

Sprinkler Pump

Etanorm FXM

Installation/Operating Manual



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Installation/Operating Manual Etanorm FXM

Original operating manual

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Glossary

Back pull-out design

The complete back pull-out unit can be pulled out without having to remove the pump casing from the piping.

Back pull-out unit

Pump without pump casing; partly completed machinery

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

FM

Certification by FM Global (FM = Factory Mutual) regarding property insurance in industry and risk management; FM Approved products

Hydraulic system

The part of the pump in which the kinetic energy is converted into pressure energy

Pump

Machine without drive, additional components or accessories

Pump set

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

UL

Certification of materials, components and end products regarding product safety (UL = Underwriters Laboratories)

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 facility 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 8)

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 and installation dimensions for the pump (set), weights
Drawing of auxiliary connections	Description of auxiliary connections
Hydraulic characteristic curve	Characteristic curves showing head, NPSH required, efficiency and power input
General assembly drawing ¹⁾	Sectional drawing of the pump
Sub-supplier product literature ¹⁾	Operating manuals and other product literature describing accessories and integrated machinery components
Spare parts lists ¹⁾	Description of spare parts
Piping layout ¹⁾	Description of auxiliary piping
List of components ¹⁾	Description of all pump components
Assembly drawing ¹⁾	Sectional drawing of the installed shaft seal


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
⇒	Result of an action
⇔	Cross-references

¹ If agreed to be included in the scope of supply

Symbol	Description
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
 DANGER	DANGER This signal word indicates a high-risk hazard which, if not avoided, will result in death or serious injury.
 WARNING	WARNING This signal word indicates a medium-risk hazard which, if not avoided, could result in death or serious injury.
CAUTION	CAUTION This signal word indicates a hazard which, if not avoided, could result in damage to the machine and its functions.
	General hazard In conjunction with one of the signal words this symbol indicates a hazard which will or could result in death or serious injury.
	Electrical hazard In conjunction with one of the signal words this symbol indicates a hazard involving electrical voltage and identifies information about protection against electrical voltage.
	Machine damage 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
 - Name plate
- 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. (⇒ Section 1.4, Page 6)
- 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 (set) to handle the fluids described in the data sheet or product literature of the pump model.
- Never operate the pump (set) without the fluid to be handled.
- Observe the minimum flow rate and maximum flow rate indicated in the data sheet or product literature (to prevent overheating, mechanical seal damage, cavitation damage, bearing damage, etc).
- Always operate the pump (set) in the direction of rotation it is intended for.
- Do not throttle the flow rate on the suction side of the pump (to prevent cavitation damage).
- Consult the manufacturer about any use or mode of operation not described in the data sheet or product literature.

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) during operation.
- 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 stopping 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 30)
- Decontaminate pumps which handle fluids posing a health hazard. (⇒ Section 7.3, Page 34)
- 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 26)

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)

3 Transport/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

	DANGER
	<p>The pump (set) could slip out of the suspension arrangement Danger to life from falling parts!</p> <ul style="list-style-type: none"> ▷ Always transport the pump (set) in the specified position. ▷ Never attach the suspension arrangement to the free shaft end or the motor eyebolt. ▷ Observe the information about weights, centre of gravity and fastening points. ▷ Observe the applicable local accident prevention regulations. ▷ Use suitable, permitted lifting accessories, e.g. self-tightening lifting tongs.

To transport the pump/pump set or back pull-out unit suspend it from the lifting tackle as shown.

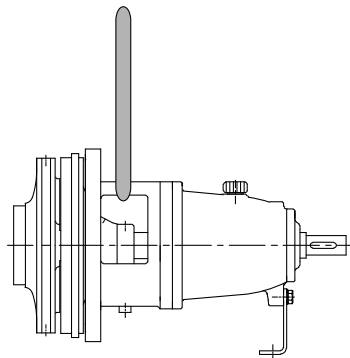


Fig. 1: Transporting the back pull-out unit

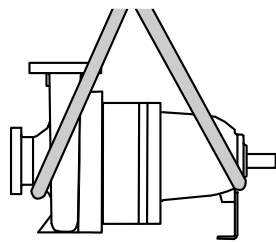


Fig. 2: Transporting the pump

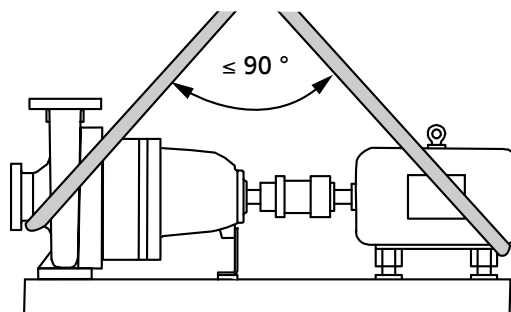


Fig. 3: Transporting the pump set

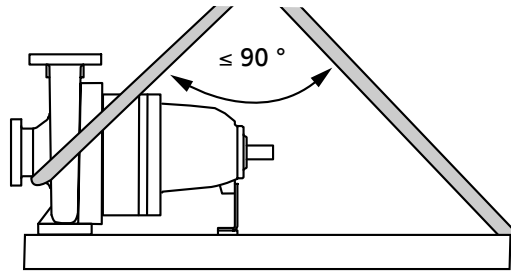


Fig. 4: Transporting the pump on the baseplate

3.3 Storage/preservation

	CAUTION
	<p>Damage during storage due to humidity, dirt or vermin Corrosion/contamination of the pump (set)!</p> <ul style="list-style-type: none"> ▷ For outdoor storage cover the pump (set) or the packaged pump (set) and accessories with waterproof material.
	CAUTION
	<p>Wet, contaminated or damaged openings and connections Leakage or damage to the pump!</p> <ul style="list-style-type: none"> ▷ Clean and cover pump openings and connections as required prior to putting the pump into storage.

If commissioning is to take place some time after delivery, we recommend that the following measures be taken for pump (set) storage.

- Store the pump (set) in a dry, protected room where the atmospheric humidity is as constant as possible.
- Rotate the shaft by hand once a month, e.g. via the motor fan.

If properly stored indoors, the pump set is protected for a maximum of 12 months. New pumps/pump sets are supplied by our factory duly prepared for storage.



For storing a pump (set) which has already been operated, the shutdown measures must be adhered to. (⇒ Section 6.3.1, Page 30)

3.4 Return to supplier

1. Drain the pump as per operating instructions. (⇒ Section 7.3, Page 34)
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 49)

	NOTE
	<p>If required, a blank certificate of decontamination can be downloaded from the following web site: www.ksb.com/certificate_of_decontamination</p>

3.5 Disposal

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

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

- Volute casing pump for sprinkler installations to FM 3-7, NFPA 20

4.2 Product information as per Regulation No. 1907/2006 (REACH)

For information as per chemicals Regulation (EC) No. 1907/2006 (REACH), see <https://www.ksb.com/ksb-en/About-KSB/Corporate-responsibility/reach/>.

4.3 Designation

Example: Etanorm FXM 150-080-310 SC 1A

Table 4: Designation key

Code	Description	
Etanorm	Type series	
FXM	Additional code	
	F	Fire-fighting pump
	X	Special design
	M	FM-approved, UL-approved
150	Nominal suction nozzle diameter [mm]	
080	Nominal discharge nozzle diameter [mm]	
310	Nominal impeller diameter [mm]	
S	Casing material	
	S	Nodular cast iron
C	Impeller material	
	C	Stainless steel
1A	Shaft seal, e.g. gland packing	

4.4 Name plate

Name plate to FM -approval



Fig. 5: Name plate (example)

1	KSB Code	2	Type series, size
3	KSB order number, order item number and consecutive number	4	FM-approved rated flow
5	FM-approved head	6	FM-approved speed
7	Required motor power	8	Impeller diameter
9	Number of stages	10	Year of construction
11	FM seal of approval		

Name plate to UL-approval

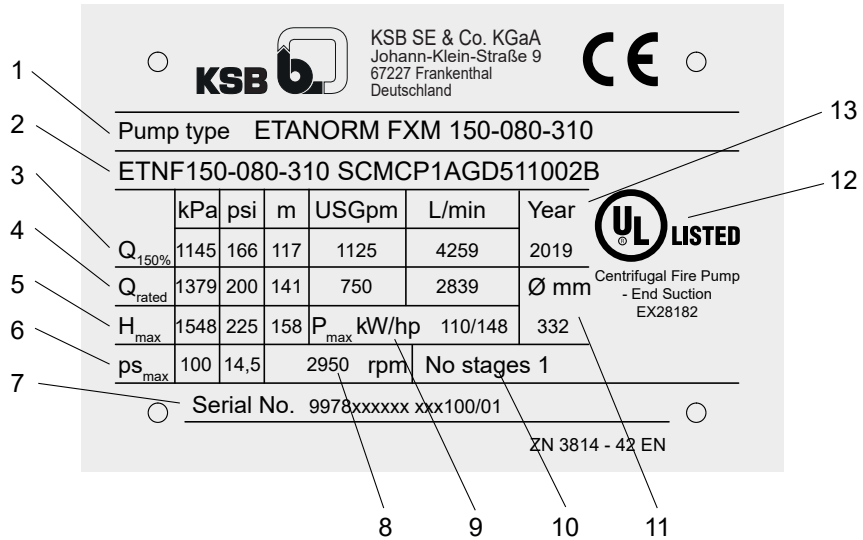


Fig. 6: Name plate (example)

1	Type series, size	2	KSB Code
3	1.5 times the UL-approved head and approved rated flow	4	UL-approved head and approved rated flow
5	Maximum head	6	Maximum inlet pressure
7	KSB order number, order item number and consecutive number	8	UL-approved speed
9	Max. required motor rating	10	Number of stages
11	Impeller diameter	12	UL seal of approval
13	Year of construction		

4.5 Design details

Design

- Volute casing pump
- Horizontal installation
- Back pull-out design
- Single-stage

Pump casing

- Radially split volute casing
- Volute casing with integrally cast pump feet
- Replaceable casing wear rings
- Connecting dimensions to DIN EN or ASME

Impeller type

- Closed radial impeller with multiply curved vanes

Shaft seal

- Gland packing
- Shaft equipped with replaceable shaft protecting sleeve in the shaft seal area

Bearings

- Grease-packed deep groove ball bearings

4.6 Configuration and function

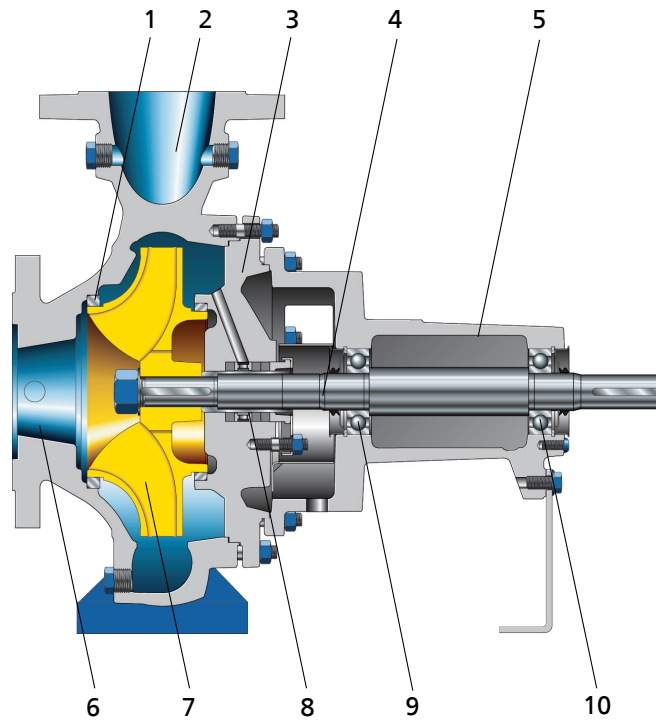


Fig. 7: Sectional drawing

1	Clearance gap	2	Discharge nozzle
3	Casing cover	4	Shaft
5	Bearing bracket	6	Suction nozzle
7	Impeller	8	Shaft seal
9	Rolling element bearing, pump end	10	Rolling element bearing, motor end

Design The pump is designed with an axial fluid inlet and a radial outlet. The hydraulic system runs in its own bearings and is connected to the motor by a shaft coupling.

Function The fluid enters the pump axially via the suction nozzle (6) and is accelerated outward by the rotating impeller (7). In the flow passage of the pump casing the kinetic energy of the fluid is converted into pressure energy. The fluid is pumped to the discharge nozzle (2), where it leaves the pump. The clearance gap (1) prevents any fluid from flowing back from the casing to the suction nozzle. At the rear side of the impeller, the shaft (4) enters the casing via the casing cover (3). The shaft passage through the cover is sealed to atmosphere with a shaft seal (8). The shaft runs in rolling element bearings (9 and 10), which are supported by a bearing bracket (5) linked with the pump casing and/or casing cover.

Sealing The pump is sealed with a gland packing.

4.7 Scope of supply

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

- Pump
- Baseplate
- Coupling
- Coupling guard
- Drive
- Supply system for double mechanical seal

4.8 Dimensions and weights

For dimensions and weights please refer to the general arrangement drawing/outline drawing of the pump/pump set.

5 Installation at Site

5.1 Safety regulations

For positioning, installing and operating sprinkler pumps, always comply with the following fire protection standards and fire protection directives:

- FM 3-7
- NFPA 20

5.2 Checks to be carried out prior to installation

Place of installation

	WARNING
	<p>Installation on a mounting surface which is unsecured and cannot support the load Personal injury and damage to property!</p> <ul style="list-style-type: none"> ▷ Use a concrete of compressive strength class C12/15 which meets the requirements of exposure class XC1 to EN 206-1. ▷ The mounting surface must be set, flat, and level. ▷ Observe the weights indicated.

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.

5.3 Installing the pump set

Always install the pump set in a horizontal position.

5.3.1 Installation on a foundation

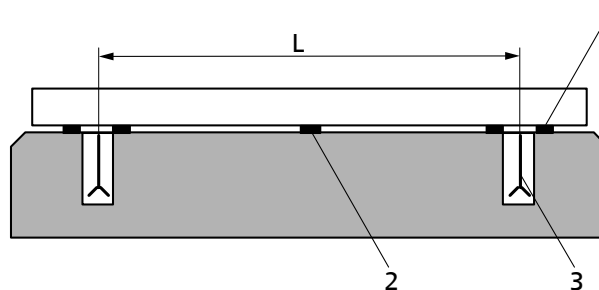


Fig. 8: Fitting the shims

L	Bolt-to-bolt distance	1	Shim
2	Shim if (L) > 800 mm	3	Foundation bolt

- ✓ The foundation has the required strength and characteristics.
 - ✓ The foundation has been prepared in accordance with the dimensions given in the outline drawing/general arrangement drawing.
1. Position the pump set on the foundation and level it with the help of a spirit level placed on the shaft and discharge nozzle.
Permissible deviation: 0.2 mm/m
 2. Use shims (1) for height compensation, if necessary.
Always fit shims, if any, immediately to the left and right of the foundation bolts (3) between the baseplate/foundation frame and the foundation.
For a bolt-to-bolt distance (L) > 800 mm fit additional shims (2) halfway between the bolt holes.
All shims must lie perfectly flush.
 3. Insert the foundation bolts (3) into the holes provided.


4. Use concrete to set the foundation bolts (3) into the foundation.
5. Wait until the concrete has set firmly, then level the baseplate.
6. Tighten the foundation bolts (3) evenly and firmly.

	NOTE
	<p>For optimum smooth running, baseplates should be grouted with low-shrinkage concrete in the following cases:</p> <ul style="list-style-type: none"> - For all vibration-critical applications - Baseplates with a width > 400 mm - Baseplates made of grey cast iron
	NOTE
	<p>For low-noise operation contact the manufacturer to check whether the pump set can be installed on anti-vibration mounts.</p>
	NOTE
	<p>Expansion joints can be fitted between the pump and the suction/discharge line. (Only if permitted in accordance with the fire protection directives!)</p>


5.4 Piping

5.4.1 Connecting the piping

	DANGER
	<p>Impermissible loads acting on the pump nozzles Danger to life from escaping hot, toxic, corrosive or flammable fluids!</p> <ul style="list-style-type: none"> ▷ Do not use the pump as an anchorage point for the piping. ▷ Anchor the pipes in close proximity to the pump and connect them properly without transmitting any stresses or strains. ▷ Observe the permissible forces and moments at the pump nozzles. ▷ Take appropriate measures to compensate for thermal expansion of the piping.
	CAUTION
	<p>Incorrect earthing during welding work at the piping Destruction of rolling element bearings (pitting effect)!</p> <ul style="list-style-type: none"> ▷ Never earth the electric welding equipment on the pump or baseplate. ▷ Prevent current flowing through the rolling element bearings.
	NOTE
	<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>

	NOTE
	<p>Connect FM-certified or UL-certified pumps in compliance with the corresponding fire protection directive (FM 3-7, NFPA 20).</p>

- ✓ It has been ensured that a positive suction pressure is maintained continuously over the entire flow rate range.
- ✓ It has been ensured that the friction losses in the suction head line will not exceed a value of 0.4 bar (6 psi) at a flow rate of 150 % of Q_{rated} . The corresponding lengths of elbows and valves were taken into account in this calculation.
- ✓ The suction head line has been laid 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 sizes of the pipelines are equal to or greater than the nominal sizes of the pump nozzles.
Observe the specifications in fire protection directives FM 3-7 or NFPA 20 for the suction line design and the installation of check valves and shut-off valves.
- ✓ To prevent excessive pressure losses, adapters to larger nominal sizes must be in accordance with the fire protection directives.
- ✓ Pressure gauges supplied are fitted in the suction line and discharge line. For the correct installation position observe the instructions of the corresponding fire protection directive.
- ✓ The supplied safety valve is installed in the discharge line. For the correct installation position observe the instructions of the corresponding fire protection directive.
- ✓ The pipelines have been supported 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 nozzle and discharge nozzle of the pump.

	CAUTION
	<p>Welding beads, scale and other impurities in the piping Damage to the pump!</p> <ul style="list-style-type: none"> ▷ Remove any impurities from the piping. ▷ If necessary, install a filter. ▷ Observe the information in (⇒ Section 7.2.2.2, Page 33) .

3. Check that the inside of the pump is free from any foreign objects. Remove any foreign objects.

4. If required, install a filter in the piping (see drawing: Filter in the piping). Observe the regulations laid down in the fire protection directives!

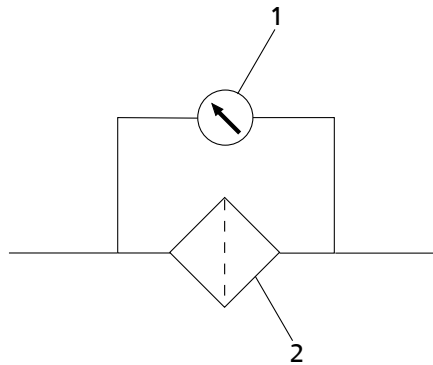


Fig. 9: Filter in the piping

1	Differential pressure gauge	2	Filter
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	NOTE
	<p>Use a filter with laid-in wire mesh (mesh width 0.5 mm, wire diameter 0.25 mm) of corrosion-resistant material. Use a filter with a filter area three times the cross-section of the piping. Conical filters have proved suitable.</p>

5. Connect the pump nozzles to the piping.

	CAUTION
	<p>Aggressive flushing liquid and pickling agent Damage to the pump! ▶ Match the cleaning operation mode and duration of flushing and pickling to the casing materials and seal materials used.</p>

5.4.2 Permissible forces and moments at the pump nozzles

The data on forces and moments apply to static pipelines only. The values are only applicable if the pump is installed on a baseplate and bolted to a rigid and level foundation.

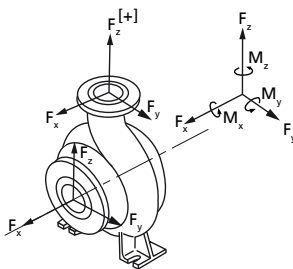



Fig. 10: Forces and moments at the pump nozzles

Table 5: Forces and moments at the pump nozzles for casing material S (EN-GJS-400-15 / A536 Gr. 60-40-18)


Size	Suction nozzle								Discharge nozzle							
	DN	Fx [N]	Fy [N]	Fz [N]	ΣF [N]	Mx [N]	My [N]	Mz [N]	DN	Fx [N]	Fy [N]	Fz [N]	ΣF [N]	Mx [N]	My [N]	Mz [N]
125-065-310	125	1708	1525	1366	2666	903	647	817	65	793	732	903	1407	647	476	512
150-080-310	150	2135	1952	1708	3359	1074	744	878	80	964	878	1074	1689	683	488	561
200-100-310.1	200	2867	2562	2318	4490	1403	976	1135	100	1281	1159	1440	2249	756	537	622
200-100-310	200	2867	2562	2318	4490	1403	976	1135	100	1281	1159	1440	2249	756	537	622
200-125-310	200	2867	2562	2318	4490	1403	976	1135	125	1525	1366	1708	2666	903	647	817

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5.4.3 Auxiliary connections

	<p>! WARNING</p>
	<p>Failure to use or incorrect use of auxiliary connections (e.g. barrier fluid, flushing liquid, etc.) Risk of injury from escaping fluid! Risk of burns! Malfunction of the pump!</p> <ul style="list-style-type: none"> ▷ Refer to the general arrangement drawing, the piping layout and pump markings (if any) for the quantity, dimensions and locations of auxiliary connections. ▷ Use the auxiliary connections provided.

5.5 Enclosure/insulation

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

5.6 Checking the coupling alignment

	<p>CAUTION</p>
	<p>Misalignment of pump and motor shafts Damage to pump, motor and coupling!</p> <ul style="list-style-type: none"> ▷ Always check the coupling after the pump has been installed and connected to the piping. ▷ Also check the coupling of pump sets supplied with pump and motor mounted on the same baseplate.

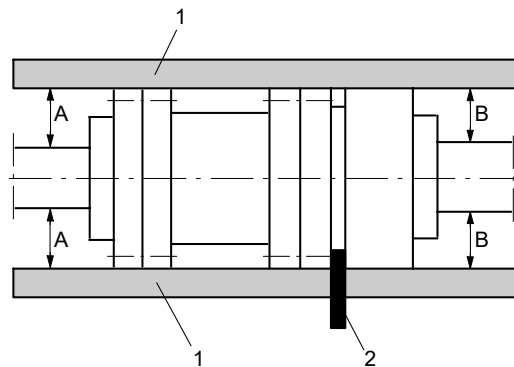


Fig. 11: Spacer-type coupling, checking the coupling alignment

1	Straight edge	2	Gauge
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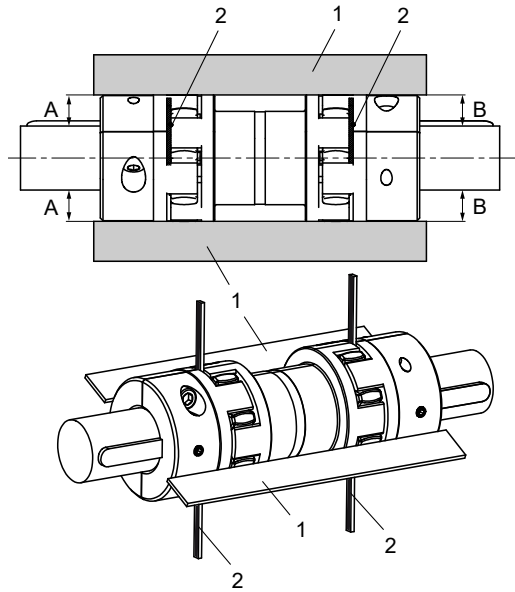


Fig. 12: Double Cardan spacer-type coupling, checking the coupling alignment

1	Straight edge	2	Gauge
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Table 6: Permissible alignment offset of coupling halves

Coupling type	Radial offset	Axial offset
	[mm]	[mm]
Spacer-type coupling (⇒ Fig. 11)	≤ 0,1	≤ 0,1
Double Cardan coupling (⇒ Fig. 12)	≤ 0,5	≤ 0,5

- ✓ The coupling guard and its footboard, if applicable, have been removed.
- 1. Loosen the support foot and re-tighten it without transmitting any stresses and strains.
- 2. Place the straight edge axially on both coupling halves.
- 3. 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. Observe the permissible radial offset in coupling half alignment (⇒ Table 6) both during standstill and at operating temperature as well as under inlet pressure.
- 4. Check the distance (dimension see general arrangement drawing) between the two coupling halves around the circumference. The coupling is correctly aligned if the distance between the two coupling halves is the same at all points around the circumference. Observe the permissible axial offset in coupling half alignment (⇒ Table 6) both during standstill and at operating temperature as well as under inlet pressure.
- 5. If the alignment is correct, re-install the coupling guard and its footboard (if any).

Checking the coupling alignment with a laser tool

Coupling alignment may also be checked with a laser tool. Observe the documentation provided by the manufacturer of the measuring instrument.

5.7 Aligning the pump and motor

After having installed the pump set and connected the piping, check the coupling alignment and, if required, re-align the pump set (at the motor).

5.7.1 Levelling the pump set with adjusting screws

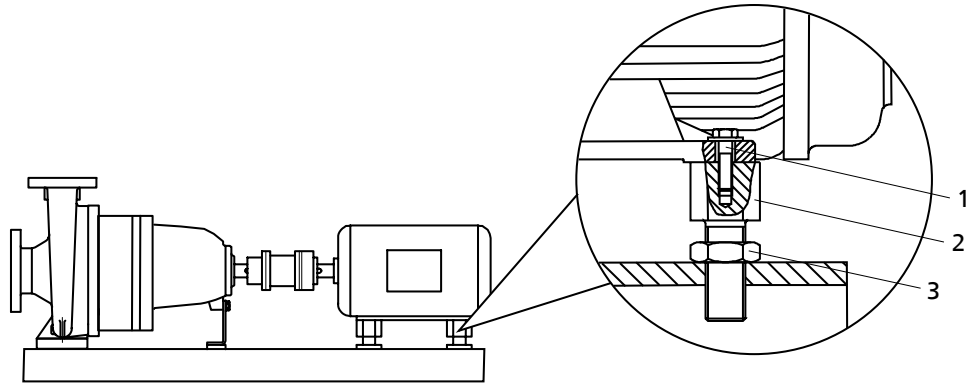


Fig. 13: Levelling the pump set with adjusting screws

1	Hexagon head bolt	3	Locknut
2	Adjusting screw		

- ✓ The coupling guard and the footboard for the coupling guard, if any, have been removed.
- 1. Check the coupling alignment.
- 2. Unscrew the hexagon head bolts (1) at the motor and the locknuts (3) at the baseplate.
- 3. Turn the adjusting screws (2) by hand or by means of an open-end wrench until the coupling alignment is correct and all motor feet rest squarely on the baseplate.
- 4. Re-tighten the hexagon head bolts (1) at the motor and the locknuts (3) at the baseplate.
- 5. Check that the coupling and shaft can easily be rotated by hand.

	⚠ WARNING
	<p>Unprotected rotating coupling Risk of injury by rotating shafts!</p> <ul style="list-style-type: none"> ▷ Always operate the pump set with a coupling guard. If the customer specifically requests not to include a coupling guard in KSB's delivery, then the operator must supply one! ▷ Observe all relevant regulations for selecting a coupling guard.

- 6. Re-install the coupling guard and the footboard for the coupling guard, if any.
- 7. Check the distance between coupling and coupling guard.
The coupling and coupling guard must not come into contact.

5.7.2 Levelling the pump set without adjusting screws

Compensate any differences in shaft centreline heights of pump and motor by means of shims.

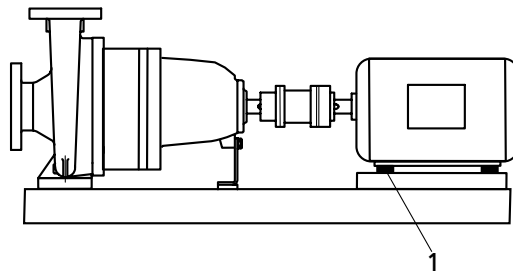


Fig. 14: Levelling the pump set without adjusting screws

1	Shim
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- ✓ The coupling guard and its footboard, if any, have been removed.
 1. Check the coupling alignment.
 2. Loosen the hexagon head bolts at the motor.
 3. Insert shims underneath the motor feet until the difference in shaft centreline height has been compensated.
 4. Re-tighten the hexagon head bolts.
 5. Check proper functioning of coupling/shaft.
Check that coupling/shaft can easily be rotated by hand.

	<p>! WARNING</p>
	<p>Unprotected rotating coupling Risk of injury by rotating shafts!</p> <ul style="list-style-type: none"> ▷ Always operate the pump set with a coupling guard. If the customer specifically requests not to include a coupling guard in KSB's delivery, then the operator must supply one! ▷ Observe all relevant regulations for selecting a coupling guard.

6. Fit the coupling guard and its footboard, if any.
7. Check the distance between coupling and coupling guard.
The coupling guard must not touch the coupling.

5.8 Electrical connection

	<p>! DANGER</p>
	<p>Electrical connection work by unqualified personnel Danger of death from electric shock!</p> <ul style="list-style-type: none"> ▷ Always have the electrical connections installed by a trained and qualified electrician. ▷ Observe regulations IEC 60364 .

	<p>! WARNING</p>
	<p>Incorrect connection to the mains Damage to the power supply network, short circuit!</p> <ul style="list-style-type: none"> ▷ Observe the technical specifications of the local energy supply companies.

	<p>NOTE</p>
	<p>Fitting a motor protection device is recommended. However, this device must not trip the pump set; it must serve as an indicator only.</p>

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	NOTE
	<p>In compliance with IEC 60034-8, three-phase motors are always wired for clockwise rotation (looking at the motor shaft stub). The pump's direction of rotation is indicated by an arrow on the pump.</p>

1. Check the available mains voltage against the data on the name plate.
2. Select an appropriate starting method.
3. Match the motor's direction of rotation to that of the pump.
4. Observe the manufacturer's product literature supplied with the motor.

5.9 Checking the direction of rotation

	! WARNING
	<p>Hands inside the pump casing Risk of injuries, damage to the pump!</p> <ul style="list-style-type: none"> ▷ Always disconnect the pump set from the power supply and secure it against unintentional start-up before inserting your hands or other objects into the pump.

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

The correct direction of rotation of motor and pump is clockwise (seen from the drive end).

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 is running in the wrong direction of rotation, check the electrical connection of the motor and the control system if applicable.

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 mechanically connected as specified.
- The pump set has been properly connected to the power supply and is equipped with all protection devices.
- The pump has been primed with the fluid to be handled. The pump has been vented.
- The direction of rotation has been checked.
- All auxiliary connections required are connected and operational.
- The lubricants have been checked.
- After prolonged shutdown of the pump (set), the activities required for returning the equipment to service have been carried out. (⇒ Section 6.4, Page 30)

6.1.2 Priming and venting the pump

	CAUTION
	<p>Shaft seal failure caused by insufficient lubrication Damage to the pump!</p> <p>▷ Before starting up the pump set, vent the pump and suction line and prime both with the fluid to be handled.</p>

1. Vent the pump and suction line and prime both with the fluid to be handled.
2. Fully open the shut-off element in the suction line.

Connection 6D can be used for venting.

6.1.3 Final check

1. Remove the coupling guard and its footboard, if any.
2. Check the coupling alignment; re-align the coupling, if required.
3. Check proper functioning of coupling/shaft.
 Check that coupling/shaft can be easily rotated by hand.
4. Fit the coupling guard and its footboard, if any.
5. Check the distance between coupling and coupling guard.
 The coupling guard must not touch the coupling.

6.1.4 Starting up for a test run

	<p>⚠ WARNING</p>
	<p>Non-compliance with the permissible pressure limits and temperature limits if the pump is operated with the suction line and/or discharge line closed Risk of injury by escaping fluid handled!</p> <ul style="list-style-type: none"> ▷ Never operate the pump with the shut-off elements in the suction line and/or discharge line closed. ▷ Only start up the pump set with the discharge-side shut-off element slightly or fully open.

1. Set the selector switch at the control cabinet to manual operation.
2. Start up the motor.
3. Open the shut-off element in the test pipe.

6.1.5 Checking the shaft seal

Shaft seals are fitted prior to delivery.
Observe the instructions on dismantling (⇒ Section 7.4.6, Page 36) or assembly (⇒ Section 7.5.3, Page 39) .

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

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

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.

After five minutes of operation

	<p>⚠ WARNING</p>
	<p>Unprotected rotating parts Risk of personal injury!</p> <ul style="list-style-type: none"> ▷ Do not touch rotating parts. ▷ When the pump is running, perform any work with utmost caution.

The leakage can be reduced.

1. Tighten the nuts on 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 Switching the pump set off after testing

1. Close the shut-off element in the test pipe.
2. Switch off the motor.
Make sure it runs down smoothly to a standstill.
3. Set the selector switch to automatic.

6.2 Operating limits

	WARNING
	<p>Non-compliance with operating limits for pressure and temperature Risk of injuries by escaping fluid!</p> <ul style="list-style-type: none"> ▷ Comply with the operating range indicated in the documentation. ▷ Avoid prolonged operation against a closed shut-off element. ▷ Never operate the pump at temperatures exceeding those specified in the data sheet or on the name plate unless the written consent of the manufacturer has been obtained.

6.2.1 Ambient temperature

	CAUTION
	<p>Operation outside the permissible ambient temperature Damage to the pump (set)!</p> <ul style="list-style-type: none"> ▷ Observe the specified limits for permissible ambient temperatures.

Observe the following parameters and values during operation:

Table 7: Permissible ambient temperatures

Permissible ambient temperature	Value
Maximum	50 °C
Minimum	See data sheet.

6.2.2 Frequency of starts

	CAUTION
	<p>Re-starting while motor is still running down Damage to the pump (set)!</p> <ul style="list-style-type: none"> ▷ Do not re-start the pump set before the pump rotor has come to a standstill.

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). If the start-ups are evenly spaced over the period indicated, the following limits serve as orientation for start-up with the discharge-side gate valve slightly open: The frequency of starts shall not exceed 6 start-ups per hour (h).

6.2.3 Fluid handled

6.2.3.1 Flow rate

Table 8: Flow rate

Temperature range (t)	Minimum flow rate	Maximum flow rate
4 to 40 °C	2 % or 5 % of Q _{rated} ²⁾	140 % of Q _{rated} (for pump certified to FM) 150 % of Q _{rated} (for pump certified to UL)

The calculation formula below can be used to check if an additional heat build-up could lead to a dangerous temperature increase at the pump surface.

$$T_o = T_f + \Delta \vartheta$$

$$\Delta \vartheta = \frac{g \times H}{c \times \eta} \times (1 - \eta)$$

Table 9: Key

Symbol	Description	Unit
c	Specific heat capacity	J/kg K
g	Acceleration due to gravity	m/s ²
H	Pump discharge head	m
T _f	Fluid temperature	°C
T _o	Temperature at the casing surface	°C
η	Pump efficiency at duty point	-
Δϑ	Temperature difference	K

6.2.3.2 Density of the fluid handled

The power input of the pump set will change in proportion to the density of the fluid handled.

	CAUTION
	<p>Impermissibly high density of the fluid handled Motor overload!</p> <ul style="list-style-type: none"> ▷ Observe the information about fluid density in the data sheet. ▷ Make sure the motor has sufficient power reserves.

6.2.3.3 Abrasive fluids

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.

Observe the water quality regulations laid down in FM 3-7 and other applicable fire protection directives.

² Depending on maximum head

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.
 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.

The pump (set) is removed from the piping and stored



- ✓ The pump has been properly drained. (⇒ Section 7.3, Page 34)
- ✓ The safety instructions for dismantling the pump have been observed. (⇒ Section 7.4.1, Page 34)
- ✓ The permissible ambient temperature for storing the pump is 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 nozzle and discharge nozzle. It is advisable to then close the pump nozzles (e.g. with plastic caps).
 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.
 - Observe the additional instructions on preservation. (⇒ Section 3.3, Page 12)

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.

6.4 Returning to service


For returning the equipment to service observe the sections on commissioning/start-up and the operating limits. (⇒ Section 6.1, Page 26)

In addition, carry out all servicing/maintenance operations before returning the pump (set) to service. (⇒ Section 7, Page 31)


	<p>! WARNING</p> <p>Failure to re-install or re-activate protective devices Risk of injury from moving parts or escaping fluid!</p> <ul style="list-style-type: none"> ▷ As soon as the work is completed, properly re-install and re-activate any safety-relevant devices and protective devices.
	<p>NOTE</p> <p>If the equipment has been out of service for more than one year, replace all elastomer seals.</p>


7 Servicing/Maintenance

7.1 Safety regulations


	CAUTION
	<p>Improperly serviced pump set Damage to the pump set!</p> <ul style="list-style-type: none"> ▷ Service the pump set regularly. ▷ Prepare a maintenance schedule with special emphasis on lubricants, shaft seal and coupling.

The operator ensures that maintenance, inspection and installation are performed by authorised, qualified specialist personnel who are thoroughly familiar with the manual.

	⚠ WARNING
	<p>Unintentional starting of the pump set Risk of injury by moving components and shock currents!</p> <ul style="list-style-type: none"> ▷ Ensure that the pump set cannot be started unintentionally. ▷ Always make sure the electrical connections are disconnected before carrying out work on the pump set.

	⚠ WARNING
	<p>Insufficient stability Risk of crushing hands and feet!</p> <ul style="list-style-type: none"> ▷ During assembly/dismantling, secure the pump (set)/pump parts to prevent tilting or tipping over.


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.



	NOTE
	<p>All maintenance work, service work and installation work can be carried out by KSB Service or authorised workshops. For contact details please refer to the enclosed "Addresses" booklet or visit "www.ksb.com/contact" on the Internet.</p>

Never use force when dismantling and reassembling the pump set.

7.2 Servicing/Inspection


7.2.1 Supervision of operation


	CAUTION
	<p>Excessive temperatures as a result of bearings running hot or defective bearing seals Damage to the pump set!</p> <ul style="list-style-type: none"> ▷ Regularly check the lubricant level. ▷ Regularly check the rolling element bearings for running noises.

	CAUTION
	<p>Increased wear due to dry running Damage to the pump set!</p> <ul style="list-style-type: none"> ▷ Never operate the pump set without liquid fill. ▷ Never close the shut-off element in the suction line and/or supply line during pump operation.
	CAUTION
	<p>Impermissibly high temperature of fluid handled Damage to the pump!</p> <ul style="list-style-type: none"> ▷ Prolonged operation against a closed shut-off element is not permitted (heating up of the fluid). ▷ Observe the temperature limits in the data sheet and in the section on operating limits.

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

- The pump must run quietly and free from vibrations at all times.
- Check the shaft seal.
- Check the static sealing elements 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 bearing temperature.
The bearing temperature must not exceed 90 °C (measured on the outside of the bearing bracket).

	CAUTION
	<p>Operation outside the permissible bearing temperature Damage to the pump!</p> <ul style="list-style-type: none"> ▷ The bearing temperature of the pump (set) must never exceed 90 °C (measured on the outside of the bearing bracket).

	NOTE
	<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>

False alarm pump operation

If the pump is started up due to false alarm with no fire-fighting water being drawn, it can be operated for a maximum of 48 hours. However, proper functioning of a by-pass line must be ensured through which a minimum flow is pumped in order to dissipate any excessive temperature rise.

After prolonged false-alarm operation, always dismantle the pump and inspect it for any signs of wear or damage; if necessary, repair it by replacing any affected components.

7.2.2 Inspection work

	CAUTION
	<p>Excessive temperatures caused by friction, impact or frictional sparks Damage to the pump set!</p> <ul style="list-style-type: none"> ▷ Regularly check the coupling guard, plastic components and other guards of rotating parts for deformation and sufficient distance from rotating parts.

7.2.2.1 Checking the coupling

Check the flexible elements of the coupling. Replace the relevant parts in due time if there is any sign of wear and check the alignment.

7.2.2.2 Cleaning filters

	CAUTION
	<p>Insufficient inlet pressure due to clogged filter in the suction line Damage to the pump!</p> <ul style="list-style-type: none"> ▷ Monitor contamination of filter with suitable means (e.g. differential pressure gauge). ▷ Clean filter at appropriate intervals.

7.2.3 Lubrication and lubricant change of rolling element bearings

	CAUTION
	<p>Excessive temperatures as a result of bearings running hot or defective bearing seals Damage to the pump set!</p> <ul style="list-style-type: none"> ▷ Regularly check the condition of the lubricant.

7.2.3.1 Grease lubrication

The bearings are supplied packed with high-quality lithium-soap grease.

7.2.3.1.1 Intervals

Under normal conditions the grease-lubricated bearings will run for 15,000 operating hours or 2 years. Under unfavourable operating conditions (e.g. high room temperature, high atmospheric humidity, dust-laden air, aggressive industrial atmosphere etc.), check the bearings earlier and clean and relubricate them if required.

7.2.3.1.2 Grease quality

Optimum grease properties for rolling element bearings

Table 10: Grease quality to DIN 51825

Soap basis	NLGI grade	Worked penetration at 25° C in mm/10	Drop point
Lithium	2 to 3	220-295	≥ 175 °C

- Free of resin and acid
- Not liable to crumble
- Rust-preventive characteristics


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If required, the bearings may be lubricated with greases of other soap bases. Make sure to remove any old grease and rinse the bearings thoroughly.

7.2.3.1.3 Grease quantity

Use 15 grams of grease per bearing.

7.2.3.1.4 Changing the grease


	CAUTION
	<p>Mixing greases of differing soap bases Changed lubricating qualities!</p> <ul style="list-style-type: none"> ▷ Thoroughly clean the bearings. ▷ Adjust the re-lubrication intervals to the grease used.

✓ The pump has been dismantled for changing the grease.

1. Remove the outer cover plate of each bearing with a suitable tool. Dispose of the cover plates.
2. Only half-fill the bearing cavities with grease.

Continue using the bearings without the outer cover plates (variant Z C3).


7.3 Drainage/cleaning

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

1. Use connection 6B to drain the fluid handled (see drawing of auxiliary connections).
2. Always flush the system if it has been used for handling noxious, explosive, hot or other hazardous fluids.
 Always flush and clean the pump before transporting it to the workshop.
 Provide a certificate of decontamination for the pump. (⇒ Section 11, Page 49)

7.4 Dismantling the pump set

7.4.1 General information/Safety regulations

	⚠ DANGER
	<p>Insufficient preparation of work on the pump (set) Risk of injury!</p> <ul style="list-style-type: none"> ▷ Properly shut down the pump set. ▷ Close the shut-off elements in the suction line and discharge line. ▷ Drain the pump and release the pump pressure. (⇒ Section 7.3, Page 34) ▷ Shut off any auxiliary connections. ▷ Allow the pump set to cool down to ambient temperature.

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	<p>! WARNING</p>
	<p>Unqualified personnel performing work on the pump (set) Risk of injury!</p> <ul style="list-style-type: none"> ▷ Always have repair work and maintenance work performed by specially trained, qualified personnel.
	<p>! WARNING</p>
	<p>Hot surface Risk of injury!</p> <ul style="list-style-type: none"> ▷ Allow the pump set to cool down to ambient temperature.
	<p>! WARNING</p>
	<p>Improper lifting/moving of heavy assemblies or components Personal injury and damage to property!</p> <ul style="list-style-type: none"> ▷ Use suitable transport devices, lifting equipment and lifting tackle to move heavy assemblies or components.

Always observe the safety instructions and information.

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

For dismantling and reassembly observe the exploded views and the general assembly drawing. (⇒ Section 9.1, Page 46)

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



	<p>NOTE</p>
	<p>All maintenance work, service work and installation work can be carried out by KSB Service or authorised workshops. For contact details please refer to the enclosed "Addresses" booklet or visit "www.ksb.com/contact" on the Internet.</p>
	<p>NOTE</p>
	<p>After a prolonged period of operation the individual components may be hard to pull off the shaft. If this is the case, use a brand name penetrating agent and/or - if possible - an appropriate puller.</p>

7.4.2 Preparing the pump set

1. Interrupt the power supply and secure the pump against unintentional start-up.
2. Disconnect and remove all auxiliary pipework.
3. Remove the coupling guard.
4. Remove the coupling spacer, if any.



7.4.3 Removing the motor

	<p>NOTE</p>
	<p>On pump sets with spacer-type couplings, the back pull-out unit can be removed while the motor remains bolted to the baseplate.</p>

	 WARNING
	<p>Motor tipping over Risk of crushing hands and feet!</p> <ul style="list-style-type: none"> ▷ Suspend or support the motor to prevent it from tipping over.

1. Disconnect the motor from the power supply.
2. Unbolt the motor from the baseplate.
3. Shift the motor to separate it from the pump.

7.4.4 Removing the back pull-out unit

	 WARNING
	<p>Back pull-out unit tilting Risk of crushing hands and feet!</p> <ul style="list-style-type: none"> ▷ Suspend or support the bearing bracket at the pump end.

- ✓ The notes and steps stated in (⇒ Section 7.4.1, Page 34) to (⇒ Section 7.4.3, Page 35) have been observed and carried out.
1. If required, suspend or support bearing bracket 330 to prevent it from tipping over.
 2. Unbolt support foot 183 from the baseplate.
 3. Undo nut 920.01 at the volute casing.
 4. Use forcing screws 901.30 to remove the back pull-out unit from its seat in the volute casing. Pull the back pull-out unit completely out of the volute casing.
 5. Remove and dispose of gasket 400.10.
 6. Place the back pull-out unit on a clean and level surface.

7.4.5 Removing the impeller

- ✓ The notes and steps stated in (⇒ Section 7.4.1, Page 34) to (⇒ Section 7.4.4, Page 36) have been observed and carried out.
 - ✓ The back pull-out unit has been placed in a clean and level assembly area.
1. Undo impeller nut 922 (right-hand thread).
 2. Remove and dispose of joint ring 411.31.
 3. Remove impeller 230 with an impeller removal tool.
 4. Place impeller 230 on a clean and level surface.
 5. Remove keys 940.01 and 940.09 from shaft 210.

7.4.6 Dismantling the gland packing

- ✓ The notes and steps stated in (⇒ Section 7.4.1, Page 34) to (⇒ Section 7.4.5, Page 36) have been observed and carried out.
 - ✓ The back pull-out unit has been placed in a clean and level assembly area.
1. Undo nuts 920.02 at the gland follower and loosen gland follower 452.
 2. Loosen nuts 920.15 at casing cover 161.
 3. Use forcing screws 901.31 to separate casing cover 161 from bearing bracket 330.
 4. Remove gland follower 452 from casing cover 161 and remove the gland packing.
 5. Remove stuffing box ring 454.
 6. Remove packing rings 461 and lantern ring 458, if any.



7. Pull shaft protecting sleeve 524 off shaft 210.
8. Remove and dispose of gasket 400.75.

7.4.7 Dismantling the bearings

- ✓ The notes and steps stated in (⇒ Section 7.4.1, Page 34) to (⇒ Section 7.4.6, Page 36) have been observed and carried out.
- ✓ The bearing bracket has been placed in a clean and level assembly area.
 1. Undo the grub screw in the coupling hub.
 2. Pull the coupling hub off pump shaft 210 with a puller or, for split-hub coupling designs, undo the screws and take off the hub halves.
 3. Remove key 940.02.
 4. Remove axial seal rings 411.77 and 411.78.
 5. Remove pump-end bearing cover 360.01 and drive-end bearing cover 360.02.
 6. Remove circlips 932.01 and 932.02.
 7. Press shaft 210 out of the bearing seats.
 8. Remove radial ball bearings 321.01 and 321.02, and place them on a clean and level surface.

7.5 Reassembling the pump set

7.5.1 General information/Safety regulations

	<p>! WARNING</p>
	<p>Improper lifting/moving of heavy assemblies or components Personal injury and damage to property!</p> <ul style="list-style-type: none"> ▷ Use suitable transport devices, lifting equipment and lifting tackle to move heavy assemblies or components.
	<p>CAUTION</p>
	<p>Improper reassembly Damage to the pump!</p> <ul style="list-style-type: none"> ▷ Reassemble the pump (set) in accordance with the general rules of sound engineering practice. ▷ Use original spare parts only.

Sequence Always re-assemble the pump in accordance with the corresponding general assembly drawing and/or exploded view.

Sealing elements Gaskets


- Always use new gaskets, making sure that they have the same thickness as the old ones.
- Always fit gaskets of asbestos-free materials or graphite without using lubricants (e.g. copper grease, graphite paste).

O-rings

- Never use O-rings that have been made by cutting an O-ring cord to size and gluing the ends together.

Packing rings

- Always use pre-compressed packing rings.

	CAUTION
	<p>Contact of O-ring with graphite or similar material Fluid could escape!</p> <ul style="list-style-type: none"> ▷ Do not coat O-ring with graphite or similar material. ▷ Use animal fats or lubricants based on silicone or PTFE.

- Assembly adhesives** Avoid the use of assembly adhesives if possible.
Should an assembly adhesive be required after all, use a commercially available contact adhesive (e.g. Pattex) or sealant (e.g. HYLOMAR or Epple 33).
Only apply adhesive at selected points and in thin layers.
Never use quick-setting adhesives (cyanoacrylate adhesives).
Coat the locating surfaces of the individual components with graphite or similar before reassembly.
- Tightening torques** For reassembly, tighten all screws and bolts as specified in this manual.
(⇒ Section 7.6, Page 41) (Also see general assembly drawing and data sheet.)

7.5.2 Installing the bearing assembly

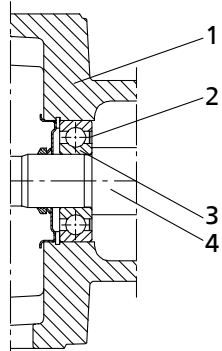


Fig. 15: Installing the radial ball bearing

1	Bearing bracket	2	Shield
3	Radial ball bearing	4	Shaft

- ✓ The individual parts have been placed in a clean and level assembly area.
 - ✓ All dismantled parts have been cleaned and checked for wear.
 - ✓ Any damaged or worn parts have been replaced by original spare parts.
 - ✓ The sealing surfaces have been cleaned.
1. Press radial ball bearings 321.01 and 321.02 onto shaft 210.
Make sure the bearing side with the shield rests against the shaft shoulder (see illustration: Installing the radial ball bearings).
 2. Slide the pre-assembled shaft into bearing bracket 330.
 3. Fit circlips 932.01 and 932.02.
 4. Fit bearing covers 360.01 and 360.02.
 5. Fit axial seal rings 411.77 and 411.78.
 6. Insert key 940.02.
 7. Fit the coupling hub on pump shaft 210. For split-hub coupling designs, fit the hub halves on pump shaft 210. Fit and tighten the screws clamping the hub halves together. Observe the tightening torques. (⇒ Section 7.6, Page 41)
 8. Secure the coupling hub with a grub screw.

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7.5.3 Fitting the gland packing

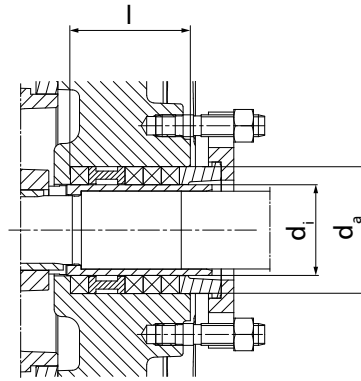


Fig. 16: Gland packing chamber (example)

Table 11: Gland packing chamber

Gland packing chamber			Packing cross-section [mm]	Packing rings ³⁾
$\varnothing d_i$ [mm]	$\varnothing d_a$ [mm]	l [mm]		
50	70	66	□ 10 x 196	4 packing rings, 1 lantern ring



Fig. 17: Packing ring cut to size


- ✓ The notes and steps stated in (⇒ Section 7.5.1, Page 37) and (⇒ Section 7.5.2, Page 38) have been observed and carried out.
 - ✓ The bearing assembly as well as the individual parts have been placed in a clean and level assembly area.
 - ✓ All dismantled parts have been cleaned and checked for wear.
 - ✓ Any damaged or worn parts have been replaced by original spare parts.
 - ✓ The sealing surfaces have been cleaned.
1. Clean the gland packing chamber.
 2. Insert packing ring 461 into the gland packing chamber of casing cover 161.
 3. Use stuffing box ring 454 to tamp down packing ring 461.
 4. Slide shaft protecting sleeve 524 (chamfered side first) into the gland packing chamber from the pump end.
 5. Insert lantern ring 458, if any (see drawing above).
Insert subsequent packing rings one at a time, with their joints staggered at approximately 90°. Use stuffing box ring 454 to seat each individual packing ring in the gland packing chamber. Once each packing ring is in place, slide shaft protecting sleeve 524 back into position.
 6. Place gland follower 452 on studs 902.2 and tighten it lightly and evenly with hexagon nuts 920.2, so that packing rings 461 are not compressed yet.
 7. Use a feeler gauge to verify that gland follower 452 is fitted centred and at a right angle to the shaft.
 8. Slide new gasket 400.75 onto shaft 210.
 9. Loosen forcing screws 901.31.
 10. Guide bearing bracket 330 over studs 902.15 of casing cover 161. Insert the casing cover into the locating fit of bearing bracket 330.
Verify that shaft 210 and shaft protecting sleeve 524 are aligned properly.
 11. Fit and tighten nuts 920.15. Observe the tightening torques.
(⇒ Section 7.6, Page 41)
 12. Tighten gland follower 452 lightly and evenly.
The pump rotor must be easy to rotate.

³⁾ For operation with positive suction head and suction pressure > 2.75 bar, the lantern ring is replaced by 2 additional packing rings.

7.5.4 Fitting the impeller


- ✓ The notes and steps stated in (⇒ Section 7.5.1, Page 37) to (⇒ Section 7.5.3, Page 39) have been observed and carried out.
- ✓ The assembled bearing bracket as well as the individual parts have been placed in a clean and level assembly area.
- ✓ All dismantled parts have been cleaned and checked for wear.
- ✓ Any damaged or worn parts have been replaced by original spare parts.
- ✓ The sealing surfaces have been cleaned.
 1. Insert keys 940.01 and 940.09. Slide impeller 230 onto shaft 210.
 2. Insert new joint ring 411.31 into the groove of impeller nut 922.
 3. Fit and tighten impeller nut 922 on shaft 210. Observe the tightening torque. (⇒ Section 7.6, Page 41)

7.5.5 Installing the back pull-out unit

	<p>! WARNING</p>
	<p>Back pull-out unit tilting Risk of crushing hands and feet!</p> <p>▷ Suspend or support the bearing bracket at the pump end.</p>

- ✓ The notes and steps stated in (⇒ Section 7.5.1, Page 37) to (⇒ Section 7.5.4, Page 40) have been observed and carried out.
- ✓ Any damaged or worn parts have been replaced by original spare parts.
- ✓ The sealing surfaces have been cleaned.
- ✓ For back pull-out units without coupling, fit the coupling in accordance with the manufacturer's instructions.
 1. Insert new gasket 400.10 into volute casing 102.
 2. Loosen forcing screws 901.30.
 3. Secure the back pull-out unit against tilting.
 4. Guide the back pull-out unit over studs 902.01 and into volute casing 102.
 5. Tighten nut 920.01 at the volute casing. Observe the tightening torques.
 6. Bolt support foot 183 to the baseplate.

7.5.6 Mounting the motor

	<p>NOTE</p>
	<p>Steps 1 and 2 do not apply to versions with spacer-type coupling.</p>

1. Shift the motor to connect it to the pump via the coupling.
2. Fasten the motor to the baseplate.
3. Align pump and motor. (⇒ Section 5.7, Page 22)
4. Connect the motor to the power supply (refer to manufacturer's product literature).

7.6 Tightening torques

7.6.1 Tightening torques for the pump

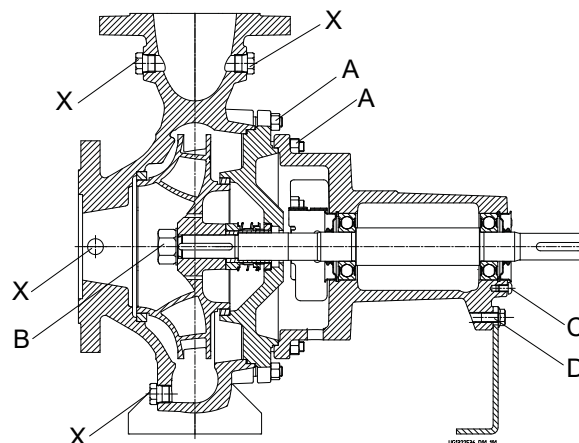


Fig. 18: Tightening points

Table 12: Tightening torques

Position	Thread	Tightening torques
		[Nm]
A	M16	130
B	M30 × 1,5	200
C	M10	38
D	M12	90
X	1/2	130

7.6.2 Tightening torques for the pump set

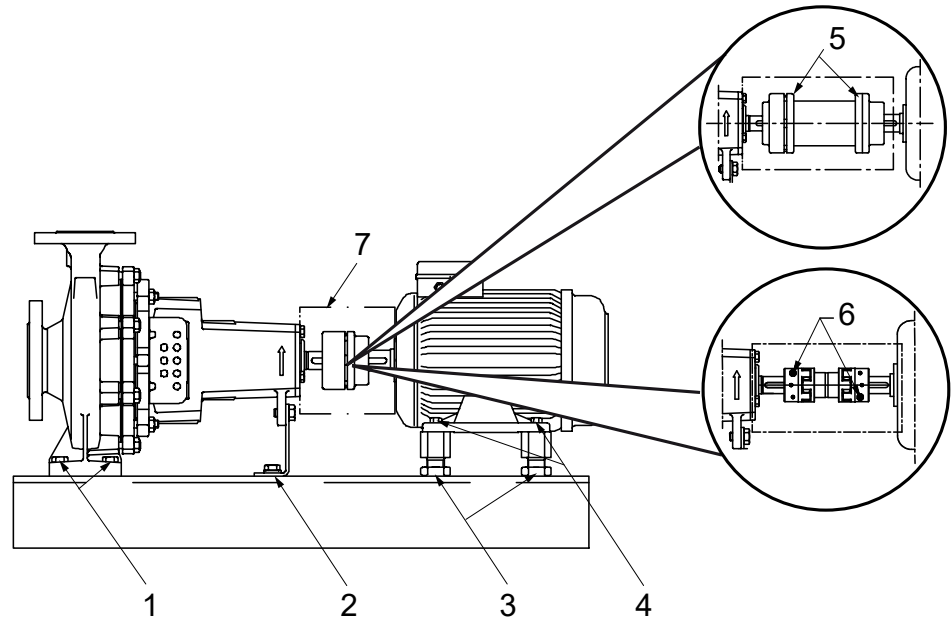


Fig. 19: Position of bolts/screws at the pump set

Table 13: Tightening torques for bolted/screwed connections at the pump set

Position	Thread size	Tightening torque	Notes
		[Nm]	
1	M12	30	Pump on baseplate
	M16	75	
	M20	75	
2	M12	30	
3	M24 × 1,5	140	Adjusting screws in baseplate
	M36 × 1,5	140	
4	M6	10	Motor on baseplate or motor on adjusting screws or bases
	M8	10	
	M10	15	
	M12	30	
	M16	75	
	M20	140	
	M24	140	
5	M6	13	Coupling (only for spacer-type coupling made by Flender)
	M8	18	
	M10	44	
6	M8	34	Coupling (only for double Cardan spacer-type coupling and split-hub coupling design, make: KTR)
	M10	67	
	M12	115	
	M16	290	
	M20	560	
7	M6	10	Coupling guard

7.7 Spare parts stock

7.7.1 Ordering spare parts

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

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

Refer to the name plate for all data.

Also specify the following data:

- Part number and description (⇒ Section 9.1, Page 46)
- Quantity of spare parts
- Shipping address
- Mode of dispatch (freight, mail, express freight, air freight)

7.7.2 Recommended spare parts stock

Table 14: Quantity of spare parts for recommended spare parts stock for 2 years' operation to DIN 24296

Part No.	Description	Number of pumps							10 and more
		2	3	4	5	6 and 7	8 and 9		
210	Shaft	1	1	1	2	2	2	20 %	
230	Impeller	1	1	1	2	2	2	20 %	
321	Rolling element bearing (set)	1	1	2	2	2	2	25 %	
330	Bearing bracket	-	-	-	-	-	1	2	
502.01	Casing wear ring	2	2	2	3	3	4	50 %	
502.02	Casing wear ring	2	2	2	3	3	4	50 %	
-	Gasket (set)	4	6	8	8	9	10	100 %	
461	Gland packing (set)	4	4	6	6	6	8	100 %	
524	Shaft protecting sleeve	2	2	2	3	3	4	50 %	

8 Trouble-shooting

	WARNING
	<p>Improper work to remedy faults Risk of injury!</p> <p>▷ For any work performed to remedy faults, observe the relevant information given in this operating 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 service is required.

- A Pump delivers insufficient flow rate
- B Motor is overloaded
- C Excessive discharge pressure
- D Increased bearing temperature
- E Leakage at the pump
- F Excessive leakage at the shaft seal
- G Vibrations during pump operation
- H Impermissible temperature increase in the pump

Table 15: Trouble-shooting

A	B	C	D	E	F	G	H	Possible cause	Remedy ⁴⁾
X	-	-	-	-	-	-	-	Pump delivers against an excessively high pressure.	Re-adjust to duty point. Check system for impurities. Fit a larger impeller. ⁵⁾ Increase the speed (turbine, I.C. engine).
X	-	-	-	-	-	X	X	Pump or piping are not completely vented or primed.	Vent and/or prime.
X	-	-	-	-	-	-	-	Supply line or impeller clogged	Remove deposits in the pump and/or piping.
X	-	-	-	-	-	-	-	Formation of air pockets in the piping	Alter piping layout. Fit vent valve.
X	-	-	-	-	-	X	X	Suction lift is too high/NPSHavailable (positive suction head) is too low.	Check/alter fluid level. Install pump at a lower level. Fully open the shut-off element in the suction line. Change suction line, if the friction losses in the suction line are too high. Check any strainers installed/suction opening. Observe permissible speed of pressure fall.
X	-	-	-	-	-	-	-	Air intake at the shaft seal	Supply external barrier fluid, if necessary, or increase barrier fluid pressure. Replace shaft seal.
X	-	-	-	-	-	-	-	Wrong direction of rotation	Check the electrical connection of the motor and the control system, if any.
X	-	-	-	-	-	-	-	Speed is too low. - Operation with frequency inverter - Operation without frequency inverter	- Increase voltage/frequency at the frequency inverter in the permissible range. - Check voltage.
X	-	-	-	-	-	X	-	Wear of internal components	Replace worn components by new ones.
-	X	-	-	-	-	X	-	Pump back pressure is lower than specified in the purchase order.	Re-adjust to duty point. In the case of persistent overloading, turn down impeller. ⁵⁾

⁴ Pump pressure must be released before attempting to remedy faults on parts which are subjected to pressure.

⁵ Contact the manufacturer.

A	B	C	D	E	F	G	H	Possible cause	Remedy ⁴⁾
-	X	-	-	-	-	-	-	Density or viscosity of fluid handled higher than stated in purchase order	Contact the manufacturer.
-	-	-	-	-	X	-	-	Use of unsuitable shaft seal materials	Change the material combination. ⁵⁾
-	X	-	-	-	X	-	-	Gland follower over-tightened or cocked	Adjust.
-	X	X	-	-	-	-	-	Speed is too high.	Reduce speed. ⁵⁾
-	-	-	-	X	-	-	-	Tie bolts/sealing element defective	Fit new sealing element between volute casing and casing cover. Re-tighten the bolts.
-	-	-	-	-	X	-	-	Worn shaft seal	Fit new shaft seal. Check flushing liquid/barrier fluid.
X	-	-	-	-	X	-	-	Score marks or roughness on shaft protecting sleeve / shaft sleeve	Replace shaft protecting sleeve/shaft sleeve. Fit new shaft seal.
-	-	-	-	-	X	-	-	Dismantle to find out.	Correct. Fit new shaft seal, if required.
-	-	-	-	-	X	-	-	Vibrations during pump operation	Correct the suction conditions. Re-align the pump set. Re-balance the impeller. Increase pressure at the pump suction nozzle.
-	-	-	X	-	X	X	-	Pump set is misaligned.	Re-align pump set.
-	-	-	X	-	X	X	-	Pump is warped or sympathetic vibrations in the piping.	Check the piping connections and secure fixing of pump; if required, reduce distances between the pipe clamps. Fix the pipelines using anti-vibration material.
-	-	-	X	-	-	-	-	Increased axial thrust ⁵⁾	Clean balancing holes in the impeller. Replace the casing wear rings.
-	-	-	X	-	-	-	-	Insufficient or excessive quantity of lubricant or unsuitable lubricant.	Top up, reduce or change lubricant.
-	-	-	X	-	-	-	-	Non-compliance with specified coupling distance	Correct the distance according to general arrangement drawing.
X	X	-	-	-	-	-	-	Motor is running on two phases only.	Replace the defective fuse. Check the electric cable connections.
-	-	-	-	-	-	X	-	Rotor out of balance	Clean the impeller. Re-balance the impeller.
-	-	-	-	-	-	X	-	Defective bearing(s)	Replace.
-	-	-	X	-	-	X	X	Flow rate is too low.	Increase the minimum flow rate.
-	-	-	-	-	X	-	-	Incorrect inflow of circulation liquid	Increase the free cross-section.

9 Related Documents

9.1 General assembly drawing with list of components

9.1.1 Etanorm FXM

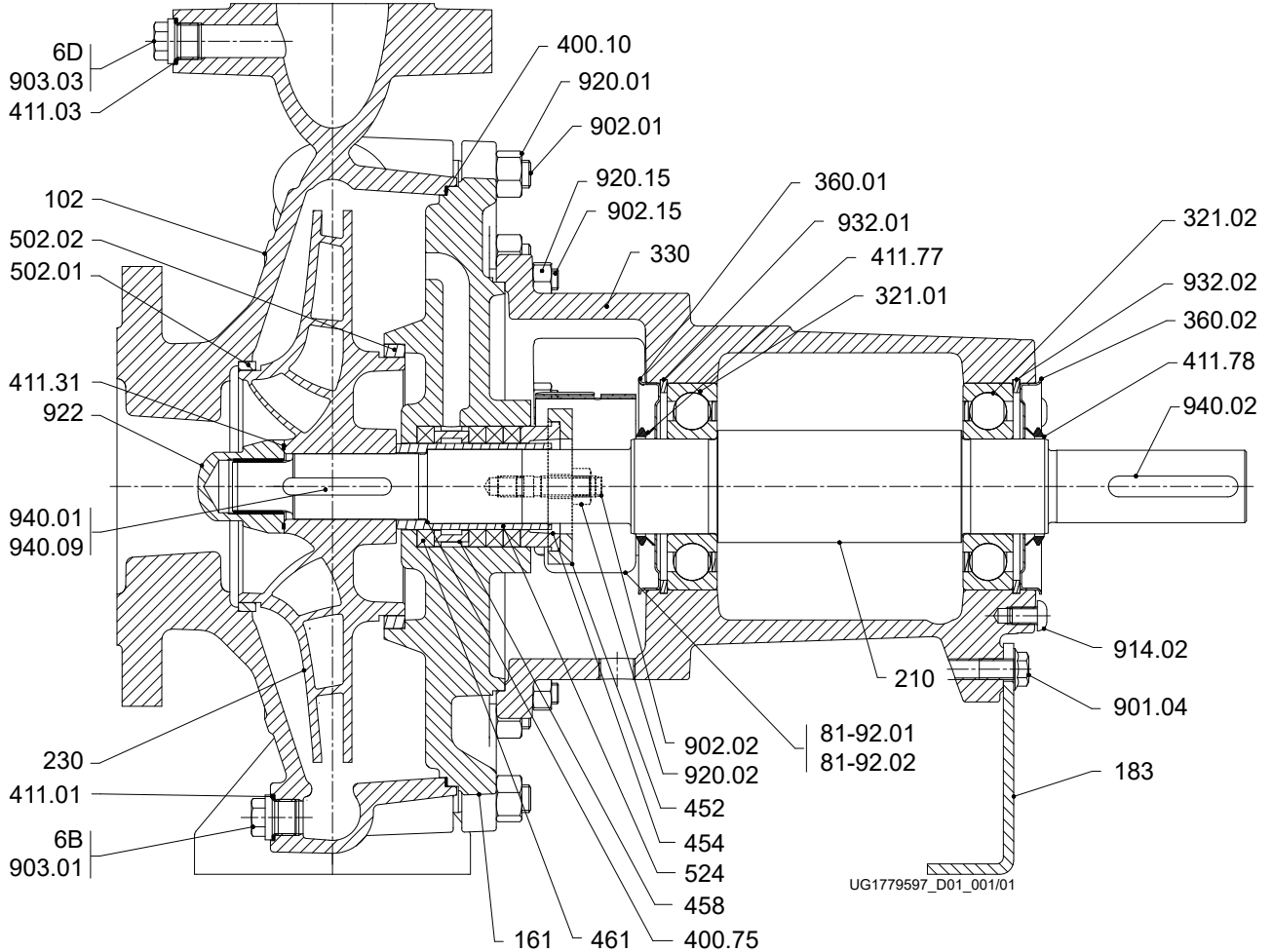


Fig. 20: General assembly drawing, pump with gland packing, type P1 - Na

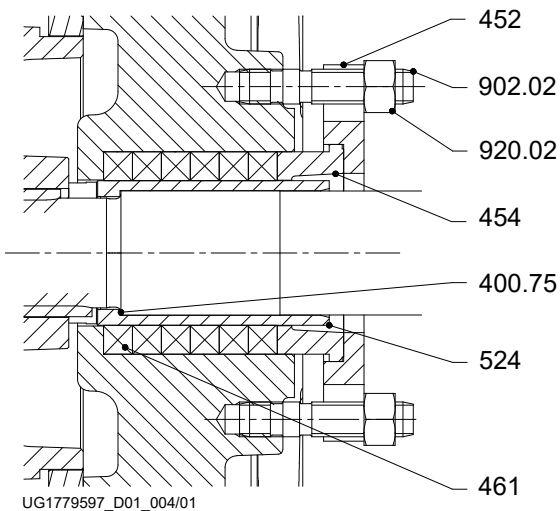


Fig. 21: Detailed view, pump with gland packing, type P2 - Nb

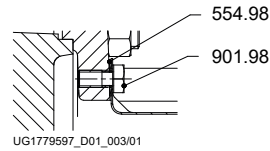


Fig. 22: Detailed view, fastening of cover plate

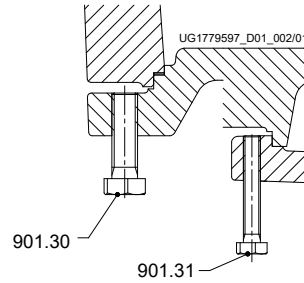


Fig. 23: Detailed view, forcing screws

Table 16: List of components

Part No.	Description	Part No.	Description
102	Volute casing	524	Shaft protecting sleeve
161	Casing cover	554.98	Washer
183	Support foot	81-92.01/02	Cover plate
210	Shaft	901.04/30/31/98	Hexagon head bolt
230	Impeller	902.01/02/15	Stud
321.01/02	Deep groove ball bearing	903.01/03	Screw plug
330	Bearing bracket	914.02	Hexagon socket head cap screw
360.01/02	Bearing cover	920.01/02/15	Nut
400.10/75	Gasket	922	Impeller nut
411.01/03/31/77/78	Joint ring	932.01/02	Circlip
452	Gland follower	940.01/02/09	Key
454	Stuffing box ring	Connection:	
458	Lantern ring	6B	Fluid drain
461	Gland packing	6D	Fluid filling and venting
502.01/02	Casing wear ring	8B	Leakage drain

10 EU Declaration of Conformity

Manufacturer: **KSB SE & Co. KGaA**
Johann-Klein-Straße 9
67227 Frankenthal (Germany)

The manufacturer herewith declares that the product:

Etanorm FXV, Etanorm FXM

KSB order number:

- is in conformity with the provisions of the following directives / regulations as amended from time to time:
 - Pump (set): 2006/42/EC Machinery Directive
 - Electrical components⁶⁾: 2011/65/EU Restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)

The manufacturer also declares that

- the following harmonised international standards⁷⁾ 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

.....⁸⁾.....

Name
Function
Company
Address

⁶ Where applicable

⁷ Apart from the standards listed here referring to the Machinery Directive, further standards are observed for explosion-proof versions (ATEX Directive) as applicable and are listed in the legally binding EU Declaration of Conformity.

⁸ A signed, legally binding EU Declaration of Conformity is supplied with the product.

11 Certificate of Decontamination

Type:
 Order number /
 Order item number⁹⁾:
 Delivery date:
 Application:
 Fluid handled⁹⁾:

Please tick where applicable⁹⁾:



Corrosive



Oxidising



Flammable



Explosive



Hazardous to health



Seriously hazardous to health



Toxic



Radioactive



Bio-hazardous



Safe

Reason for return⁹⁾:
 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 and 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 intermediate piece 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

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⁹ Required field

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