

In-line Pump

Etaline-R

Installation/Operating Manual



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Installation/Operating Manual Etaline-R

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 line 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 line which is connected to the suction nozzle

1 General

1.1 Principles

This operating manual is supplied as an integral part of the type series and variants indicated on the front cover. The 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 uniquely 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.

Noise characteristics see (⇒ Section 4.7, Page 17)

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 manual is aimed at the target group of trained and qualified specialist technical personnel. (⇒ Section 2.4, 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 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
Drawing for assembly	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 upon in scope of supply

Symbol	Description
1.	Step-by-step instructions
2.	
	Note Recommendations and important information on how to handle the product



2 Safety

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

2.1 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.

2.2 General

This manual contains general installation, operating and maintenance instructions that must be observed to ensure safe pump operation and prevent personal injury and damage to property.

The safety information in all sections of this manual must be complied with.

This manual must be read and completely understood by the specialist personnel/operators responsible prior to installation and commissioning.

The contents of this manual must be available to the specialist personnel at the site at all times.

Information attached directly to the pump must always be complied with and be 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 in this manual.

2.3 Intended use

The pump (set) must only be operated within the operating limits described 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 to handle the fluids described in the data sheet or product literature of the pump model.
- Never operate the pump without the fluid 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, mechanical seal damage, cavitation damage, bearing damage, etc).
- 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.

Prevention of foreseeable misuse

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

2.4 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.

2.5 Consequences and risks caused by non-compliance with this manual

- Non-compliance with this operating manual 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

2.6 Safety awareness

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

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

2.7 Safety information for the operator/user

- The operator shall fit contact guards for hot, cold and moving parts and check that the guards function properly.
- Do not remove any 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 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.

2.8 Safety information for maintenance, inspection and installation work

- Modifications or alterations of the pump are only permitted with the manufacturer's prior consent.
- Use only original spare parts or parts authorised by the manufacturer. The use of other parts can invalidate any liability of the manufacturer for resulting damage.
- The operator ensures that all maintenance, inspection and installation work is 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.
- The pump casing 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 35)
- As soon as the work has been completed, re-install and/or re-activate any safety-relevant and protective devices. Before returning the product to service, observe all instructions on commissioning. (⇒ Section 6.1, Page 26)

2.9 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 2.3, Page 8)

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 (as applicable) 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. ▷ Give due attention to the weight data and the centre of gravity. ▷ Observe the applicable local health and safety regulations. ▷ Use suitable, permitted lifting accessories, e.g. self-tightening lifting tongs.

To transport the pump/pump set suspend it from the lifting tackle as shown below.

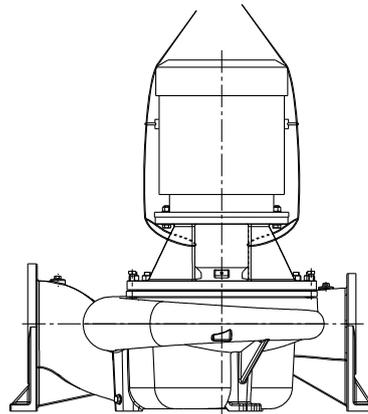


Fig. 1: Transporting the pump set

	CAUTION
	<p>Incorrect transport of the pump Damage to the shaft seal!</p> <ul style="list-style-type: none"> ▷ For transport, lock the pump shaft with a suitable transport lock to prevent any movement of the shaft.

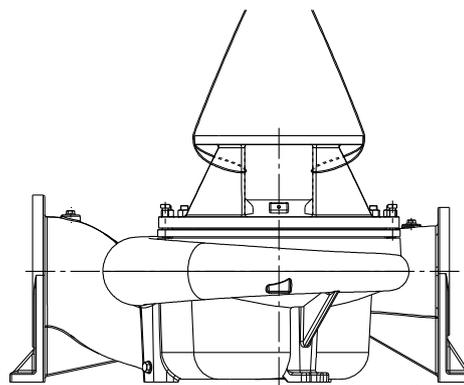


Fig. 2: Transporting the pump

3.3 Storage/preservation

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

	<p style="background-color: #FFD700; margin: 0;">CAUTION</p> <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 packed or unpacked pump (set) and accessories with waterproof material.
	<p style="background-color: #FFD700; margin: 0;">CAUTION</p> <p>Wet, contaminated or damaged openings and connections Leakage or damage to the pump set!</p> <ul style="list-style-type: none"> ▷ Only remove caps/covers from the openings of the pump set at the time of installation.

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, observe the instructions in (⇒ Section 6.3.1, Page 30) .

3.4 Return to supplier

1. Drain the pump as per operating instructions. (⇒ Section 7.3, Page 35)
2. Always flush and clean the pump, particularly if it has been used for handling noxious, explosive, hot or other hazardous fluids.
3. If the pump set has handled fluids whose residues could lead to corrosion damage in the presence of atmospheric humidity or could ignite upon contact with oxygen, the pump set must also be neutralised, and anhydrous inert gas must be blown through the pump to ensure drying.
4. Always complete and enclose a certificate of decontamination when returning the pump (set).
Always indicate any safety and decontamination measures taken.
(⇒ Section 11, Page 50)

	<p style="background-color: #0070C0; color: white; margin: 0;">NOTE</p> <p>If required, a blank certificate of decontamination can be downloaded from the following web site: www.ksb.com/certificate_of_decontamination</p>
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3.5 Disposal

	 WARNING
	<p>Fluids, 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 residues of the fluid handled.▷ 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

- Water pump with shaft seal

Pump for handling clean or aggressive fluids not chemically and mechanically aggressive to the pump materials.

4.2 Product Information as per Regulation No. 547/2012 (for water pumps with a maximum shaft power of 150 kW) implementing "Ecodesign" Directive 2009/125/EC

- Minimum efficiency index: see name plate, key to name plate (⇒ Section 4.4, Page 15)
- The benchmark for the most efficient water pumps is $MEI \geq 0.70$.
- Year of construction: see name plate, key to name plate (⇒ Section 4.4, Page 15)
- Manufacturer's name or trade mark, commercial registration number and place of manufacture: see data sheet or order documentation
- Product's type and size identifier: see name plate, key to name plate (⇒ Section 4.4, Page 15)
- Hydraulic pump efficiency (%) with trimmed impeller: see data sheet
- Pump performance curves, including efficiency characteristics: see documented characteristic curve
- The efficiency of a pump with a trimmed impeller is usually lower than that of a pump with full impeller diameter. Trimming of the impeller will adapt the pump to a fixed duty point, leading to reduced energy consumption. The minimum efficiency index (MEI) is based on the full impeller diameter.
- Operation of this water pump with variable duty points may be more efficient and economic when controlled, for example, by the use of a variable speed drive that matches the pump duty to the system.
- Information on dismantling, recycling and disposal after decommissioning: (⇒ Section 3.5, Page 13)
- Information on benchmark efficiency or benchmark efficiency graph for $MEI = 0.7$ (0.4) for the pump based on the model shown in the Figure are available at: <http://www.europump.org/efficiencycharts>

4.3 Designation

Example: Etaline-RG 200 - 400

Table 4: Key to the designation

Code	Description
Etaline-R	Type series
G	Casing material, e.g. G = grey cast iron
200	Nominal discharge nozzle diameter [mm]
400	Nominal impeller diameter [mm]

4.4 Name plate

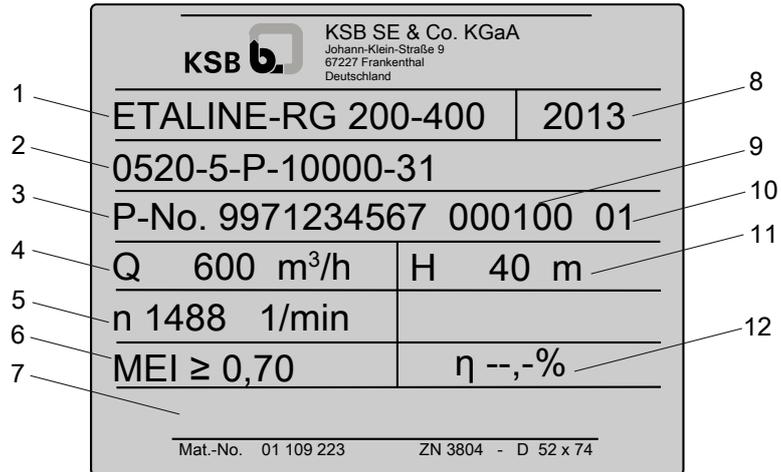


Fig. 3: Name plate (example)

1	Type series, size and version	2	Customer reference
3	KSB order number (ten digits)	4	Flow rate
5	Speed	6	Minimum efficiency index
7	Customer reference	8	Year of construction
9	Order item number (six digits)	10	Consecutive number (two digits)
11	Head	12	Efficiency (see data sheet)

4.5 Design details

Design

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

Pump casing

- Radially split volute casing
- Replaceable casing wear rings
- Volute casing with integrally cast pump feet

Impeller type

- Closed radial impeller with multiply curved vanes

Bearings

- Radial ball bearing
- Grease lubrication

Shaft seal

- KSB cartridge seal

4.6 Configuration and function

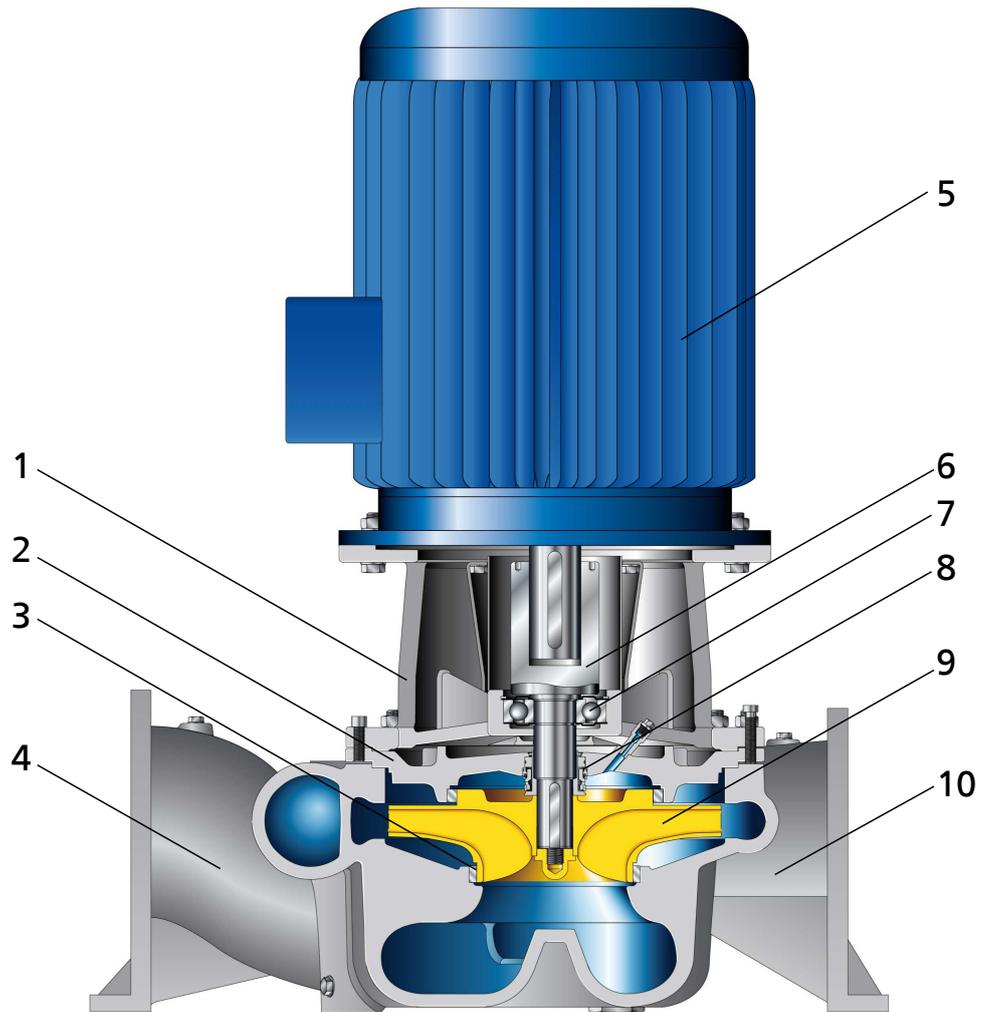


Fig. 4: Sectional drawing

1	Bearing bracket	2	Casing cover
3	Clearance gap	4	Suction nozzle
5	Motor	6	Drive shaft
7	Rolling element bearings	8	Shaft seal
9	Impeller	10	Discharge nozzle

Design The hydraulic system and the motor are connected via a stub shaft and form a close-coupled unit.

The impeller (9) and rotor are arranged on a common drive shaft (6).

Function The fluid enters the pump via the suction nozzle (4) and is accelerated outward in a radial flow by the rotating impeller (9). 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 (10), where it leaves the pump. The clearance gap (3) prevents any fluid from flowing back from the casing to the suction nozzle. At the rear side of the impeller, the shaft (6) enters the casing via the casing cover (2). The shaft passage through the cover is sealed to the atmosphere with a dynamic shaft seal (8). The shaft is supported by an oil-lubricated rolling element bearing (7). The motor (5) is connected to the casing via a bearing bracket (1).

Sealing The pump is sealed by a shaft seal (8).

4.7 Noise characteristics

Table 5: Surface sound pressure level L_{pA} ²⁾³⁾

Rated power input P_N [kW]	Pump	Pump set
	1450 rpm [dB]	1450 rpm [dB]
15	64	69
19	65	69
22	66	70
30	67	71
37	69	72
45	70	73
55	71	74
75	72	75
90	73	76
110	74	76
132	76	79
160	76	79
200	77	80
250	78	81
315	79	82
400	79	82

4.8 Scope of supply

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

- Pump
- Drive** ▪ Surface-cooled IEC frame three-phase squirrel-cage motor
- Special accessories** ▪ As required

4.9 Dimensions and weights

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

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

3) Increase for 60 Hz operation: 3500 rpm, +3dB; 1750 rpm + 1dB

5 Installation at Site

5.1 Safety regulations

	 DANGER
	<p>Improper installation in potentially explosive atmospheres Damage to the pump set!</p> <ul style="list-style-type: none"> ▸ Comply with the applicable local explosion protection regulations. ▸ Observe the information given in the data sheet and on the pump/motor name plates.

5.2 Checks to be carried out prior to installation

Place of installation

	 WARNING
	<p>Installation on 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 have set and must be completely horizontal and even. ▸ 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

	CAUTION
	<p>Dry running / Ingress of leakage into the motor Damage to the motor!</p> <ul style="list-style-type: none"> ▸ Always install the pump set in vertical position.

Installation on a foundation with foundation bolts

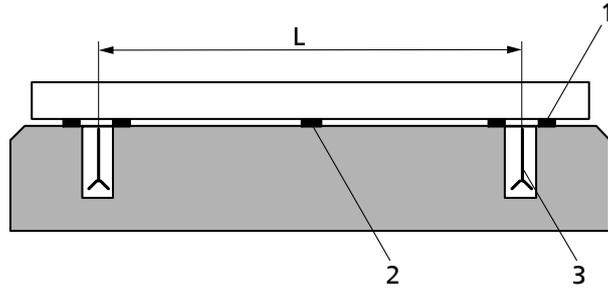


Fig. 5: Fitting the shims

L	Bolt-to-bolt distance	1	Shim
2	Shim for bolt-to-bolt distance > 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 align it.
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 align the baseplate.
 6. Tighten the foundation bolts (3) evenly and firmly.

Installation on a foundation with chemical anchors

- Fasten the pump feet to a concrete foundation with chemical anchors.

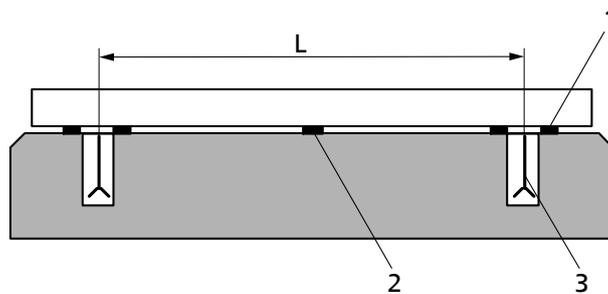


Fig. 6: Installation on a foundation with chemical anchors

L	Anchor-to-anchor distance	1	Shim
2	Shim	3	Chemical anchors

- ✓ 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 align it.
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 chemical anchors (3) between the pump and the foundation.
For an anchor-to-anchor distance (L) > 800 mm fit additional shims (2) halfway between the anchor holes.
All shims must lie perfectly flush.

3. Drill the holes as specified in the "Chemical anchor dimensions" table. Then clean the holes.

	⚠ WARNING
	<p>Improper handling of mortar cartridges Skin sensitisation or irritation!</p> <ul style="list-style-type: none"> ▷ Wear suitable protective clothing.

4. Insert the mortar cartridges into the drilled holes. Observe the curing times of the mortar cartridges!
5. Insert threaded rods into the corresponding drilled holes with an electric tool (e.g. impact drill, hammer drill).
6. After the curing time (see table "Curing times of mortar cartridge"), tighten the chemical anchors (3) evenly and tightly.

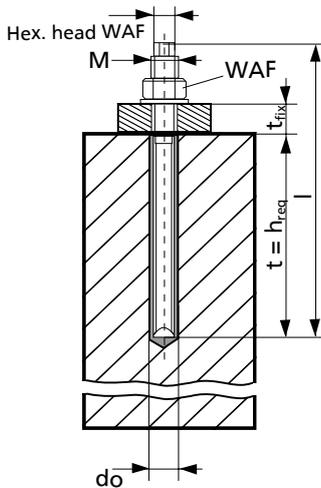


Fig. 7: Dimensions

Table 6: Chemical anchor dimensions

Size	d _o [mm]	t=h _{erf} [mm]	t _{fix} [mm]	SW [mm]	M [mm]	Hex. head WAF [mm]	Torque _{ass} _y [Nm]
M 24x300	28	210	65	36	24	-	150

Table 7: Curing times of mortar cartridge

Floor temperature	Curing time [min]
-5 °C to 0 °C	240
0 °C to +10 °C	45
+10 °C to +20 °C	20
> +20 °C	10

5.4 Piping

5.4.1 Connecting the piping

	⚠ DANGER
	<p>Excessive loads acting on the pump nozzles Danger to life from leakage of 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 pipelines in close proximity to the pump and connect them without transmitting any stresses or strains. ▷ Take appropriate measures to compensate 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>

- ✓ The suction lift line has been laid with a rising slope, the suction head line 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.
- ✓ Adapters to larger diameters have a diffuser angle of approx. 8° to prevent excessive pressure losses.
- ✓ 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 and discharge nozzles 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 34) .

3. If required, install a filter in the piping (see drawing: Filter in the piping).

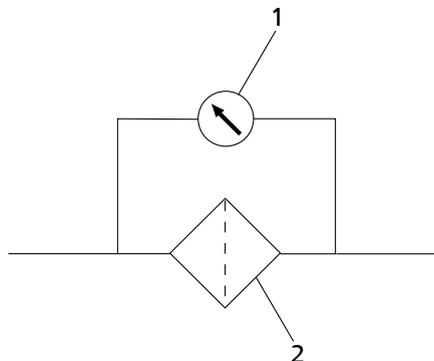


Fig. 8: Filter in the piping

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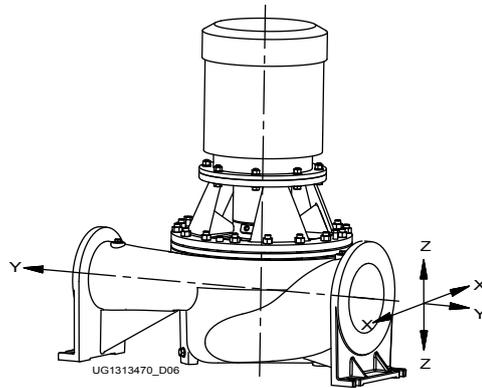
	NOTE
	<p>Use a filter with laid-in wire mesh of 0.5 mm x 0.25 mm (mesh size x wire diameter) made of corrosion-resistant material. Use a filter with a filter area three times the cross-section of the piping. Conical filters have proved suitable.</p>

4. Connect the pump nozzles to the piping.

	CAUTION
	<p>Aggressive flushing and pickling agents Damage to the pump! ▷ Match the cleaning operation mode and duration for flushing and pickling service to the casing and seal materials used.</p>

5.4.2 Permissible forces and moments at the pump nozzles

The following condition must be met:



$$\left(\frac{\sum |F|}{\sum |F|_{\max}} \right)^2 + \left(\frac{\sum |M|}{\sum |M|_{\max}} \right)^2 \leq 2$$

Forces and moments at the pump nozzles

$\sum |F|$ and $\sum |M|$ are the sums of the absolute values of the respective forces and moments acting on the nozzles.

$\sum |F|_{\max}$ and $\sum |M|_{\max}$ are the sums of the absolute values of the permissible forces and moments acting on the nozzles.

The data on forces and moments apply to static piping loads only. If the limits are exceeded, they must be checked and verified.

If a computerised strength analysis is required, please contact KSB.

The values are only applicable if the pump is bolted to a rigid and level foundation.

Table 8: Forces and moments at the pump nozzles

Sizes	Suction nozzle [N]				Discharge nozzle [N]				Suction nozzle [Nm]				Discharge nozzle [Nm]			
	F _x	F _y	F _z	Σ F	F _x	F _y	F _z	Σ F	M _x	M _y	M _z	Σ M	M _x	M _y	M _z	Σ M
150-500	2250	2510	2025	3932	1685	1875	1515	2941	1375	900	1075	2150	1000	625	775	1575
250-250	2790	3130	2530	4897	2790	3130	2530	4897	1975	1325	1575	3025	1975	1325	1575	3025
250-260																
200-330	2790	3130	2530	4897	2250	2510	2025	3932	1975	1325	1575	3025	1375	900	1075	2150
200-400																
200-500																
250-300	3355	3750	3015	5865	2790	3130	2530	4897	2775	1900	2225	4200	1975	1325	1575	3025
250-330																
250-400																
250-500																
300-360	3355	3750	3015	5865	3355	3750	3015	5865	2775	1900	2225	4200	2775	1900	2225	4200
300-400	3915	4365	3525	6841	3355	3750	3015	5865	3625	2500	2925	5450	2775	1900	2225	4200
300-500	3915	4365	3525	6841	3355	3750	3015	5865	3625	2500	2925	5450	2775	1900	2225	4200
350-340	3915	4365	3525	6841	3915	4365	3525	6841	3625	2500	2925	5450	3625	2500	2925	5450

5.4.3 Vacuum balance line

	NOTE
	<p>Where fluid has to be pumped out of a vessel under vacuum, installing a vacuum balance line is recommended.</p>

The following rules apply to vacuum balance lines:

- Minimum nominal line diameter 25 mm.
- The line extends above the highest permissible fluid level in the vessel.

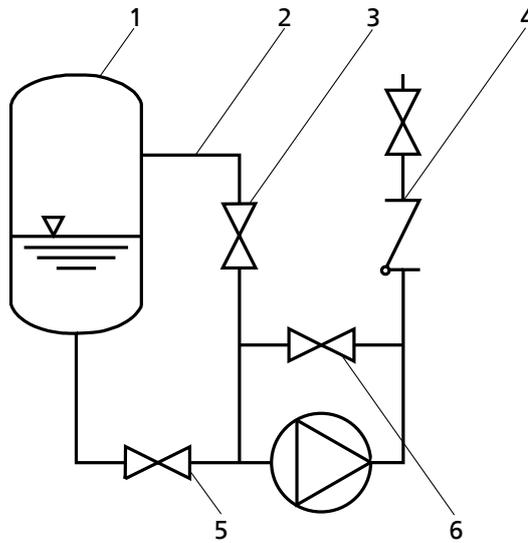


Fig. 9: Vacuum balance system

1	Vessel under vacuum	2	Vacuum balance line
3	Shut-off element	4	Swing check valve
5	Main shut-off element	6	Vacuum-tight shut-off element

	NOTE
	An additional line (from the pump discharge nozzle to the balance line) fitted with a shut-off element facilitates venting of the pump before start-up.

5.4.4 Auxiliary connections

 	! DANGER
	<p>Risk of potentially explosive atmosphere by mixing of incompatible fluids in the auxiliary piping</p> <p>Risk of burns!</p> <p>Explosion hazard!</p> <ul style="list-style-type: none"> ▷ Make sure that the barrier fluid and quench liquid are compatible with the fluid pumped.

	! WARNING
	<p>Failure to use or incorrect use of auxiliary connections (e.g. barrier fluid, flushing liquid, etc.)</p> <p>Risk of injury from escaping fluid!</p> <p>Risk of burns!</p> <p>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>⚠ WARNING</p>
	<p>The volute casing and casing/discharge cover take on the same temperature as the fluid handled Risk of burns!</p> <ul style="list-style-type: none"> ▸ Insulate the volute casing. ▸ Fit protective equipment.
	<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 Electrical connection

	<p>⚠ DANGER</p>
	<p>Work on the pump set 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 and, for explosion-proof models, EN 60079.
	<p>⚠ WARNING</p>
	<p>Incorrect connection to the mains Damage to the mains network, short circuit!</p> <ul style="list-style-type: none"> ▸ Observe the technical specifications of the local energy supply companies. <ol style="list-style-type: none"> 1. Check the available mains voltage against the data on the name plate. 2. Select an appropriate start-up method.
	<p>NOTE</p>
	<p>A motor protection device is recommended.</p>

5.6.1 Setting the time relay

	<p>CAUTION</p>
	<p>Switchover between star and delta on three-phase motors with star-delta starting takes too long. Damage to the pump (set)!</p> <ul style="list-style-type: none"> ▸ Keep switch-over intervals between star and delta as short as possible.

Table 9: Time relay settings for star-delta starting:

Motor rating	Y time to be set
≤ 30 kW	< 3 s
> 30 kW	< 5 s

5.6.2 Connecting the motor

	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. Match the motor's direction of rotation to that of the pump.
2. Observe the manufacturer's product literature supplied with the motor.

5.7 Checking the direction of rotation

	⚠ DANGER
	<p>Temperature increase resulting from contact between rotating and stationary components Damage to the pump set!</p> <ul style="list-style-type: none"> ▸ 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.

	⚠ 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>Incorrect direction of rotation with non-reversible mechanical seal Damage to the mechanical seal and leakage!</p> <ul style="list-style-type: none"> ▸ Check the direction of rotation by starting the pump set and stopping it again immediately.

	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 the motor and pump is clockwise (seen from the motor 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 runs 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. (⇒ Section 6.1.2, Page 26)
- 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 Filling in lubricants

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

6.1.3 Checking the shaft seal

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

6.1.4 Priming and venting the pump

	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.

1. Vent the pump and suction line and prime both with the fluid to be handled. Connections 5B and 6D can be used for venting (see drawing of auxiliary connections).
2. Fully open the shut-off element in the suction line.
3. Fully open all auxiliary feed lines (barrier fluid, flushing liquid, etc), if applicable.
4. Open the shut-off element, if any, in the vacuum balance line and close the vacuum-tight shut-off element, if any. (⇒ Section 5.4.3, Page 22)

	NOTE
	<p>For design-inherent reasons some unfilled volume in the hydraulic system cannot be excluded after the pump has been primed for commissioning/start-up. However, once the motor is started up the pumping effect will immediately fill this volume with the fluid handled.</p>

6.1.5 Start-up

	<p>⚠ DANGER</p> <p>Non-compliance with the permissible pressure and temperature limits if the pump is operated with the suction and discharge lines closed.</p> <p>Explosion hazard! Leakage of hot or toxic fluids!</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 gate valve slightly or fully open.
	<p>⚠ DANGER</p> <p>Excessive temperatures due to dry running or excessive gas content in the fluid handled</p> <p>Explosion hazard! Damage to the pump set!</p> <ul style="list-style-type: none"> ▷ Never operate the pump set without liquid fill. ▷ Prime the pump as per operating instructions. ▷ Always operate the pump within the permissible operating range.
	<p>CAUTION</p> <p>Abnormal noises, vibrations, temperatures or leakage</p> <p>Damage to the pump!</p> <ul style="list-style-type: none"> ▷ Switch off the pump (set) immediately. ▷ Eliminate the causes before returning the pump set to service.
<ul style="list-style-type: none"> ✓ The system piping has been cleaned. ✓ The pump, suction line and inlet tank, if any, have been vented and primed with the fluid to be handled. ✓ The lines for priming and venting have been closed. 	
	<p>CAUTION</p> <p>Start-up against open discharge line</p> <p>Motor overload!</p> <ul style="list-style-type: none"> ▷ Make sure the motor has sufficient power reserves. ▷ Use a soft starter. ▷ Use speed control.
<ol style="list-style-type: none"> 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. 	
	<p>⚠ DANGER</p> <p>Seal leakage at operating temperature</p> <p>Hot or toxic fluid could escape!</p> <ul style="list-style-type: none"> ▷ Once the operating temperature has been reached, re-tighten the hexagon nuts between casing and casing cover.

6.1.6 Shutdown

	CAUTION
	<p>Heat build-up inside the pump Damage to the shaft seal!</p> <ul style="list-style-type: none"> ▷ Depending on the type of installation, the pump set requires sufficient after-run time – with the heat source switched off – until the fluid handled has cooled down.

- ✓ The shut-off element in the suction line is and remains open.
- 1. Close the shut-off element in the discharge line.
- 2. Switch off the motor and make sure the pump set runs down smoothly to a standstill.

	NOTE
	<p>If the discharge line is equipped with a check valve, the shut-off element in the discharge line may remain open, provided the site's requirements and regulations are taken into account and observed.</p>

For prolonged shutdown periods:

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

	CAUTION
	<p>Risk of freezing during prolonged pump shutdown periods Damage to the pump!</p> <ul style="list-style-type: none"> ▷ Drain the pump and the cooling/heating chambers (if any) or otherwise protect them against freezing.

6.2 Operating limits

	⚠ DANGER
	<p>Non-compliance with operating limits for pressure, temperature, fluid handled and speed Hot fluids escaping!</p> <ul style="list-style-type: none"> ▷ Comply with the operating data indicated in the data sheet. ▷ Avoid prolonged operation against a closed shut-off element. ▷ Never operate the pump at product temperatures exceeding those specified in the data sheet or on the name plate.

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 10: Permissible ambient temperatures

Permissible ambient temperature	Value
Maximum	40 °C
Minimum	See data sheet.

6.2.2 Frequency of starts

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). Provided that the start-ups are evenly spaced over the period indicated, the pump set can be started not more than 15 times per hour with the discharge-side gate valve slightly open.

	CAUTION
	<p>Re-starting while motor is still running down Damage to the pump (set)!</p> <p>▷ Do not re-start the pump set before the pump rotor has come to a standstill.</p>

6.2.3 Fluid handled

6.2.3.1 Flow rate

Table 11: Flow rate

	Minimum flow rate	Maximum flow rate
For a short period (approximately 2 minutes)	25 % of $Q_{opt.}^{4)}$	See hydraulic characteristic curves
Continuous operation	$Q_{low\ flow} \geq 45\ %\ of\ Q_{opt.}^{4)}$	

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 12: Key

Symbol	Description	Unit
c	Specific heat capacity	J/kg K
g	Gravitational constant	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	-
$\Delta \vartheta$	Temperature difference	K

6.2.3.2 Density of the fluid handled

The pump input power changes in proportion to the density of the fluid handled.

4) Duty point at maximum efficiency

	CAUTION
	<p>Impermissibly high density of the fluid handled Motor overload!</p> <ul style="list-style-type: none"> ▷ Observe the information on 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.

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 operation 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 pipe and stored

- ✓ The pump has been properly drained. (⇒ Section 7.3, Page 35)
- ✓ The safety instructions for dismantling the pump have been observed. (⇒ Section 7.4.1, Page 36)
 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.

Observe any additional instructions and information provided. (⇒ Section 3, Page 11)

6.4 Returning to service

For returning the equipment to service, observe the sections on commissioning/start-up (⇒ Section 6.1, Page 26) and the operating limits. (⇒ Section 6.2, Page 28)

In addition, carry out all servicing/maintenance operations before returning the pump (set) to service. (⇒ Section 7, Page 32)

	WARNING
	<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, re-install and re-activate any safety-relevant devices and protective devices.

**NOTE**

If the pump has been out of service for more than one year, replace all elastomer seals.

7 Servicing/Maintenance

7.1 Safety regulations

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

	<p style="background-color: #f4a460; padding: 2px;">⚠ WARNING</p> <p>Unintentional starting of pump set Risk of injury by moving parts!</p> <ul style="list-style-type: none"> ▷ Ensure that the pump set cannot be started up unintentionally. ▷ Always make sure the electrical connections are disconnected before carrying out work on the pump set.
	<p style="background-color: #f4a460; padding: 2px;">⚠ WARNING</p> <p>Fluids handled and supplies posing a health hazard and/or hot fluids handled and supplies Risk of injury!</p> <ul style="list-style-type: none"> ▷ Observe all relevant laws. ▷ When draining the fluid take appropriate measures to protect persons and the environment. ▷ Decontaminate pumps which handle fluids posing a health hazard.
	<p style="background-color: #f4a460; padding: 2px;">⚠ WARNING</p> <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 tipping or falling over.

A regular maintenance schedule will help avoid expensive repairs and contribute to trouble-free, reliable operation of the pump (set) with a minimum of maintenance expenditure and work.

	<p style="background-color: #0070c0; color: white; padding: 2px;">NOTE</p> <p>All maintenance, service and installation work can be carried out by KSB Service or authorised workshops. Find your contact in the attached "Addresses" booklet or on the Internet at "www.ksb.com/contact".</p>
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Never use force when dismantling and reassembling the pump set.

7.2 Maintenance/inspection

7.2.1 Supervision of operation

	<p style="background-color: #f4d03f; padding: 2px;">CAUTION</p> <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.
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	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. (⇒ Section 6.2, Page 28)

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 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.
- Cooling system
Take the pump out of service at least once a year to thoroughly clean the cooling system.
- Monitor the stand-by pump.
To make sure that the stand-by pumps are ready for operation, start them up once a week.
- 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>

7.2.2 Inspection work

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

7.2.2.1 Checking the clearances

For checking the clearance gaps remove the impeller, if required.

If the clearance gap is larger than permitted (see the following table), fit new casing wear ring 502.1 and, if applicable, 502.2.

The clearance gaps given refer to the diameter.

Table 13: Clearance gaps between impeller and casing / between impeller and casing cover

	Etaline-R
New	0.4 mm
Maximum permissible enlargement	0.6 mm

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.

7.2.2.3 Lubrication and lubricant change of rolling element bearings

7.2.2.3.1 Grease lubrication

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

7.2.2.3.1.1 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.

7.2.2.3.1.2 Grease quality

Optimum grease properties for rolling element bearings

- High melting point lithium soap base grease
- Free of resin and acid
- Not liable to crumble

- Good rust-preventive characteristics
- Penetration number between 2 and 3 (corresponding to a worked penetration of 220 to 295 mm/10)
- Drop point ≥ 175 °C

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.

7.2.2.3.1.3 Grease quantity

Table 14: Grease quantity for grease-lubricated radial ball bearings to DIN 625

Shaft unit ⁵⁾	Code	Quantity per bearing [g]
65	6413 C3 ⁶⁾	40

7.2.2.3.1.4 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 must be dismantled for changing the grease. (⇒ Section 7.4, Page 36)
1. Fill the bearing cavities with grease.

7.3 Drainage/cleaning

	! WARNING
	<p>Fluids, 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 residues of the fluid handled. ▸ 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 pump 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 cleaning record for the pump.

5) Shaft unit see data sheet.
 6) With Nilos ring 6413 AV

7.4 Dismantling the pump set

7.4.1 General information/Safety regulations

	<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 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 safety information.
(⇒ Section 7.1, Page 32)

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.

	<p>NOTE</p> <p>All maintenance, service and installation work can be carried out by KSB Service or authorised workshops. Find your contact in the attached "Addresses" booklet or on the Internet at "www.ksb.com/contact".</p>
	<p>⚠ DANGER</p> <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 suction and discharge line. ▷ Drain the pump and release the pump pressure. (⇒ Section 7.3, Page 35) ▷ Close any auxiliary connections. ▷ Allow the pump set to cool down to ambient temperature.
	<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. De-energise the pump set and secure it against unintentional start-up.
2. Reduce pressure in the piping by opening a consumer installation.
3. Disconnect and remove all auxiliary pipework.

7.4.3 Dismantling the complete pump set

	NOTE
	The pump casing can remain installed in the piping for further dismantling.

- ✓ The notes and steps stated (⇒ Section 7.4.1, Page 36) into (⇒ Section 7.4.2, Page 37) have been observed/carried out.
1. Disconnect the discharge and suction nozzles from the piping.
 2. Depending on the pump/motor size, remove the supports from the pump set.
 3. Remove the complete pump set from the piping.

7.4.4 Removing the motor

	WARNING
	Motor tilting Risk of crushing hands and feet! ▷ Suspend or support the motor to prevent it from tilting.

- ✓ The notes and steps stated in (⇒ Section 7.4.1, Page 36) to (⇒ Section 7.4.3, Page 37) have been observed/carried out.
1. Undo hexagon nuts 920.11.
 2. Undo hexagon head bolts 901.18.
 3. Remove the motor.

7.4.5 Removing the back pull-out unit

	WARNING
	Back pull-out unit tilting Risk of squashing hands and feet! ▷ Suspend or support the back pull-out unit at the pump end.

- ✓ The notes and steps stated in (⇒ Section 7.4.1, Page 36) to (⇒ Section 7.4.4, Page 37) have been observed/carried out.
1. If required, suspend or support the back pull-out unit to prevent it from tipping over.
 2. Undo hexagon nut 920.1 at the volute casing.
 3. Use forcing screws 901.31 to press the back pull-out unit out of volute casing.
 4. Remove and dispose of gasket 400.19.
 5. Place the back pull-out unit on a clean and level surface.

7.4.6 Removing the impeller

- ✓ The notes and steps stated in (⇒ Section 7.4.1, Page 36) to (⇒ Section 7.4.5, Page 37) have been observed/carried out.
- ✓ The back pull-out unit is kept in a clean and level assembly area.
 1. Undo impeller nut 922.4 (right-hand thread).
 2. Remove impeller 230 with an impeller removal device.
 3. Place impeller 230 on a clean and level surface.
 4. Remove key 940.01 from shaft 210.
 5. **Sizes 250-250, 250-300, 250-340:** Remove intermediate ring 509.

7.4.7 Removing the mechanical seal

- ✓ The notes and steps stated in (⇒ Section 7.4.1, Page 36) to (⇒ Section 7.4.6, Page 38) have been observed/carried out.
- ✓ The back pull-out unit is kept in a clean and level assembly area.
- ✓ The impeller has been removed.
 1. Use two pry bars to prise out complete mechanical seal 433 (cartridge design) at the circumferential groove (see Fig.: Prising out the mechanical seal using pry bars



Fig. 10: Prising out the mechanical seal using pry bars

2. Remove and dispose of gasket 400.04.

7.4.8 Dismantling the bearings

- ✓ The notes and steps stated in (⇒ Section 7.4.1, Page 36) to (⇒ Section 7.4.7, Page 38) have been observed/carried out.
- ✓ The bearing bracket has been placed on a clean and level surface.
 1. Remove contact guard 680.
 2. Undo cover bolts 914.03, remove casing cover 161 and thrower 507 from the shaft.
 3. Remove circlip 932.02 and press shaft 210 out of the bearing seat towards the motor.
 4. Remove circlip 932.20 and ring 500.18.
 5. Remove ball bearing 321 from shaft 210 and place on a clean and level surface.
 6. Remove ring 550.21.

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.

	CAUTION
	<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 reassemble the pump in accordance with the corresponding general assembly drawing or exploded view.

Seal elements Check O-rings for any damage and replace by new O-rings, if required.
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).

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 42)

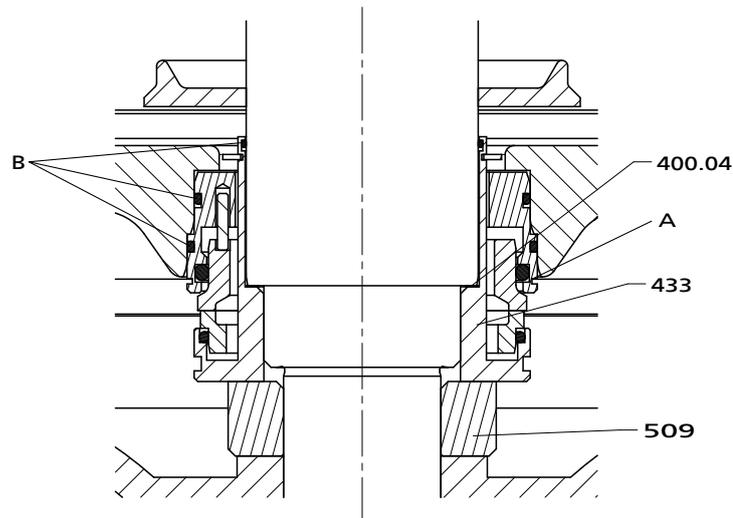
7.5.2 Installing the bearings

1. Slide (Nilos) rings 500.21 along the shaft until they abut the shaft shoulder, observing the correct direction of assembly.
2. Press ball bearing 321 onto shaft 210.
3. Fill bearing with grease. (⇒ Section 7.2.2.3.1, Page 34)
4. Insert (Nilos) ring 500.18 and fit circlip 932.20 in shaft 210.
5. Slide pre-assembled shaft into bearing bracket 330 and fit circlip 932.02.
6. Slide thrower 507 onto the shaft.
7. Screw casing cover 161 to bearing bracket 330 using hexagon socket head cap screws 914.03.

7.5.3 Installing the mechanical seal

The following rules must be observed when installing the mechanical seal:

- Work cleanly and accurately.
- Prevent any damage to the sealing surfaces or O-rings.


Fig. 11: Installing the KSB cartridge seal

400.04	Gasket	A	Circumferential groove
509 ⁷⁾	Intermediate ring	B	O-rings
433	Mechanical seal		

- ✓ The notes and steps stated in (⇒ Section 7.5.1, Page 38) have been observed/ carried out.
 - ✓ The bearing assembly as well as the individual parts are kept 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. Apply a suitable lubricant to the mechanical seal's O-rings (B) to reduce to the friction when sliding on the cartridge seal.
 2. Insert gasket 400.04 into the mechanical seal.
 3. Press mechanical seal 433 into casing cover 161 up to the circumferential groove (A).

	CAUTION
	Elastomers in contact with oil/grease Shaft seal failure! <ul style="list-style-type: none"> ▷ Use water as assembly lubricant. ▷ Never use oil or grease as assembly lubricant.
	NOTE
	To reduce friction forces when assembling the seal, wet the shaft sleeve and the location of the stationary ring with water.

7) On sizes 250-250, 250-300, 250-340 only:

7.5.4 Fitting the impeller

- ✓ The notes and steps stated in (⇒ Section 7.5.1, Page 38) to (⇒ Section 7.5.3, Page 39) have been observed/carried out.
 - ✓ The pre-assembled unit (motor, shaft, drive lantern/motor stool, discharge cover) as well as the individual parts are kept 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. **Sizes 250-250, 250-300, 350-340:**
Insert intermediate ring 509.
 2. Insert key 940.01 and slide impeller 230 onto shaft 210.
 3. Fasten impeller nut 922. (⇒ Section 7.6, Page 42)

7.5.5 Installing the back pull-out unit

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

- ✓ The notes and steps stated in (⇒ Section 7.5.1, Page 38) to (⇒ Section 7.5.4, Page 41) have been observed/carried out.
 - ✓ Any damaged or worn parts have been replaced by original spare parts.
 - ✓ The sealing surfaces have been cleaned.
1. If required, suspend or support the back pull-out unit to prevent it from tipping over.
 2. Fit new gasket 400.19 into the recess of volute casing 102.
 3. Push the back pull-out unit into volute casing 102.
 4. Fasten hexagon nut 920.02 at volute casing 102.

7.5.6 Mounting the motor

- ✓ The notes and steps stated in (⇒ Section 7.5.1, Page 38) to (⇒ Section 7.5.5, Page 41) have been observed/carried out.
1. Fit contact guard 680 over the outer bearing seat of bearing bracket 330.
 2. Fit the motor shaft stub into shaft 210.
 3. Screw the motor to the bearing bracket with bolt 901.18, disc 550.18/.11 and nut 920.11.

7.6 Tightening torques

7.6.1 Tightening torques for the pump set

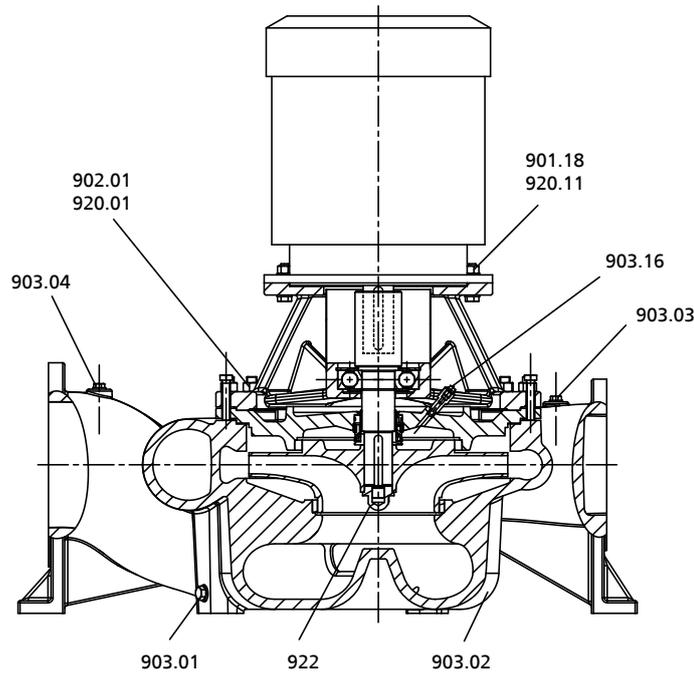


Fig. 12: Tightening points

Table 15: Tightening torques for bolted/screwed connections at the pump

Part No.	Description	Material	Stamp mark	Thread	Tightening torques [Nm]		
					New threads ⁸⁾	- 15 % ⁹⁾	- 20 % ⁹⁾
902.01/ 920.01	Stud/ nut	1.7709+QT	GA	M16	190	162	152
		Monix 3K	MM		320	272	256
		1.7218+QT+A2D	G	M20	330	281	264
		Monix 3K	MM (M3k)		620	572	496
922	Impeller nut	1.4571	-	M 20 x 1.5	200	-	-
				M 24 x 1.5	500	-	-
901.18/ 920.11	Hexagon head bolt/ nut	8.8	-	M12	55	-	-
				M16	130	-	-
				M20	240	-	-
903.01/ 903.02	Screw plug	Steel	-	G 3/4	220	-	-
903.03/ 903.04				G 1/2	130	-	-
903.16				G 1/4	55	-	-

7.7 Spare parts stock

7.7.1 Ordering spare parts

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

- Type series
- Size
- KSB order number

8) These values are determined on the basis of a friction coefficient of $\mu = 0.12$.

9) After repeated tightening of the threads and in case of good lubrication the values shall be reduced by 15 to 20 %.

- Order item number
- Consecutive number
- Year of construction

Refer to the name plate for all data. (⇒ Section 4.4, Page 15)

Also specify the following data:

- Description
- Part No.
- Quantity of spare parts
- Shipping address
- Mode of dispatch (freight, mail, express freight, air freight)

Refer to the exploded view or general assembly drawing for part numbers and descriptions. (⇒ Section 9.1, Page 47)

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

Table 16: Quantity of spare parts for recommended spare parts stock

Part No.	Description	Number of pumps (including stand-by pumps)						
		2	3	4	5	6 and 7	8 and 9	10 and more
210	Shaft	1	1	1	2	2	2	20 %
230	Impeller	1	1	1	2	2	3	20 %
400	Gasket (set)	4	6	8	8	9	12	150 %
433	Mechanical seal	1	1	2	2	2	3	30 %
502.01/02	Casing wear ring	2	2	2	3	3	4	50 %
321	Radial ball bearing	1	1	2	2	2	3	50 %

7.7.3 Interchangeability of pump components

Components featuring the same number in a column are interchangeable.

Sizes	Description																	
	Volute casing	Casing cover	Shaft										Impeller	Deep-groove ball bearing	Mechanical seal	Casing wear ring (suction side)	Casing wear ring (discharge side)	Intermediate ring
			Part No.															
	102	161	210										230	321	433	502.01	502.02	509
Motor																		
		132M	160L 160M	180M 180L	200L	225S 225M	250M	280S 280M	315S 315M 315L	315								
150-500	○	1	■	■	■	3	4	5	6	7	■	○	1	1	1	1▲	1	
250-250	○	2	9	10	11	12	13	■	■	■	■	○	1	1	2	2	1	
250-260	○	3	■	1	2	3	4	5	■	■	■	○	1	1	1	2	-	
200-330	○	4	■	1	2	3	4	5	6	7	■	○	1	1	3●	3●	-	
200-400	○	5	■	1	2	3	4	5	6	7	8	○	1	1	4	4△	-	
200-500	○	1	■	■	■	■	4	5	6	7	8	○	1	1	5	1▲	-	

Sizes	Description																
	Volute casing	Casing cover	Shaft									Impeller	Deep-groove ball bearing	Mechanical seal	Casing wear ring (suction side)	Casing wear ring (discharge side)	Intermediate ring
			Part No.														
	102	161	210										230	321	433	502.01	502.02
		Motor															
		132M	160L 160M	180M 180L	200L	225S 225M	250M	280S 280M	315S 315M 315L	315							
250-300	○	4	■	10	11	12	13	14	15	■	■	○	1	1	6	3●	1
250-330	○	6	■	1	2	3	4	5	6	7	■	○	1	1	4	3●	-
250-400	○	7	■	■	■	3	4	5	6	7	8	○	1	1	7	1▲	-
250-500	○	8	■	■	■	■	■	5	6	7	8	○	1	1	8	1▲	-
350-340	○	9	■	■	11	12	13	14	15	16	■	○	1	1	9▲	4Δ	1
300-360	○	10	■	■	■	■	4	5	6	7	■	○	1	1	10Δ	1▲	-
300-400	○	10	■	■	■	■	■	5	6	7	8	○	1	1	11	1▲	-
300-500	○	7	■	■	■	■	■	■	■	7	8	○	1	1	11	1▲	-

Table 17: Key to the symbols

Symbol	Description
○	Components differ
■	This pump/motor combination is not possible
● Δ ▲	Additional marking for components that can be interchanged across columns

Table 18: Motor / Power

Motor	Power
132	.../754, .../406, .../556
160	.../1104, .../1504, .../756, .../1106
180	.../1854, .../2204, .../1506
200	.../3004, .../1856, .../2206
225	.../3704, .../4504, .../3006
250	.../5504, .../3706
280	.../7504, ...9004, .../4506, .../5506
315	.../11004, .../13204, .../16004, .../20004, .../25004, .../31504, .../7506, .../9006, .../11006, .../13206, .../16006, .../20006

8 Trouble-shooting

	WARNING
	<p>Improper remedial work on the pump (set) Risk of injury!</p> <p>▷ For any work performed in order to remedy faults on the pump (set) observe the relevant information given in this operating manual or the product literature provided by the accessories manufacturers.</p>

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

- A Pump delivers insufficient flow rate
- B Motor is overloaded
- C Motor protection switch / thermistor trip device trips the unit
- D Increased bearing temperature
- E Leakage at the pump
- F Excessive leakage at the shaft seal
- G Vibrations during pump operation
- H Impermissible rise of temperature inside the pump

Table 19: Trouble-shooting

A	B	C	D	E	F	G	H	Possible cause	Remedy ¹⁰⁾
X								Pump delivers against an excessively high pressure.	Re-adjust to duty point. Check system for impurities. Fit a larger impeller. ¹⁰⁾ Increase the speed (frequency inverter).
X						X	X	Pump and/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/NPSH _{available} (positive suction head) is too low.	Check/alter liquid level (open system). Increase system pressure (closed system). 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.	Clean barrier fluid duct or increase barrier fluid pressure. Fit new 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.	Adjust duty point accurately. In the case of persistent overloading, turn down impeller. ¹⁰⁾

10) 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	Possible cause	Remedy ¹⁰⁾
	X							Density or viscosity of fluid handled higher than stated in purchase order	¹¹⁾
					X			Use of unsuitable shaft seal materials	Change the material combination. ¹⁰⁾
	X	X						Speed is too high.	Reduce speed. ¹⁰⁾
				X				Tie bolts/sealing element defective	Fit new seal between volute casing and discharge cover. Re-tighten the bolts.
					X			Worn shaft seal	Fit new shaft seal.
X					X			Score marks or roughness on shaft sleeve	Fit new shaft sleeve. Fit new shaft seal.
					X			Dismantle to find out.	Correct. Fit new shaft seal, if required.
					X			Vibrations during pump operation	Correct suction conditions. Re-balance the impeller. Increase pressure at the pump suction nozzle.
			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	Clean balancing holes in the impeller. Fit new casing wear rings.
			X					Insufficient or excessive quantity of lubricant or unsuitable lubricant.	Top up, reduce or change lubricant.
X	X							Motor is running on two phases only.	Replace the defective fuse. Check the electric cable connections. Check the motor winding.
						X		Rotor out of balance	Clean the impeller. Re-balance the impeller.
						X		Defective bearing(s)	Fit new bearing(s).
			X			X	X	Flow rate is too low	Increase the minimum flow rate.
		X						Incorrect setting of motor protection switch	Check setting. Fit new motor protection switch.
	X	X						Transport lock has not been removed from the shaft groove.	Remove.

11) Please contact KSB.

9 Related Documents

9.1 General assembly drawing with list of components

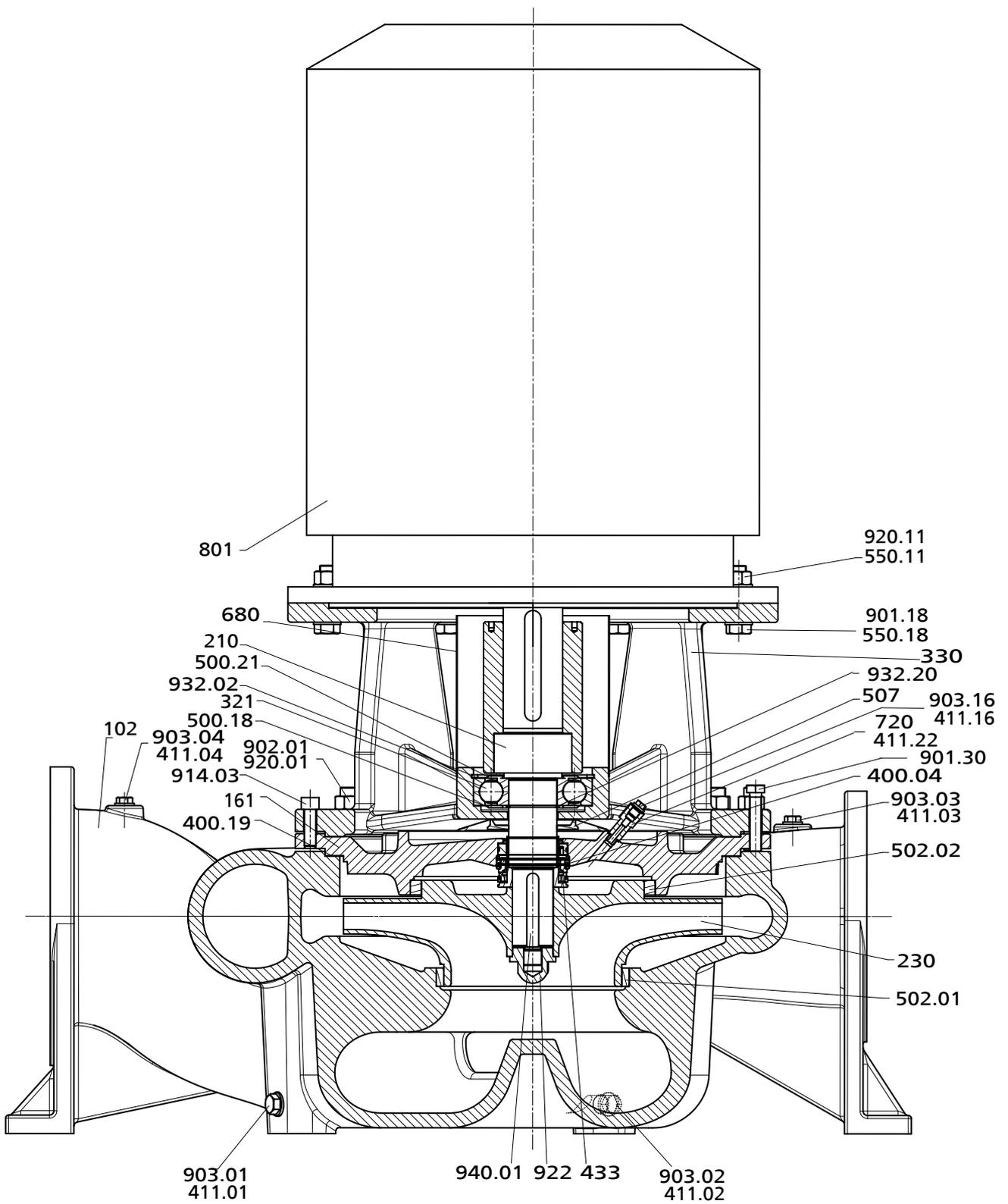


Fig. 13: General assembly drawing

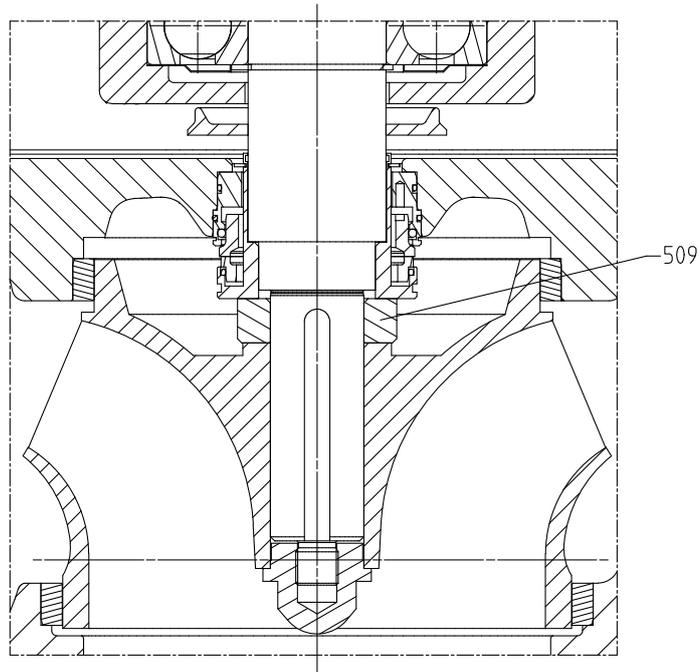


Fig. 14: Design with intermediate ring (for sizes 250-250, 250-300, 350-340 only)

Table 20: List of components

Part No.	Description	Part No.	Description
102	Volute casing	550.11/.18	Disc
161	Casing cover	680	Guard
210	Shaft	720	Fitting
230	Impeller	801	Flanged motor
321	Radial ball bearing	901.18/.30	Hexagon head bolt
330	Bearing bracket	902.01	Stud
400.04/.19	Gasket	903.01/.02/.03/.04/.16	Screw plug
411.01/.02/.03/.04/.16/.22	Joint ring	914.03	Hexagon socket head cap screw
433	Mechanical seal	920.01/.11	Nut
500.18/.21	Ring	922	Impeller nut
502.01/.02	Casing wear ring	932.02/.20	Circlip
507	Thrower	940.01	Key
509 ¹²⁾	Intermediate ring		

12) For sizes 250-250, 250-300, 250-340 only

10 EU Declaration of Conformity

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

The manufacturer herewith declares that **the product:**

Etaline-R

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

.....¹³⁾.....
Name
Function
Company
Address

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

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