTION
	<p><b>Welding beads, scale and other impurities in the piping</b> Damage to the pump!</p> <ul style="list-style-type: none"> <li>▷ Remove any impurities from the piping.</li> <li>▷ If necessary, install a filter/strainer.</li> </ul>


4. If required, install a filter/strainer in the piping.


5. Connect the pump nozzles to the piping.

	CAUTION
	<p><b>Aggressive flushing liquid and pickling agent</b> Damage to the pump!</p> <ul style="list-style-type: none"> <li>▷ Match the cleaning operation mode and duration of flushing and pickling to the casing materials and seal materials used.</li> </ul>



### 5.5 Enclosure/insulation

	⚠ WARNING
	<p><b>Failure to re-install or re-activate protective devices</b> Risk of injury from moving parts or escaping fluid!</p> <ul style="list-style-type: none"> <li>▷ As soon as the work is completed, re-install and/or re-activate any safety-relevant and protective devices.</li> </ul>

	⚠ WARNING
	<p><b>Distributor casing and bearing housing take on the same temperature as the fluid handled.</b> Risk of burns!</p> <ul style="list-style-type: none"> <li>▷ Insulate the distributor casing.</li> <li>▷ Fit protective equipment.</li> </ul>

	CAUTION
	<p><b>Heat build-up in the bearing housing</b> Damage to the bearing!</p> <ul style="list-style-type: none"> <li>▷ Never insulate the bearing housing and bearing cover.</li> </ul>

### 5.6 Aligning the pump and motor

 	⚠ DANGER
	<p><b>Inadmissible temperatures at the coupling or bearings due to misalignment of the coupling</b> Explosion hazard! Risk of burns!</p> <ul style="list-style-type: none"> <li>▷ Make sure that the coupling is correctly aligned at all times.</li> </ul>



### CAUTION

#### Misalignment of pump and motor shafts

Damage to pump, motor and coupling!

- ▷ Always check the coupling after the pump has been installed and connected to the piping.

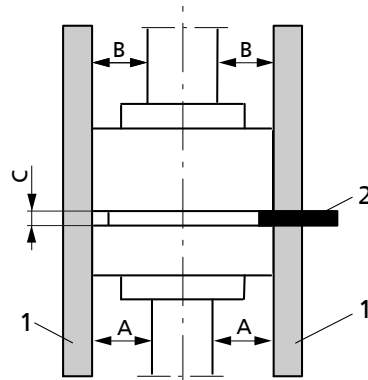


Fig. 3: Checking the coupling alignment

1	Straight-edge	2	Gauge
---	---------------	---	-------

- ✓ The coupling guard and footboard, if any, have been removed.
- 1. Place the straight-edge axially on both coupling halves.
- 2. Leave the straight-edge in this position and turn the coupling by hand.  
The coupling is aligned correctly if the distances A) and B) to the respective shafts are the same at all points around the circumference.  
The radial and axial deviation between the two coupling halves must not exceed 0.05 mm. Observe the coupling manufacturer's operating manual!
- 3. In case of misalignment, loosen the bolts on the motor and re-align.
- 4. Re-tighten the bolts.
- 5. Check coupling and shaft for proper functioning. Check that coupling/shaft can be rotated by hand.
- 6. Re-install the coupling guard and footboard, if any.
- 7. Check the distance between coupling and coupling guard. The coupling guard must not touch the coupling.

### 5.7 Permissible forces and moments at the pump nozzles

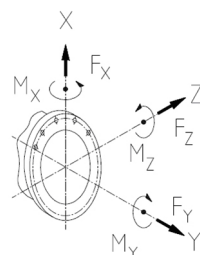


Fig. 4: Permissible forces and moments



See the general arrangement drawing for forces and moments at the pump nozzles. The values indicated do not apply to reaction forces from unbraced expansion joints! (See the general arrangement drawing for permissible values, or contact KSB)

Determine the resulting permissible forces according to

$$F_{\text{res}} \leq \sqrt{F_x^2 + F_z^2}$$




The data on forces and moments apply to static piping loads only. If the limits are exceeded, they must be checked and verified.  
The values are only applicable if the pump is installed on completely grouted elements and bolted to a rigid and level foundation.

### 5.8 Auxiliary connections


	<p><b>⚠ WARNING</b></p> <p><b>Screw plugs subjected to pressure</b> Risk of injuries by parts flying off and escaping fluid!</p> <ul style="list-style-type: none"> <li>▷ Never use screw plugs for releasing pressure from the pump casing.</li> <li>▷ Always use suitable venting devices (e.g. vent valve).</li> </ul>
	<p><b>⚠ WARNING</b></p> <p><b>Failure to use or incorrect use of auxiliary connections (e.g. barrier fluid, flushing liquid, etc.)</b> Risk of injury from escaping fluid! Risk of burns! Malfunction of the pump!</p> <ul style="list-style-type: none"> <li>▷ Refer to the general arrangement drawing, the piping layout and pump markings (if any) for the quantity, dimensions and locations of auxiliary connections.</li> <li>▷ Use the auxiliary connections provided.</li> </ul>

For auxiliary connections see other applicable documents.


### 5.9 Connection to power supply

	<p><b>⚠ DANGER</b></p> <p><b>Incorrect electrical installation</b> Explosion hazard!</p> <ul style="list-style-type: none"> <li>▷ For electrical installation, also observe the requirements of IEC 60079-14.</li> <li>▷ Always use a motor protection switch for explosion-proof motors.</li> </ul>
	<p><b>⚠ DANGER</b></p> <p><b>Electrical connection work by unqualified personnel</b> Danger of death from electric shock!</p> <ul style="list-style-type: none"> <li>▷ Always have the electrical connections installed by a trained and qualified electrician.</li> <li>▷ Observe regulations IEC 60364 and, for explosion-proof models, EN 60079.</li> <li>▷ Observe the motor manufacturer's operating instructions.</li> </ul>
	<p><b>⚠ WARNING</b></p> <p><b>Unintentional starting of the pump set</b> Risk of injury by moving components and shock currents!</p> <ul style="list-style-type: none"> <li>▷ Ensure that the pump set cannot be started unintentionally.</li> <li>▷ Always make sure the electrical connections are disconnected before carrying out work on the pump set.</li> </ul>





	<b>⚠ WARNING</b>
	<b>Incorrect connection to the mains</b> Damage to the mains network, short circuit! ▷ Observe the technical specifications of the local energy supply companies.



1. Check the available mains voltage against the data on the motor name plate.
2. Select an appropriate start-up method.


	<b>NOTE</b>
	A motor protection device is recommended.


### 5.9.1 Earthing

 	<b>⚠ DANGER</b>
	<b>Electrostatic charging</b> Explosion hazard! Fire hazard! Damage to the pump set! ▷ Connect the PE conductor to the earthing terminal provided.

### 5.10 Checking the direction of rotation

 	<b>⚠ DANGER</b>
	<b>Temperature increase resulting from contact between rotating and stationary components</b> Explosion hazard! Damage to the pump set! ▷ Never check the direction of rotation by starting up the unfilled pump set. ▷ Separate the pump from the motor to check the direction of rotation.

	<b>⚠ DANGER</b>
	<b>Rotating shaft during direction of rotation check</b> Risk of injury! ▷ Maintain a safe distance to the pump set. ▷ Comply with the general health and safety regulations.


	CAUTION
	<p><b>Drive and pump running in the wrong direction of rotation</b> Damage to the pump!</p> <ul style="list-style-type: none"> <li>▷ Refer to the arrow indicating the direction of rotation on the pump.</li> <li>▷ Check the direction of rotation. If required, check the electrical connection and correct the direction of rotation.</li> </ul>

- ✓ The pump has been completely separated from the motor.
  - ✓ All components at the motor (e.g. coupling half at the motor shaft) have been secured.
1. Start the motor and stop it again immediately to determine the motor's direction of rotation.
  2. Check the direction of rotation.  
The motor's direction of rotation must match the arrow indicating the direction of rotation on the pump.
  3. If the motor runs in the wrong direction of rotation, check the electrical connection of the motor and the control system, if applicable.

### 5.11 Removing the transport lock

Remove the transport lock, if any.

### 5.12 Filling in lubricants


	CAUTION
	<p><b>Temporary storage of the pump set too long</b> Contamination, condensation, resinification or leakage of the grease!</p> <ul style="list-style-type: none"> <li>▷ Check for contamination and condensation.</li> <li>▷ Change the complete grease fill before returning the pump set to service.</li> <li>▷ Replace the grease fill every time the bearings are dismantled.</li> </ul>


#### Grease-lubricated bearings

Grease-lubricated bearings have been packed with grease at the factory.

#### Oil-lubricated bearings

Fill the bearing housings with lubricant up to the mark.  
Oil quality: see data sheet  
Oil quantity: see data sheet

	CAUTION
	<p><b>Insufficient quantity of lubricant in bearing housing</b> Damage to the bearings!</p> <ul style="list-style-type: none"> <li>▷ Check the lubricant level regularly.</li> <li>▷ Always fill the bearing housing up to the mark.</li> </ul>

	NOTE
	<p>An excessively high oil level or grease quantity can lead to a temperature rise and to leakage of the fluid handled or oil.</p>

## 6 Commissioning/Start-up/Shutdown


### 6.1 Commissioning/Start-up

#### 6.1.1 Prerequisites for commissioning/start-up

Before commissioning/starting up the pump set, make sure that the following conditions are met:

- The pump set has been properly connected to the electric power supply and is equipped with all protection devices. (⇒ Section 5.9, Page 24)
- The pump has been flooded up to the specified minimum water level. (See general arrangement drawing)
- The direction of rotation has been checked. (⇒ Section 5.10, Page 25)
- All auxiliary connections required are connected and operational.
- The transport lock has been removed.
- The lubricants have been checked and filled in.
- After prolonged shutdown of the pump (set), the required activities have been carried out. (⇒ Section 6.4, Page 34)
- The coupling alignment has been checked.

#### 6.1.2 Filling in the lubricant

	<b>CAUTION</b>
	<p><b>Incorrect oil level in bearing housing</b> Damage to the pump!</p> <p>▷ Check the oil level only during standstill of the pump!</p>

Information about lubricants to be used see (⇒ Section 9, Page 54)

1. Prior to commissioning, check the grease fill of the thrust bearings. If required, top up or replace the lubricant.
2. Check the oil level and oil quality of the drive. If required, top up or replace the lubricant.

#### 6.1.3 Priming and venting the pump











##### Overall length of the pump $\leq 9$ m

Pumps with an overall length of up to 9 m do not need to be primed.


##### Overall length of the pump $> 9$ m

- |               |   |
|---------------|---|
| <b>Funnel</b> | <ol style="list-style-type: none"> <li>1. Rotate the funnel to open the passage.</li> <li>2. Fill water in through the funnel until the contact area of the radial bearing is moist.</li> <li>3. Rotate the funnel in the opposite direction to close the passage.</li> </ol> |
| <b>Tank</b>   | <ol style="list-style-type: none"> <li>1. Open the tank cover.</li> <li>2. Open the valve at the bottom of the tank.</li> <li>3. Fill water in through the tank until the contact area of the radial bearing is moist.</li> <li>4. Close the valve.</li> </ol>                |


### 6.1.4 Start-up

 	<div> <b>DANGER</b></div> <p><b>Non-compliance with the permissible pressure and temperature limits if the pump is operated with the suction and/or discharge line closed.</b></p> <p>Explosion hazard! Hot or toxic fluids escaping!</p> <ul style="list-style-type: none"> <li>▷ Never operate the pump with the shut-off elements in the suction line and/or discharge line closed.</li> <li>▷ Only start up the pump set with the discharge-side shut-off element slightly or fully open.</li> </ul>
 	<div> <b>DANGER</b></div> <p><b>Excessive temperatures due to dry running or excessive gas content in the fluid handled</b></p> <p>Explosion hazard! Damage to the pump set!</p> <ul style="list-style-type: none"> <li>▷ Never operate the pump set without liquid fill.</li> <li>▷ Prime the pump as per operating instructions.</li> <li>▷ Always operate the pump within the permissible operating range.</li> </ul>
	<div> <b>WARNING</b></div> <p><b>Pump sets with high noise levels</b></p> <p>Damage to hearing!</p> <ul style="list-style-type: none"> <li>▷ Persons must only enter the vicinity of the running pump set if they are wearing protective clothing/ear protection.</li> <li>▷ See noise characteristics. (⇒ Section 4.5, Page 15)</li> </ul>
	<div><b>CAUTION</b></div> <p><b>Abnormal noises, vibrations, temperatures or leakage</b></p> <p>Damage to the pump!</p> <ul style="list-style-type: none"> <li>▷ Switch off the pump (set) immediately.</li> <li>▷ Eliminate the causes before returning the pump set to service.</li> </ul>
	<ul style="list-style-type: none"> <li>✓ Intake area (e.g. intake chamber) and system piping have been cleaned.</li> <li>✓ Pump, suction line and inlet tank, if any, have been vented and primed with the fluid to be handled.</li> <li>✓ The lines for priming and venting have been closed.</li> </ul>
	<div><b>CAUTION</b></div> <p><b>Start-up against open discharge line</b></p> <p>Motor overload!</p> <ul style="list-style-type: none"> <li>▷ Make sure the motor has sufficient power reserves.</li> </ul>

1. Fully open the shut-off element in the suction head/suction lift line.
2. Close or slightly open the shut-off element in the discharge line.
3. Start up the motor.
4. Immediately after the pump has reached full rotational speed, slowly open the shut-off element in the discharge line and adjust it to comply with the duty point.



	<b>! DANGER</b>
	<b>Seal leakages at operating temperature</b> Hot or toxic fluid could escape! <ul style="list-style-type: none"> <li>▷ After the operating temperature has been reached and/or in the event of leakage, switch off the pump set and tighten the bolts on the casing to the specified torques.</li> <li>▷ If there is leakage at the shaft seal, check the coupling alignment and re-align if necessary.</li> </ul>

#### 6.1.5 Checking the shaft seal

	<b>NOTE</b>
	Depending on the design, the mechanical seal can be supplied fitted or not fitted (assembly instructions see (⇒ Section 9, Page 54) ).


**Mechanical seal** The mechanical seal only leaks slightly or invisibly (as vapour) during operation. Mechanical seals are maintenance-free.


**Gland packing** The gland packing must drip slightly during operation.  
(Approximately 20 drops per minute)

 	<b>! DANGER</b>
	<b>The temperatures at the gland packing have risen above the permissible limits</b> Explosion hazard! <ul style="list-style-type: none"> <li>▷ Gland packings are not approved for use in potentially explosive atmospheres.</li> <li>▷ Immediately switch off the pump set!</li> </ul>

The minimum leakage required depends on the fluid handled, pressure, sliding velocity and temperature.

See data sheet for the leakage rates at the gland packing.

	<b>CAUTION</b>
	<b>Excessive leakage or no leakage at the gland packing</b> Damage to the pump! <ul style="list-style-type: none"> <li>▷ Excessive leakage: Re-tighten the gland follower until the required leakage rate is reached.</li> <li>▷ No leakage: Switch off the pump set immediately.</li> </ul>

	<b>! WARNING</b>
	<b>Work in the immediate vicinity of rotating parts</b> Risk of hand injuries! <ul style="list-style-type: none"> <li>▷ Always have this work performed by trained personnel.</li> <li>▷ Take particular caution when performing this work.</li> </ul>

#### Adjusting the leakage

- Prior to commissioning**
1. Only lightly tighten the nuts of the gland follower by hand.
  2. Use a feeler gauge to verify that the gland follower is mounted centred and at a right angle to the shaft.
- ⇒ The gland must leak after the pump has been primed.  
(Only applies to pumps with suction line and the corresponding inlet pressure.)

### After five minutes of operation

The leakage can be reduced.

1. Tighten the nuts of the gland follower by 1/6 turn.
2. Monitor the leakage for another five minutes.

#### Excessive leakage:

Repeat steps 1 and 2 until the minimum value has been reached.

#### Not enough leakage:

Slightly loosen the nuts at the gland follower.

#### No leakage:

Immediately switch off pump set!


Loosen the gland follower and repeat commissioning.

#### Checking the leakage

After the leakage has been adjusted, monitor the leakage for about two hours at maximum fluid temperature.


Check that enough leakage occurs at the gland packing at minimum fluid pressure.


### 6.1.6 Shutdown

	<div style="background-color: #FFD700; padding: 5px;"><b>CAUTION</b></div> <p><b>Reverse flow of fluid handled (not applicable to pumps with reverse rotation lock)</b> Motor or winding damage!</p> <p>Excessive reverse runaway speed of the motor!</p> <ul style="list-style-type: none"> <li>▷ Thrust bearing damage following prolonged periods of reverse rotation. (Applies to the radial bearing of the oil-lubricated plain bearing design)</li> <li>▷ Observe the permissible reverse runaway speed of the motor. See the manufacturer's product literature included with the supplied documentation.</li> <li>▷ Close the shut-off elements.</li> </ul>
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✓ The shut-off element in the suction line is and remains open.


1. Close the shut-off element in the discharge line slowly.
2. Switch off the motor immediately after closing the shut-off element and make sure the pump set runs down smoothly to a standstill.

	<div style="background-color: #0070C0; color: white; padding: 5px;"><b>NOTE</b></div> <p>If the discharge line is equipped with a non-return or check valve, the shut-off element may remain open provided that the system conditions and system regulations are considered and observed.</p>
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	<div style="background-color: #0070C0; color: white; padding: 5px;"><b>NOTE</b></div> <p>If shut-off is not possible, the pump will run in reverse direction. The reverse runaway speed must be lower than the rated speed.</p>
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For prolonged shutdown periods:


1. Close the shut-off element in the suction line, if any.
2. Close the auxiliary connections.

	<div style="background-color: #FFD700; padding: 5px;"><b>CAUTION</b></div> <p><b>Risk of freezing during prolonged pump shutdown periods</b> Damage to the pump!</p> <ul style="list-style-type: none"> <li>▷ Drain the pump and the cooling/heating chambers (if any) or otherwise protect them against freezing.</li> </ul>
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## 6.2 Operating limits


	<p><b>⚠ DANGER</b></p> <p><b>Non-compliance with operating limits for pressure, temperature, fluid handled and speed</b> Explosion hazard! Hot or toxic fluid could escape!</p> <ul style="list-style-type: none"> <li>▷ Comply with the operating data indicated in the data sheet.</li> <li>▷ Never use the pump for handling fluids it is not designed for.</li> <li>▷ Avoid prolonged operation against a closed shut-off element.</li> <li>▷ Never operate the pump at temperatures, pressures or rotational speeds exceeding those specified in the data sheet or on the name plate unless the written consent of the manufacturer has been obtained.</li> </ul>
	<p><b>⚠ DANGER</b></p> <p><b>Formation of a potentially explosive atmosphere inside the pump</b> Explosion hazard!</p> <ul style="list-style-type: none"> <li>▷ When draining tanks take suitable measures to prevent dry running of the pump (e.g. fill level monitoring).</li> </ul>

### 6.2.1 Maximum operating pressure

	<p><b>CAUTION</b></p> <p><b>Permissible operating pressure exceeded</b> Damage to connections and seals!</p> <ul style="list-style-type: none"> <li>▷ Never exceed the operating pressure specified in the data sheet.</li> </ul>
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The maximum operating pressure depends on the pump size, pump material and nominal pressure of the flange design.  
Neither the material / size dependent maximum pressure nor the maximum nominal pressure of the flange must be exceeded.  
Maximum operating pressure: see data sheet.

### 6.2.2 Temperature of the fluid handled


	<p><b>CAUTION</b></p> <p><b>Fluid temperature too high or too low</b> Damage to the pump!</p> <ul style="list-style-type: none"> <li>▷ Avoid prolonged operation against a closed shut-off element.</li> <li>▷ Never operate the pump at temperatures above or below those specified in the data sheet or on the name plate unless the written consent of the manufacturer has been obtained.</li> </ul>
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If the values are not indicated in the data sheet, the following temperature limits apply. The temperatures must neither be below nor above these limits.


**Table 6:** Temperature limits of the fluid handled

Minimum fluid temperature	0 °C
Maximum fluid temperature	+ 60 °C


### 6.2.3 Abrasive fluids/solids

	<div style="background-color: #FFD700; padding: 5px;"><b>CAUTION</b></div> <p><b>Abrasive particles or solids in the fluid</b></p> <p>Damage to the pump!</p> <ul style="list-style-type: none"> <li>▷ Comply with the limits indicated in the data sheet.</li> <li>▷ Flush the piping prior to commissioning.</li> <li>▷ Install a filter in the system, if required.</li> </ul>
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Do not exceed the maximum permissible solids content specified in the data sheet. When the pump handles fluids containing abrasive substances, increased wear of the hydraulic system and shaft seal are to be expected. In this case, reduce the commonly recommended inspection intervals.

	<div style="background-color: #0070C0; color: white; padding: 5px;"><b>NOTE</b></div> <p>Solids, especially long fibres, plastic residues or similar, can lead to clogging of the barrier or flushing lines and to mechanical seal damage.</p>
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### 6.2.4 Hydraulic operating range

	<div style="background-color: #FFD700; padding: 5px;"><b>CAUTION</b></div> <p><b>Non-compliance with hydraulic operating limits</b></p> <p>Damage to the pump and motor</p> <ul style="list-style-type: none"> <li>▷ Observe the limits in the data sheet.</li> <li>▷ Brief passage through the critical range below <math>Q_{min}</math> is permissible during start-up.</li> </ul>
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#### General information on the hydraulic operating range

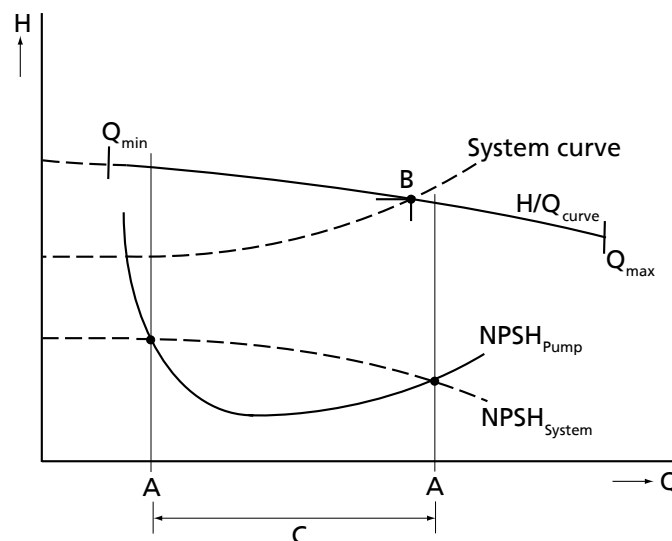


Fig. 5: Pump operating range

$NPSH_{Available}$	Inlet pressure available in the system	$NPSH_{Required}$	Required inlet pressure
A	Operating limit	B	Operating point
C	Operating range without NPSH margin		



The flow rate  $Q$  will develop automatically as a function of the discharge head  $H$ , in line with the pump's characteristic curve. The pump's permissible operating range has limits that are independent of each other in terms of their cause.

#### Part load operating limit

This limit is indicated in the  $H/Q$  characteristic by  $Q_{\min}$  or by discontinuation of the characteristic curve in the diagram.

#### NPSH-related limits under off-design conditions

The part load and overload limits are determined by the ratio of  $NPSH_{\text{Required}}$  to  $NPSH_{\text{Available}}$ .



The NPSH limits are determined as follows:

The intersections of  $NPSH_{\text{Required}}$  and  $NPSH_{\text{Available}}$  are projected onto the  $H/Q$  characteristic, where they represent the operating limits.

If the pump set is operated outside its operating limits or system-related changes occur, check the NPSH values.

If necessary, consult your nearest customer service centre.

### 6.2.5 Frequency of starts


	<p><b>! DANGER</b></p> <p><b>Excessive surface temperature of the motor</b> Explosion hazard! Damage to the motor!</p> <ul style="list-style-type: none"> <li>▷ In case of explosion-proof motors, observe the frequency of starts specified in the manufacturer's product literature.</li> </ul>
	<p><b>CAUTION</b></p> <p><b>Re-starting while motor is still running down</b> Damage to the pump (set)!</p> <ul style="list-style-type: none"> <li>▷ Do not re-start the pump set before the pump rotor has come to a standstill.</li> </ul>

The frequency of starts is usually determined by the maximum temperature increase of the motor. This largely depends on the power reserves of the motor in steady-state operation and on the starting conditions (DOL, star-delta, moments of inertia, etc).

Observe the motor manufacturer's operating instructions.

### 6.2.6 Fluid handled

#### 6.2.6.1 Temperature of the fluid handled


	<p><b>CAUTION</b></p> <p><b>Fluid temperature too high or too low</b> Damage to the pump!</p> <ul style="list-style-type: none"> <li>▷ Avoid prolonged operation against a closed shut-off element.</li> <li>▷ Never operate the pump at temperatures above or below those specified in the data sheet or on the name plate unless the written consent of the manufacturer has been obtained.</li> </ul>
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If the values are not indicated in the data sheet, the following temperature limits apply. The temperatures must neither be below nor above these limits.


**Table 7:** Temperature limits of the fluid handled

Minimum fluid temperature	0 °C
Maximum fluid temperature	+ 60 °C

### 6.2.6.2 Abrasive fluids/solids

	<div style="background-color: #FFD700; padding: 5px;"><b>CAUTION</b></div> <p><b>Abrasive particles or solids in the fluid</b></p> <p>Damage to the pump!</p> <ul style="list-style-type: none"> <li>▷ Comply with the limits indicated in the data sheet.</li> <li>▷ Flush the piping prior to commissioning.</li> <li>▷ Install a filter in the system, if required.</li> </ul>
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Do not exceed the maximum permissible solids content specified in the data sheet. When the pump handles fluids containing abrasive substances, increased wear of the hydraulic system and shaft seal are to be expected. In this case, reduce the commonly recommended inspection intervals.

	<div style="background-color: #0070C0; color: white; padding: 5px;"><b>NOTE</b></div> <p>Solids, especially long fibres, plastic residues or similar, can lead to clogging of the barrier or flushing lines and to mechanical seal damage.</p>
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## 6.3 Shutdown/storage/preservation

### 6.3.1 Measures to be taken for shutdown

#### The pump (set) remains installed

- ✓ Sufficient fluid is supplied for the functional check run of the pump.<sup>5)</sup>

1. For prolonged shutdown periods, start up the pump (set) regularly between once a month and once every three months for approximately five minutes. This will prevent the formation of deposits within the pump and the pump intake area.<sup>5)</sup>

#### The pump (set) is removed from the pipe and stored

- ✓ The pump has been properly drained and the safety instructions for dismantling the pump have been observed.

1. Spray-coat the inside wall of the pump casing, and in particular the impeller clearance areas, with a preservative.
2. Spray the preservative through the suction and discharge nozzles. It is advisable to then close the pump nozzles (e.g. with plastic caps or similar).
3. Oil or grease all exposed machined parts and surfaces of the pump (with silicone-free oil and grease, food-approved if required) to protect them against corrosion.
4. Contact KSB regarding preservation of the bearing.
5. Remove the gland packing.

If the pump set is to be stored temporarily, only preserve the wetted components made of low-alloy materials. Commercially available preservatives can be used for this purpose. Observe the manufacturer's instructions for application/removal.




Observe any additional instructions and information provided.

## 6.4 Returning to service

For returning the equipment to service, observe the sections on commissioning/start-up (⇒ Section 6.1, Page 27) and the operating limits (⇒ Section 6.2, Page 31) .


In addition, carry out all servicing/maintenance operations before returning the pump (set) to service. (⇒ Section 7, Page 36)

5) If the intake area (e.g. intake elbow) and the pump have been drained, special measures must be taken for the functional check run. See section on routine maintenance and inspection intervals or contact KSB.


	<div data-bbox="502 185 705 235">  <b>WARNING</b> </div> <p><b>Failure to re-install or re-activate protective devices</b>  Risk of injury from moving parts or escaping fluid!</p> <p>▷ As soon as the work is completed, properly re-install and re-activate any safety-relevant devices and protective devices.</p>
	<div data-bbox="502 425 587 465"> <b>NOTE</b> </div> <p>On pumps/pump sets older than 5 years we recommend replacing all elastomer seals.</p>


## 7 Servicing/Maintenance


### 7.1 Safety regulations

	<div style="background-color: #f4a460; padding: 5px;"><b>⚠ DANGER</b></div> <p><b>Improperly serviced pump set</b> Explosion hazard! Damage to the pump set!</p> <ul style="list-style-type: none"> <li>▸ Service the pump set regularly.</li> <li>▸ Prepare a maintenance schedule with special emphasis on lubricants, shaft seal and coupling.</li> </ul>
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The operator ensures that maintenance, inspection and installation are performed by authorised, qualified specialist personnel who are thoroughly familiar with the manual.

	<div style="background-color: #f4a460; padding: 5px;"><b>⚠ WARNING</b></div> <p><b>Unintentional starting of the pump set</b> Risk of injury by moving components and shock currents!</p> <ul style="list-style-type: none"> <li>▸ Ensure that the pump set cannot be started unintentionally.</li> <li>▸ Always make sure the electrical connections are disconnected before carrying out work on the pump set.</li> </ul>
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	<div style="background-color: #f4a460; padding: 5px;"><b>⚠ WARNING</b></div> <p><b>Fluids handled, consumables and supplies which are hot and/or pose a health hazard</b> Risk of injury!</p> <ul style="list-style-type: none"> <li>▸ Observe all relevant laws.</li> <li>▸ When draining the fluid take appropriate measures to protect persons and the environment.</li> <li>▸ Decontaminate pumps which handle fluids posing a health hazard.</li> </ul>
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	<div style="background-color: #f4a460; padding: 5px;"><b>⚠ WARNING</b></div> <p><b>Insufficient stability</b> Risk of crushing hands and feet!</p> <ul style="list-style-type: none"> <li>▸ During assembly/dismantling, secure the pump (set)/pump parts to prevent tilting or tipping over.</li> </ul>
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A regular maintenance schedule will help avoid expensive repairs and contribute to trouble-free, reliable operation of the pump, pump set and pump parts with a minimum of servicing/maintenance expenditure and work.

	<div style="background-color: #0070c0; color: white; padding: 5px;"><b>NOTE</b></div> <p>All maintenance, service and installation work can be carried out by KSB Service. See data sheet for contact addresses</p>
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Never use force when dismantling and reassembling the pump set.

## 7.2 Servicing/Inspection



### 7.2.1 Supervision of operation

	<div style="background-color: #e67e22; color: white; padding: 5px;"><b>⚠ DANGER</b></div> <p><b>Risk of potentially explosive atmosphere inside the pump</b> Explosion hazard!</p> <ul style="list-style-type: none"> <li>▷ The pump internals in contact with the fluid to be handled, including the seal chamber and auxiliary systems, must be filled with the fluid to be handled at all times.</li> <li>▷ Provide sufficient inlet pressure.</li> <li>▷ Provide an appropriate monitoring system.</li> </ul>
 	<div style="background-color: #e67e22; color: white; padding: 5px;"><b>⚠ DANGER</b></div> <p><b>Excessive temperatures as a result of bearings running hot or defective bearing seals</b> Explosion hazard! Fire hazard! Damage to the pump set!</p> <ul style="list-style-type: none"> <li>▷ Regularly check the lubricant level.</li> <li>▷ Regularly check the temperatures of the rolling element bearings/bearing housing.</li> <li>▷ Regularly check the rolling element bearings for running noises.</li> </ul>
 	<div style="background-color: #e67e22; color: white; padding: 5px;"><b>⚠ DANGER</b></div> <p><b>Excessive temperatures due to dry-running</b> Explosion hazard! Fire hazard! Damage to the pump set!</p> <ul style="list-style-type: none"> <li>▷ Never operate the pump set without liquid fill.</li> <li>▷ Never close the shut-off element in the suction line and/or supply line during pump operation.</li> </ul>
	<div style="background-color: #f1c40f; padding: 5px;"><b>CAUTION</b></div> <p><b>Impermissibly high temperature of fluid handled</b> Damage to the pump!</p> <ul style="list-style-type: none"> <li>▷ Prolonged operation against a closed shut-off element is not permitted (heating up of the fluid).</li> <li>▷ Observe the temperature limits in the data sheet and in the section on operating limits. (⇒ Section 6.2, Page 31)</li> </ul>


While the pump is in operation, observe and check the following:

- The pump must run quietly and free from vibrations at all times.
- In case of oil lubrication, ensure the oil level is correct. (⇒ Section 5.12, Page 26)
- Check the shaft seal. (⇒ Section 6.1.5, Page 29)
- Check the static seals for leakage.
- Check the rolling element bearings for running noises.  
Vibrations, noise and an increase in current input occurring during unchanged operating conditions indicate wear.

- Monitor the correct functioning of any auxiliary connections.
- Monitor the stand-by pump.  
To make sure that the stand-by pumps are ready for operation, start them up once a month.
- Monitor the bearing temperature.  
The bearing temperature must not exceed the value specified in the data sheet (measured on the outside of the bearing housing).  
If temperature monitoring is provided, the bearing temperatures indicated in the data sheet apply to the measuring points of the sensors.
- Check the flexible or torsion-resistant elements of the coupling/universal-joint shaft and replace as necessary.
- Check any pressure gauges.
- Check the drive as described in the manufacturer's product literature.
- Check that the fitted coupling guard does not touch the coupling.
- Make sure that the earth connection is fitted and marked.
- Cooling system (if any)  
Take the pump out of service at least once a year to thoroughly clean the cooling system.

	<p><b>CAUTION</b></p> <p><b>Operation outside the permissible bearing temperature</b> Damage to the pump!</p> <ul style="list-style-type: none"> <li>▸ The bearing temperature of the pump (set) must never exceed the value specified in the data sheet (measured on the outside of the bearing housing).</li> </ul>
	<p><b>NOTE</b></p> <p>After commissioning, increased temperatures may occur at grease-lubricated rolling element bearings due to the running-in process. The final bearing temperature is only reached after a certain period of operation (up to 48 hours depending on the conditions).</p>

### 7.2.2 Inspection work

	<p><b>! DANGER</b></p> <p><b>Excessive temperatures caused by friction, impact or frictional sparks</b> Explosion hazard! Fire hazard! Damage to the pump set!</p> <ul style="list-style-type: none"> <li>▸ Regularly check the coupling guard, plastic components and other guards of rotating parts for deformation and sufficient distance from rotating parts.</li> </ul>
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#### 7.2.2.1 General information

Check and service all components of the pump set as described in the corresponding operating manuals provided by the manufacturers.  
For the manufacturer's product literature see other applicable documents.

#### 7.2.2.2 Routine maintenance and inspection intervals

**Table 8:** Routine maintenance and inspection intervals

Interval	Number of persons	Time	Maintenance job
Daily	1	6 min.	▪ Check shaft seal leakage.

Interval	Number of persons	Time	Maintenance job
Daily	1	6 min.	<ul style="list-style-type: none"> <li>Check the oil level and top up the oil, if required (only for oil-lubricated bearings)</li> </ul>
Weekly	1	15 min.	<ul style="list-style-type: none"> <li>Check pump operation (inlet pressure, head, bearing temperature, noise and vibrations).</li> </ul>
Monthly	1	15 min.	<ul style="list-style-type: none"> <li>Check torsional play/condition of the coupling/universal-joint shaft (see operating manual for the coupling/universal-joint shaft).</li> </ul>
	1	15 min.	<ul style="list-style-type: none"> <li>Switch to a stand-by pump, if any, or carry out a functional check run (5 minutes).</li> </ul>
<sup>6)</sup>	1	15 min.	<ul style="list-style-type: none"> <li>Re-lubricate grease-packed rolling element bearings, re-lubrication quantity see data sheet</li> </ul>
<sup>6)</sup>	1	15 min.	<ul style="list-style-type: none"> <li>Check oil-lubricated rolling element bearings</li> </ul>
Every 4 years or if discharge head drops	2	<sup>7)</sup>	<ul style="list-style-type: none"> <li>Generally inspect and overhaul the pump in accordance with the operating instructions.</li> <li>Check and replace, if necessary: <ul style="list-style-type: none"> <li>Bearings, casing wear ring, impeller wear ring, shaft protecting sleeve</li> <li>Impeller and shaft</li> <li>Fit new seals and gaskets.</li> </ul> </li> </ul>

### 7.2.2.3 Checking the clearances

Excessive clearances will affect pump performance. Losses in efficiency and discharge head will occur.

To check the clearances, remove the rotor. If the clearance gap is larger than permitted, replace the casing wear ring and impeller wear ring (if any).

Clearances: see data sheet



#### NOTE

If the maximum clearances specified are exceeded, replace the components affected.

### 7.2.2.4 Cleaning filters



#### CAUTION




**Insufficient inlet pressure due to clogged filter/strainer in the suction line**  
Damage to the pump!

- ▷ Monitor contamination of filter/strainer with suitable means (e.g. differential pressure gauge).
- ▷ Clean filter/strainer at appropriate intervals.

<sup>6)</sup> See data sheet for intervals

<sup>7)</sup> Depending on work required due to operating hours, operating conditions etc.



### 7.2.2.5 Lubrication and lubricant change of the thrust and radial bearings

	<div data-bbox="507 232 683 277"><b>⚠ DANGER</b></div> <p><b>Excessive temperatures as a result of bearings running hot or defective bearing seals</b>  Explosion hazard!  Fire hazard!  Damage to the pump set!</p> <ul style="list-style-type: none"> <li>▷ Regularly check the bearing seals.</li> <li>▷ Regularly check the condition of the lubricant.</li> <li>▷ Regularly check the oil level and top up the oil (oil-lubricated bearings only).</li> </ul>
	<div data-bbox="507 622 639 658"><b>CAUTION</b></div> <p><b>Temporary storage of the pump set too long</b>  Deposits, condensation, resinification or leakage of grease!</p> <ul style="list-style-type: none"> <li>▷ Change the complete grease fill before returning the pump set to service.</li> <li>▷ Replace the grease fill every time the bearings are dismantled.</li> </ul>
	<div data-bbox="507 869 639 904"><b>CAUTION</b></div> <p><b>Pump stored too long or incorrectly</b>  Damage to the pump!</p> <ul style="list-style-type: none"> <li>▷ Check especially the rolling element bearings and the lubricant. If any damage is suspected, replace the rolling element bearings.</li> </ul>

#### 7.2.2.5.1 Grease lubrication

The bearings are supplied packed with high-quality grease.

##### 7.2.2.5.1.1 Re-lubricating with grease

	<div data-bbox="507 1294 703 1339"><b>⚠ WARNING</b></div> <p><b>Work in the immediate vicinity of rotating parts</b>  Risk of hand injuries!</p> <ul style="list-style-type: none"> <li>▷ Always have this work performed by trained personnel.</li> <li>▷ Take particular caution when performing this work.</li> </ul>
	<div data-bbox="507 1541 639 1576"><b>CAUTION</b></div> <p><b>Contaminated lubricating nipples</b>  Contamination of the lubricating grease!</p> <ul style="list-style-type: none"> <li>▷ Clean the grease lubricating nipples before re-lubricating them.</li> </ul>

1. Clean the lubricating nipples, if contaminated.
2. Position the grease press on the lubricating nipple.
3. Press in the grease.



#### 7.2.2.5.1.2 Changing the grease

- ✓ The bearing assembly must be dismantled to change the grease.
  1. Thoroughly clean bearing, bearing housing and bearing cover with petrol, benzene or a similar cleaning agent. Carefully remove the cleaning agent from the components again.
  2. Check that all parts are in perfect working order. Replace any damaged parts.
  3. Completely fill the cavities between the rolling elements of the bearings with grease.
  4. Fill the cavities in the bearing cover with grease until they are about half full.

#### 7.2.2.5.1.3 Intervals

- Re-lubricating with grease: see data sheet for intervals, at least every 2 years
- Changing the grease: every time the pump is dismantled

#### 7.2.2.5.1.4 Grease quality

- Grease quality: see data sheet



#### 7.2.2.5.1.5 Grease quantity

- Quantities for lubrication and re-lubrication: see data sheet


#### 7.2.2.5.2 Oil lubrication

The rolling element bearings are usually lubricated with mineral oil.

#### 7.2.2.5.2.1 Topping up/changing the lubricant

	<b>CAUTION</b>  <b>Insufficient quantity of lubricant in bearing housing</b> Damage to the bearings! ▷ Check the lubricant level regularly. ▷ Fill the bearing housing up to the mark.
	<b>NOTE</b>  An excessively high oil level or grease quantity can lead to a temperature rise and to leakage of the fluid handled or oil.

Oil is usually topped up during standstill of the pump. If it is unavoidable to top up the constant level-oiler with the pump running, temporary oil leakage may occur. Provide an appropriate drip collector.

	<b>WARNING</b>  <b>Lubricants posing a health hazard and/or hot lubricants</b> Hazard to persons and the environment! ▷ When draining the lubricant take appropriate measures to protect persons and the environment. ▷ Wear safety clothing and a protective mask if required. ▷ Collect and dispose of any lubricants. ▷ Observe all legal regulations on the disposal of fluids posing a health hazard.
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- ✓ A suitable container for the used oil is on hand.
  1. Place the container beneath the lubricant draining element.
  2. Unscrew/open the lubricant draining element and drain the lubricant.

3. Once the bearing housing has run empty, close the lubricant drain.
4. Remove the venting element.
5. Fill the lubricant up to the mark using the opening provided for the venting element.
6. After a short time, check whether the oil level has dropped at the marking. If the oil level is too low, top it up with oil.

#### 7.2.2.5.2 Intervals

- Oil change interval: see data sheet



#### 7.2.2.5.3 Oil quality

- Oil quality: see data sheet

#### 7.2.2.5.4 Oil quantity

- Oil quantity: see data sheet

### 7.3 Drainage/cleaning



	<div style="background-color: #f4a460; padding: 5px;"> <b>WARNING</b></div> <p><b>Fluids handled, consumables and supplies which are hot and/or pose a health hazard</b></p> <p>Hazard to persons and the environment!</p> <ul style="list-style-type: none"> <li>▷ Collect and properly dispose of flushing fluid and any fluid residues.</li> <li>▷ Wear safety clothing and a protective mask if required.</li> <li>▷ Observe all legal regulations on the disposal of fluids posing a health hazard.</li> </ul>
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If the fluids handled by the pump (set) leave residues which might lead to corrosion damage when coming into contact with atmospheric humidity, or which might ignite when coming into contact with oxygen, the pump (set) must be flushed through, neutralised, and anhydrous inert gas must be blown through the pump for drying purposes.

If available, use the suction-side connections to drain the fluid handled (see general arrangement drawing/outline drawing).

### 7.4 Dismantling the pump set

#### 7.4.1 General information/Safety regulations

	<div style="background-color: #d9534f; padding: 5px;"> <b>DANGER</b></div> <p><b>Insufficient preparation of work on the pump (set)</b></p> <p>Risk of injury!</p> <ul style="list-style-type: none"> <li>▷ Properly shut down the pump set.</li> <li>▷ Close the shut-off elements in the suction line and discharge line.</li> <li>▷ Drain the pump and release the pump pressure.</li> <li>▷ Shut off any auxiliary feed lines.</li> <li>▷ Allow the pump set to cool down to ambient temperature.</li> </ul>
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	<p><b>⚠ WARNING</b></p> <p><b>Unqualified personnel performing work on the pump (set)</b> Risk of injury!</p> <ul style="list-style-type: none"> <li>▷ Always have repair work and maintenance work performed by specially trained, qualified personnel.</li> </ul>
	<p><b>⚠ WARNING</b></p> <p><b>Improper lifting/moving of heavy assemblies or components</b> Personal injury and damage to property!</p> <ul style="list-style-type: none"> <li>▷ Use suitable transport devices, lifting equipment and lifting tackle to move heavy assemblies or components.</li> </ul>
	<p><b>⚠ WARNING</b></p> <p><b>Unintentional starting of the pump set</b> Risk of injury by moving components and shock currents!</p> <ul style="list-style-type: none"> <li>▷ Ensure that the pump set cannot be started unintentionally.</li> <li>▷ Always make sure the electrical connections are disconnected before carrying out work on the pump set.</li> </ul>
	<p><b>⚠ WARNING</b></p> <p><b>Hot surface</b> Risk of injury!</p> <ul style="list-style-type: none"> <li>▷ Allow the pump set to cool down to ambient temperature.</li> </ul>
	<p><b>⚠ WARNING</b></p> <p><b>Components with sharp edges</b> Risk of cutting or shearing injuries!</p> <ul style="list-style-type: none"> <li>▷ Always use appropriate caution for installation and dismantling work.</li> <li>▷ Wear work gloves.</li> </ul>


Observe the general safety instructions and information. (⇒ Section 2.7, Page 10)




For any work on the motor, observe the instructions of the relevant motor manufacturer.

For dismantling and reassembly refer to the general drawing.

In the event of damage you can always contact our service departments.

#### 7.4.2 Preparing the pump set


	<p><b>⚠ DANGER</b></p> <p><b>The pump or individual components could slip out of the suspension arrangement</b> Danger to life from falling parts!</p> <ul style="list-style-type: none"> <li>▷ Always transport the pump or components in the specified position.</li> <li>▷ Never suspend the pump from its free shaft end.</li> <li>▷ Observe the information given for the individual components regarding weights, centre of gravity and fastening points.</li> <li>▷ Observe the applicable local accident prevention regulations.</li> <li>▷ Use suitable, permitted lifting accessories, e.g. self-tightening lifting tongs.</li> </ul>
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	<div data-bbox="507 190 683 235"> <b>DANGER</b></div> <p><b>Pump (set) tipping over</b>            Danger to life from pump or components tipping over!</p> <ul style="list-style-type: none"> <li>▷ Never undo screwed connections without suspending and securing the components to be dismantled in a hoisting tackle.</li> <li>▷ Only dismantle the pump (set) in the specified order.</li> <li>▷ Only deposit components on suitable surfaces and in centre-of-gravity position, so that they cannot tip over.</li> </ul>
	<div data-bbox="507 537 587 571"><b>NOTE</b></div> <p><b>Vertical installation</b>            For dismantling a vertically installed pump, the complete pump has to be removed and placed in horizontal position. Then, the complete rotor can be removed and dismantled.</p>

#### Preparing for dismantling



- ✓ The gate valves in the suction and discharge lines have been closed.
  - ✓ The motor has been disconnected from the power supply and secured against unintentional start-up.
  - ✓ The pump has been drained.
1. Remove the flushing line and any auxiliary feed lines connected to the pump.
  2. Remove coupling guard 681 and guard plates 680.
  3. Separate the pump-end coupling half as described in the operating instructions for the coupling. (See the manufacturer's product literature included with the supplied documentation.)












#### 7.4.3 Dismantling the supplied design/installation

	<div data-bbox="507 1220 587 1254"><b>NOTE</b></div> <p>See other applicable documents for removing and dismantling the delivered design/installation.</p>
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### 7.5 Reassembling the pump set

#### 7.5.1 General information/Safety regulations

	<div data-bbox="507 1527 683 1572"> <b>DANGER</b></div> <p><b>The pump or individual components could slip out of the suspension arrangement</b>            Danger to life from falling parts!</p> <ul style="list-style-type: none"> <li>▷ Always transport the pump or components in the specified position.</li> <li>▷ Never suspend the pump from its free shaft end.</li> <li>▷ Observe the information given for the individual components regarding weights, centre of gravity and fastening points.</li> <li>▷ Observe the applicable local accident prevention regulations.</li> <li>▷ Use suitable, permitted lifting accessories, e.g. self-tightening lifting tongs.</li> </ul>
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	<div data-bbox="507 197 683 241"> <b>DANGER</b></div> <p><b>Pump (set) tipping over</b>            Danger to life from pump or components tipping over!</p> <ul style="list-style-type: none"> <li>▷ Never undo screwed connections without suspending and securing the components to be dismantled in a hoisting tackle.</li> <li>▷ Only dismantle the pump (set) in the specified order.</li> <li>▷ Only deposit components on suitable surfaces and in centre-of-gravity position, so that they cannot tip over.</li> </ul>
	<div data-bbox="507 542 703 586"> <b>WARNING</b></div> <p><b>Improper lifting/moving of heavy assemblies or components</b>            Personal injury and damage to property!</p> <ul style="list-style-type: none"> <li>▷ Use suitable transport devices, lifting equipment and lifting tackle to move heavy assemblies or components.</li> </ul>
	<div data-bbox="507 777 703 822"> <b>WARNING</b></div> <p><b>Unqualified personnel performing work on the pump (set)</b>            Risk of injury!</p> <ul style="list-style-type: none"> <li>▷ Always have repair work and maintenance work performed by specially trained, qualified personnel.</li> </ul>
	<div data-bbox="507 1012 703 1057"> <b>WARNING</b></div> <p><b>Unintentional starting of the pump set</b>            Risk of injury by moving components and shock currents!</p> <ul style="list-style-type: none"> <li>▷ Ensure that the pump set cannot be started unintentionally.</li> <li>▷ Always make sure the electrical connections are disconnected before carrying out work on the pump set.</li> </ul>
	<div data-bbox="507 1292 639 1337"><b>CAUTION</b></div> <p><b>Improper reassembly</b>            Damage to the pump!</p> <ul style="list-style-type: none"> <li>▷ Reassemble the pump (set) in accordance with the general rules of sound engineering practice.</li> <li>▷ Replace any damaged/worn parts.</li> <li>▷ Use original spare parts only.</li> </ul>
	<div data-bbox="507 1606 703 1650"> <b>WARNING</b></div> <p><b>Components heated up for installation</b>            Risk of burns to hands!</p> <ul style="list-style-type: none"> <li>▷ Wear protective gloves suitable for installation work.</li> <li>▷ Let components cool down after installation.</li> </ul>

Observe the general safety instructions and information. (⇒ Section 2.7, Page 10)


For any work on the motor, observe the instructions of the relevant motor manufacturer.

For dismantling and reassembly refer to the general assembly drawing.

In case of damage you can always contact our service departments.

- Sequence** Always reassemble the pump in accordance with the corresponding general assembly drawing and installation instructions.
- O-rings/V-rings**
- Never use O-rings that have been glued together from material sold by the metre.
  - Replace all O-rings and V-rings and clean their locating fits on the shaft. Fit all sealing elements on the relevant components before starting with the assembly.
- Assembly adhesives**
- Observe the installation instructions regarding cleaning, lubricating and sealing agents.
  - Remove any residues of liquid sealants before starting with the assembly.
- Tightening torques** For reassembly, tighten all screws and bolts as specified in this manual.

### 7.5.2 Assembling the supplied design/installation

	<p><b>NOTE</b></p> <p>See other applicable documents for installing and assembling the delivered design/installation.</p>
---	---

## 7.6 Spare parts stock

### 7.6.1 Ordering spare parts

Please order any replacement or spare parts required from:

**KSB Pumps Company Limited**

16/2, Sir Aga Khan Road  
Lahore, Pakistan

Telefax: +92 42 3636 8878-4  
Telephone: +92 42 3630 4173-4

Always quote the following data when ordering replacement or spare parts:

- Order number
- Order item number
- Type series
- Size
- Year of construction

Refer to the name plate for all data.

Also specify the following data:

- Part number and description
- Quantity of spare parts
- Shipping address
- Mode of dispatch (freight, mail, express freight, air freight)

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8) With keys, shaft bolts/screws and shaft nuts  
9) Optional  
10) If any  
11) If the thrust and radial bearing is a plain bearing  
12) Supplied by the metre  
13) Not considered in DIN 24296

### 7.6.2 Recommended spare parts stock for 2 years' operation to DIN 24296

**Table 9:** Quantity of spare parts for recommended spare parts stock

Part No.	Description		Number of pumps (including stand-by pumps)						
			2	3	4	5	6 / 7	8 / 9	10 and more
			Quantity of spare parts						
211	Pump shaft <sup>8)9)</sup>		1	1	1	2	2	2	20 %
212	Intermediate shaft <sup>8)10)</sup>		1*n <sup>10)</sup>	1*n <sup>10)</sup>	1*n <sup>10)</sup>	2*n <sup>10)</sup>	2*n <sup>10)</sup>	2*n <sup>10)</sup>	20 %
213	Top shaft <sup>8)</sup>		1	1	1	2	2	2	20 %
230	Impeller <sup>9)</sup>		1*n <sup>10)</sup>	1*n <sup>10)</sup>	1*n <sup>10)</sup>	2*n <sup>10)</sup>	2*n <sup>10)</sup>	2*n <sup>10)</sup>	20 %
231	Suction stage impeller <sup>10)9)</sup>		1	1	1	2	2	2	20 %
	Rotor <sup>9)</sup> (for multistage pumps)		1	1	1	2	2	2	20 %
320	Angular contact ball bearing		1	1	1	2	2	3	25 %
321	Deep groove ball bearing <sup>10)</sup>		1	1	1	2	2	3	25 %
382.1	Bearing carrier <sup>11)</sup>		1	1	1	2	2	4	50 %
384	Thrust collar <sup>11)</sup>		1	1	1	2	2	4	50 %
400.1-x	Gasket		4*n <sup>10)</sup>	6*n <sup>10)</sup>	8*n <sup>10)</sup>	8*n <sup>10)</sup>	9*n <sup>10)</sup>	12*n <sup>10)</sup>	150 %
411.1 x .	Joint ring		4*n <sup>10)</sup>	6*n <sup>10)</sup>	8*n <sup>10)</sup>	8*n <sup>10)</sup>	9*n <sup>10)</sup>	12*n <sup>10)</sup>	150 %
412.1-x	O-ring		4*n <sup>10)</sup>	6*n <sup>10)</sup>	8*n <sup>10)</sup>	8*n <sup>10)</sup>	9*n <sup>10)</sup>	12*n <sup>10)</sup>	150 %
422.1-x	Felt ring		4*n <sup>10)</sup>	6*n <sup>10)</sup>	8*n <sup>10)</sup>	8*n <sup>10)</sup>	9*n <sup>10)</sup>	10*n <sup>10)</sup>	100 %
433	Mechanical seal	Mechanical seal, complete <sup>9)</sup>	1	1	2	2	2	3	25 %
		Primary ring <sup>9)</sup>	2	3	4	5	6	7	90 %
		Mating ring <sup>9)</sup>	2	3	4	5	6	7	90 %
		O-rings <sup>9)</sup>	2	3	4	5	7	9	100 %
		Secondary seal at mating ring <sup>9)</sup>	2	3	4	5	7	9	100 %
		Set of springs <sup>9)</sup>	1	1	1	1	2	2	20 %
461	Gland packing (set) <sup>12)</sup>		4	4	6	6	6	8	100 %
502	Casing wear ring		2*n	2*n	2*n	3*n	3*n	4*n	50 %
503	Impeller wear ring <sup>10)</sup>		2*n	2*n	2*n	3*n	3*n	4*n	50 %
521	Stage sleeve <sup>10)13)</sup>		2*n	2*n	2*n	3*n	3*n	4*n	50 %
524.1-x	Shaft protecting sleeve (shaft seal) <sup>10)</sup>		2	2	2	3	3	4	50 %
526/920.x	Centring sleeve/locknut <sup>13)</sup>		1	1	1	2	2	2	20 %
529	Bearing sleeve (shaft protecting sleeve)		2	3	4	5	7	9	100 %
540	Bush (thrust and radial bearing) <sup>11)</sup>		1	1	2	2	3	4	50 %
541	Interstage bush <sup>10)13)</sup>		2*n	3*n	4*n	5*n	7*n	9*n	100 %
52-1	Locking sleeve, complete <sup>10)13)</sup>		1*n	1*n	1*n	2*n	2*n	2*n	20 %
544	Threaded bush <sup>13)</sup>		2	3	4	5	7	9	
545.1-x	Bearing bush		2*n	3*n	4*n	5*n	7*n	9*n	100 %
840	Torque-transmitting coupling elements		1	1	2	2	3	4	30 %
851/852	Conical/threaded coupling		1*n	1*n	2*n	2*n	3*n	4*n	30 %
920.1	Nut with two flats <sup>10)13)</sup>		1	1	2	2	3	4	30 %
931.1 x .	Lock washer <sup>10)13)</sup>		1	1	2	2	3	4	30 %

## 8 Trouble-shooting

	 <b>WARNING</b>
	<b>Improper work to remedy faults</b> Risk of injury! <p>► For any work performed to remedy faults, observe the relevant information given in this instruction manual and/or in the product literature provided by the accessories manufacturer.</p>

If problems occur that are not described in the following table, consultation with the KSB customer service is required.

- A Pump discharge pressure too low
- B Excessive discharge pressure
- C Excessive flow rate
- D Insufficient flow rate
- E Excessive power consumption
- F Pump is running, but does not deliver
- G Pump stops during operation
- H Vibrations and noise during pump operation
- I Impermissible temperature increase in the pump
- J Excessive bearing temperature
- K Excessive leakage at the shaft seal
- L Motor is overloaded
- M Leakage at the pump

Table 10: Trouble-shooting

A	B	C	D	E	F	G	H	I	J	K	L	M	Possible cause	Remedy <sup>14)</sup>
X	X	X	X	X	X	X	X	X	X	-	X	-	Operating point B does not match the Q and H performance data calculated in advance.	<ul style="list-style-type: none"> <li>Re-adjust to duty point (e.g. close/open shut-off element accordingly).</li> </ul>
X	-	-	X	-	X	-	-	-	-	-	-	-	Pump or piping are not completely vented.	<ul style="list-style-type: none"> <li>Vent the pump.</li> </ul>
X	-	-	X	-	X	X	X	X	-	-	-	-	Supply line or impeller clogged	<ul style="list-style-type: none"> <li>Clean the impeller.</li> <li>Check system for impurities.</li> <li>Remove deposits in pump and/or piping.</li> <li>Check any strainers installed/suction opening.</li> </ul>
X	-	-	X	-	X	X	X	-	-	-	-	-	Formation of air pockets in the piping	<ul style="list-style-type: none"> <li>Fit venting device.</li> <li>Alter piping layout.</li> </ul>

14) Pump pressure must be released before attempting to remedy faults on parts which are subjected to pressure.



A	B	C	D	E	F	G	H	I	J	K	L	M	Possible cause	Remedy <sup>14)</sup>
X	-	-	X	-	X	X	X	-	-	-	-	-	NSPH available/water level too low	<ul style="list-style-type: none"> <li>Check operating mode.</li> <li>Increase back pressure by throttling.</li> <li>Correct the suction conditions.</li> <li>Increase suction head.</li> <li>Install pump at a lower level.</li> <li>Fully open the shut-off element in the suction line (if any).</li> <li>Alter the inlet line if piping losses are too high.</li> </ul>
X	-	-	X	-	X	X	-	-	-	-	-	-	Air intake at the shaft seal	<ul style="list-style-type: none"> <li>Clean the barrier fluid line, supply external barrier fluid if necessary, or increase barrier fluid pressure.</li> <li>Check liquid supply system.</li> <li>Fit new shaft seal.</li> <li>Replace shaft protecting sleeve.</li> </ul>
X	-	-	X	X	-	-	X	-	-	-	X	-	Wrong direction of rotation	<ul style="list-style-type: none"> <li>Interchange two of the phases of the power cable.</li> <li>Check electrical connections.</li> </ul>
X	-	-	X	-	-	-	X	-	-	-	-	-	Speed too low	<ul style="list-style-type: none"> <li>Increase speed.<sup>15)</sup></li> <li>Check switchgear.</li> <li>Fit larger impeller.<sup>15)</sup></li> </ul>
X	-	-	X	X	X	X	X	-	-	-	-	-	Wear of internal components	<ul style="list-style-type: none"> <li>Check fluid handled for contamination by chemicals; check solids content.</li> <li>Replace worn components by new ones.</li> </ul>
-	-	-	-	X	-	-	X	-	-	-	X	-	Pump pressure lower than specified in the purchase order	<ul style="list-style-type: none"> <li>Re-adjust to duty point.</li> <li>Increase back pressure by throttling.</li> </ul>
-	-	-	-	X	-	-	-	-	-	-	X	-	Density or viscosity of the fluid handled is higher than stated in the purchase order.	<ul style="list-style-type: none"> <li>Reduce speed.</li> <li>In the case of persistent overloading, turn down impeller if possible.</li> </ul>
-	X	X	-	X	-	-	X	-	X	-	X	-	Speed too high	<ul style="list-style-type: none"> <li>Reduce speed.<sup>15)</sup></li> <li>In the case of persistent overloading, turn down impeller if possible.<sup>15)</sup></li> </ul>
-	-	-	-	-	-	-	-	-	-	-	-	X	Tie bolts/sealing elements	<ul style="list-style-type: none"> <li>Check.</li> <li>Re-tighten the bolts.</li> <li>Fit new sealing elements.</li> <li>Check pipeline connections and secure fixing of pump; improve fixing of pipelines if necessary.</li> </ul>
-	-	-	-	X	-	-	X	-	X	X	X	-	The pump set is misaligned.	<ul style="list-style-type: none"> <li>Check the coupling and re-align if required.</li> </ul>

15) Contact the manufacturer.

A	B	C	D	E	F	G	H	I	J	K	L	M	Possible cause	Remedy <sup>14)</sup>
-	-	-	-	X	-	-	X	-	X	X	X	-	Pump is warped.	<ul style="list-style-type: none"> <li>Check piping connections and fixing of pump.</li> </ul>
-	-	-	-	-	-	-	-	-	X	-	-	-	Increased axial thrust <sup>15)</sup>	<ul style="list-style-type: none"> <li>Clean balancing holes in the impeller.</li> <li>Fit new wear rings.</li> </ul>
-	-	-	-	-	-	-	-	-	-	X	-	-	Shaft seal worn / score marks or roughness on shaft protecting sleeve.	<ul style="list-style-type: none"> <li>Check flushing liquid/barrier fluid pressure.</li> <li>Clean barrier fluid line, supply external barrier fluid if necessary, or increase barrier fluid pressure.</li> <li>Fit new shaft seal.</li> <li>Replace worn components by new ones.</li> <li>Replace shaft protecting sleeve.</li> </ul>
X	-	-	X	-	-	-	X	-	X	-	-	-	Unfavourable flow to pump suction nozzle	<ul style="list-style-type: none"> <li>Check the inflow conditions of the intake reservoir and intake chamber.</li> <li>Check whether pipe routing results in swirling or irregular flow (e.g. downstream of elbow) and correct if necessary.</li> </ul>
-	-	-	-	X	-	-	-	X	-	X	-	-	Gland follower, seal cover over-tightened or cocked, incorrect packing material.	<ul style="list-style-type: none"> <li>Adjust.</li> <li>Replace.</li> <li>Correct.</li> <li>Replace gland packing.</li> <li>Replace worn components by new ones.</li> </ul>
-	-	-	-	-	-	-	-	X	X	X	-	-	Lack of cooling liquid or dirty cooling chamber	<ul style="list-style-type: none"> <li>Check flushing liquid/barrier fluid pressure.</li> <li>Clean barrier fluid line, supply external barrier fluid if necessary, or increase barrier fluid pressure.</li> <li>Increase cooling liquid quantity.</li> <li>Clean the coolant/cooling chamber.</li> </ul>
-	-	-	-	-	-	-	X	-	X	-	-	-	Pump is warped or sympathetic vibrations in the piping.	<ul style="list-style-type: none"> <li>Re-align pump/drive.</li> <li>Check piping connections and secure fixing of pump; improve fixing of piping if necessary.</li> <li>Fix piping using anti-vibration material.</li> </ul>
-	-	-	-	-	-	-	-	-	X	-	-	-	Increased axial thrust	<ul style="list-style-type: none"> <li>Check duty point/pump selection.</li> <li>Check operating mode.</li> <li>Check suction-side flow conditions.</li> </ul>
-	-	-	-	-	-	-	X	-	X	-	-	-	Insufficient or excessive quantity of lubricant or unsuitable lubricant	<ul style="list-style-type: none"> <li>Clean the bearings.</li> <li>Top up, reduce or change lubricant.</li> </ul>

A	B	C	D	E	F	G	H	I	J	K	L	M	Possible cause	Remedy <sup>14)</sup>
-	-	-	-	-	-	-	-	-	X	-	-	-	Non-compliance with specified coupling distance	<ul style="list-style-type: none"> <li>Correct the distance according to general arrangement drawing.</li> </ul>
X	-	-	X	X	-	-	-	-	-	-	X	-	Motor is running on 2 phases only.	<ul style="list-style-type: none"> <li>Replace defective fuses.</li> <li>Check electrical connections.</li> <li>Check switchgear.</li> </ul>
-	-	-	-	-	-	-	X	-	X	X	-	-	Rotor out of balance	<ul style="list-style-type: none"> <li>Clean the rotor.</li> <li>Check run-out; re-align if necessary.</li> <li>Re-balance the rotor.</li> </ul>
-	-	-	-	-	-	-	X	-	X	X	-	-	Defective bearing(s)	<ul style="list-style-type: none"> <li>Replace.</li> </ul>
-	-	-	-	-	-	-	X	X	-	-	-	-	Flow rate too low	<ul style="list-style-type: none"> <li>Re-adjust to duty point.</li> <li>Fully open the shut-off element in suction/inlet line.</li> <li>Fully open the shut-off element in the discharge line.</li> <li>Re-calculate or measure hydraulic losses <math>H_v</math></li> </ul>
X	-	-	X	-	-	-	-	-	-	-	-	-	In star-delta operation, motor stuck at star stage	<ul style="list-style-type: none"> <li>Check electrical connections.</li> <li>Check switchgear.</li> <li>Close or only slightly open the shut-off element in the discharge line during start-up.</li> </ul>
X	-	-	X	-	-	-	X	-	-	-	-	-	Impermissible air or gas content in fluid handled	<ul style="list-style-type: none"> <li>Check suction line for leakage, seal if necessary.</li> <li>Replace defective parts.</li> </ul>
X	-	-	X	-	X	X	X	-	-	-	-	-	Air intake at pump inlet (e.g. air-entraining vortices)	<ul style="list-style-type: none"> <li>Check intake area for air-entraining vortices.</li> <li>Correct the suction conditions.</li> <li>Reduce flow velocity at suction line inlet.</li> <li>Increase suction head.</li> </ul>
-	-	-	-	-	-	-	X	-	-	-	-	-	Cavitation (rattling noise)	<ul style="list-style-type: none"> <li>Correct the suction conditions.</li> <li>Check operating mode.</li> <li>Increase suction head.</li> <li>Install pump at a lower level.</li> </ul>
-	-	-	-	-	-	-	X	-	X	-	-	-	Foundation not rigid enough	<ul style="list-style-type: none"> <li>Check.</li> <li>Adjust.</li> </ul>
X	-	-	X	-	X	X	X	-	-	-	-	-	Impermissible single-pump/parallel operation	<ul style="list-style-type: none"> <li>Re-adjust to duty point.</li> <li>Change system conditions.</li> <li>Adjust pump characteristic H.</li> </ul>
-	-	-	-	-	-	-	X	-	-	X	-	-	Shaft is out of true.	<ul style="list-style-type: none"> <li>Replace.</li> </ul>
-	-	-	-	X	-	-	X	X	X	-	X	-	Impeller rubs against casing components.	<ul style="list-style-type: none"> <li>Check rotor.</li> <li>Check impeller position.</li> <li>Verify that piping has been connected without transmitting any stresses or strains.</li> </ul>

A	B	C	D	E	F	G	H	I	J	K	L	M	Possible cause	Remedy <sup>14)</sup>
-	-	-	-	-	-	-	-	-	-	-	X	-	Operating voltage too low	▪ Increase the operating voltage.
-	-	-	-	-	-	-	-	-	-	X	-	-	Excessive surface pressure in the mechanical seal's sealing clearance, lack of lubricant/circulation liquid	▪ Check installation dimensions. <sup>16)</sup>

16) Disconnect the pump (set) from the power supply and release the pump pressure.

### 8.1 Explanation of faults

The example illustrated in the diagram serves to facilitate understanding of the causes of faults/malfunctions and their remedies described in the Trouble-shooting section.

Many operating faults/malfunctions on pumps are caused by hydraulic phenomena. The hydraulic behaviour of a pump is illustrated by its characteristic curves  $H$ ,  $P$ ,  $\text{Eta}$  and  $\text{NPSH}$  in combination with the system characteristic curves  $H_A$  and  $\text{NPSH}_A$  as a function of flow rate  $Q$ . The operating point  $B$  is given by the intersection between the system curve  $H_A$  and the pump's characteristic curve  $H$ .

If the cause of a fault or malfunction is unclear, consult your nearest KSB service centre.

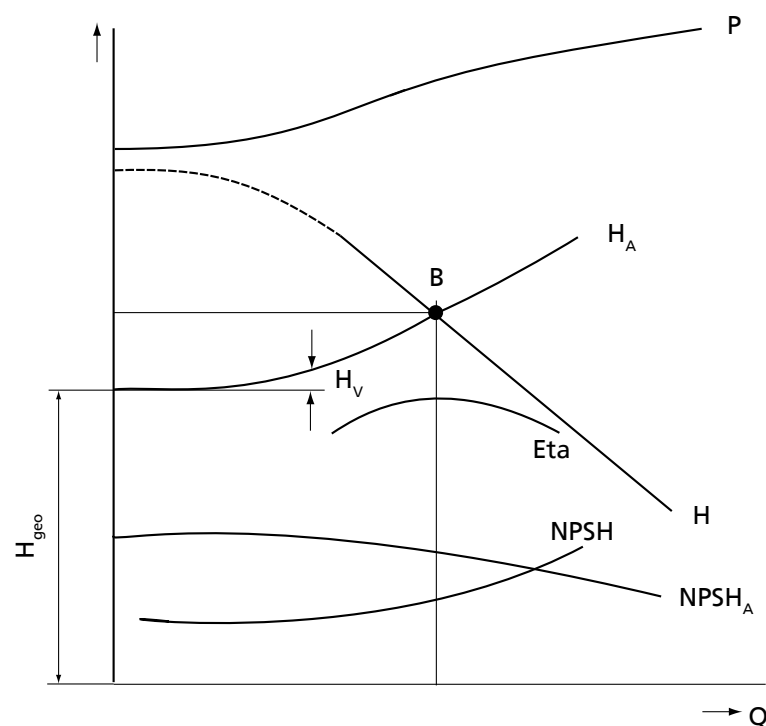


Fig. 6: Adjusting to the duty point

P	Pump power output	$H_A$	System curve
B	Operating point	$H_v$	Hydraulic losses (system)
H	Head	NPSH	Required inlet pressure
Eta	Efficiency	$\text{NPSH}_A$	Inlet pressure available in the system
Q	Flow rate	$H_{\text{geo}}$	Geodetic head

## 9 Related Documents

## 10 EU Declaration of Conformity

Manufacturer: **KSB Pumps Company Limited**  
**16/2, Sir Aga Khan Road**  
**Lahore (Pakistan)**

The manufacturer herewith declares that the product:

### B Pump

KSB order number: .....

- is in conformity with the provisions of the following Directives as amended from time to time:
  - Pump (set): Machinery Directive 2006/42/EC

The manufacturer also declares that

- the following harmonised international standards have been applied:
  - ISO 12100
  - EN 809

Person authorised to compile the technical file:

Name  
Function  
Address (company)  
Address (street, No.)  
Address (post or ZIP code, city) (country)

The EU Declaration of Conformity was issued in/on:

Place, date

.....<sup>17)</sup>.....

Name  
Function  
Company  
Address

---

17) A signed, legally binding EU Declaration of Conformity is supplied with the product.

---

## 11 Certificate of Decontamination

Type: .....  
Order number/ .....  
Order item number<sup>18)</sup>: .....  
Delivery date: .....  
Field of application: .....  
Fluid handled<sup>18)</sup>: .....

Please tick where applicable<sup>18)</sup>:



Radioactive



Explosive



Corrosive



Toxic



Harmful



Bio-hazardous



Highly flammable



Safe

Reason for return<sup>18)</sup>: .....  
Comments: .....  
.....

The product/accessories have been carefully drained, cleaned and decontaminated inside and outside prior to dispatch/ placing at your disposal.

We herewith declare that this product is free from hazardous chemicals, biological and radioactive substances.

For mag-drive pumps, the inner rotor unit (impeller, casing cover, bearing ring carrier, plain bearing, inner rotor) has been removed from the pump and cleaned. In cases of containment shroud leakage, the outer rotor, bearing bracket lantern, leakage barrier and bearing bracket or adapter have also been cleaned.

For canned motor pumps, the rotor and plain bearing have been removed from the pump for cleaning. In cases of leakage at the stator can, the stator space has been examined for fluid leakage; if fluid handled has penetrated the stator space, it has been removed.

- ☐ No special safety precautions are required for further handling.
- ☐ The following safety precautions are required for flushing fluids, fluid residues and disposal:

.....  
.....

We confirm that the above data and information are correct and complete and that dispatch is effected in accordance with the relevant legal provisions.

.....  
Place, date and signature

.....  
Address

.....  
Company stamp

<sup>18)</sup> Required fields



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**KSB SE & Co. KGaA**

Johann-Klein-Straße 9 • 67227 Frankenthal (Germany)

Tel. +49 6233 86-0

[www.ksb.com](http://www.ksb.com)