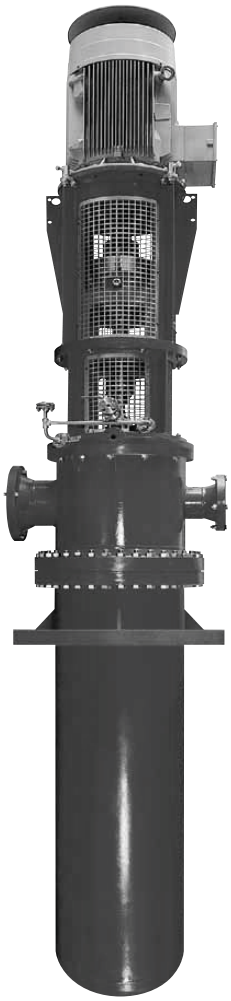
VS6 Series



Installation, Operation and Maintenance Manual

Model VS6, API 610 11th Edition, ISO 13709

ARYA SEPEHR KAYHAN

Table of Contents

1 General Information

1.1 Principles

This manual is supplied as an integral part of the type series and variants indicated on the front cover. This 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 ASK Service centre to maintain the right to claim under warranty.

1.2 Installation of partly completed machinery

To install partly completed machinery supplied by ASK, please refer to the subsections under Servicing/Maintenance.

1.3 Target group

This manual is aimed at the target group of trained and qualified specialist technical personnel.

2 Safety

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

2.1 Key to safety symbols / markings

Table 1: Definition of safety symbols/markings

Symbol	Description
	**Danger** This signal word indicates a high-risk hazard which, if not avoided, will result in death or serious injury.
	**WARNING** This signal word indicates a medium-risk hazard which, if not avoided, could result in death or serious injury.
	**CAUTION** This signal word indicates a hazard which, if not avoided, could result in damage to the machine and its functions.
	**Explosion protection** This symbol identifies information about avoiding explosions in potentially explosive atmospheres in accordance with EC Directive 94/9/EC (ATEX).
	**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 injury and damage to property.
The safety instructions in all sections of this manual must be complied with.
This manual must be read and completely understood by the responsible specialist personnel/operators prior to installation and commissioning.
The contents of this manual must be available to the specialist personnel at the site at all times.
Instructions 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 meeting all local regulations which are not taken into account in this manual.

2.3 Intended use

Only operate the pump (set) within the application limits specified in the other applicable documents.
▪ Only operate pump sets which are in perfect technical condition.
▪ Do not operate partially assembled pump sets.
▪ Only use the pump to handle the fluids described in the data sheet or product literature of the pump model.
▪ Never operate the system without the fluid to be handled.
▪ Observe the limits for continuous operation specified in the data sheet or product literature (Qmin and Qmax) (prevention of damage such as shaft fracture, bearing failure, damaged mechanical seal, etc).
▪ When handling untreated waste water the duty points in continuous operation lie within 0.7 to 1.2 x Qopt to minimize the risk of clogging/hardening.
▪ Avoid duty points for continuous operation at very low speeds and small flow rates (<0.7 x Qopt).
▪ Observe the information on the maximum flow rates provided in the data sheet or technical product literature (prevention of overheating damage, cavitation damage, bearing damage, etc).
▪ Do not throttle the flow rate on the suction side of the system (prevention of cavitation damage).
▪ For any operating modes which are not specified in the data sheet or product literature, contact the manufacturer.

Prevention of foreseeable misuse

▪ Observe the minimum flow velocities for fully open swing check valves to prevent the reduction of pressure and risk of clogging.
(Contact the manufacturer for the required minimum flow velocities/loss coefficients.)
▪ Never exceed the permissible application limits specified in the data sheet and in the product literature regarding pressure, temperature, etc.
▪ Observe all safety notes and instructions in this manual.

2.4 Personnel qualification and training

All personnel involved must be fully qualified to install, operate, maintain and inspect the machinery this manual refers to. The responsibilities, competence and supervision of all personnel involved in installation, operation, maintenance and inspection must be clearly defined by the operator.
Deficits in knowledge must be rectified by sufficiently trained specialist personnel training and instructing the personnel who will carry out the respective tasks.

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 these operating instructions

▪ 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

2.6 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 instructions for the operator / user

▪ The operator shall fit contact guards for hot, cold and moving parts, and check that the guards function properly.
▪ Never remove the contact guard when the pump is in 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.)

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 authorized by the manufacturer. The use of other parts can invalidate any liability of the manufacturer for consequential damage.
▪ The operator ensures that all maintenance, inspection and installation work is performed by authorized, qualified specialist personnel who are thoroughly familiar with the manual.
▪ Carry out work on the pump (set) during standstill only.
▪ 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.
▪ Decontaminate pumps which handle fluids posing a health hazard.
▪ As soon as the work is complete, re-install and/or re-activate any safety-relevant and protective devices. Before returning the product to service, observe all instructions on commissioning.

2.9 Unauthorized 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.

2.10 Explosion protection

Always observe the information on explosion protection given in this section when operating an explosion-proof pump set.
Sections of the manual marked by the Ex symbol apply to explosion-proof pump sets also when temporarily operated outside potentially explosive atmospheres.

Only pumps/pump sets marked as explosion-proof and identified as such in the datasheet must be used in potentially explosive atmospheres.
Special conditions apply to the operation of explosion-proof pump sets in accordance with EC Directive 94/9/EC (ATEX).
When operating explosion-proof pump sets, especially adhere to the additional requirements marked by the Ex symbol.
The explosion-proof status of the pump set is only assured if the pump set is used in accordance with its intended use. Never operate the pump (set) outside the limits stated in the data sheet and on the nameplate.
Prevent impermissible modes of operation at all times.

2.10.1 Repair

Special regulations apply to repair work on explosion-proof pumps. Modifications or alteration of the pump set may affect explosion protection and are only permitted after consultation with the manufacturer.
Repair work at the flameproof joints must only be performed in accordance with the manufacturer's instructions. Repair to the values in tables 1 and 2 of EN 60079-1 is not permitted.

3 Transport / Temporary Storage / Long-Term Storage / Disposal

3.1 Consignment receipt and unpacking

Immediately upon receipt, check that the number of boxes and pieces received is the same as shown on the freight bills. Each product has a unique serial number. Check that this number corresponds with that advised and always quote this number in correspondence as well as when ordering spare parts or further accessories. Check for shipping damage. Note any shortages or damages on the carrier’s copy of the freight bill prior to signing. Report these damages or shortages to the factory or your local factory representative immediately.

Boxes, crates, pallets or cartons may be unloaded using fork lift vehicles or slings dependent on their size and construction. If facilities are not available for lifting the materials off the carrier’s vehicle, use skids for unloading rather than allowing the parts to drop to the ground. Even though a pump is made up of heavy steel parts, it is a piece of machinery and it is essential that its parts be handled with care. It is extremely easy to damage shafting, threaded parts, and mating surfaces of parts which must fit together. Even a minor bend in one piece of shafting can cause a pump to vibrate excessively; thus shortening the life of the pump drastically.

Also check that the parts received are all of the parts required for the installation. Report any shortages or errors to the factory or your local factory representative immediately.

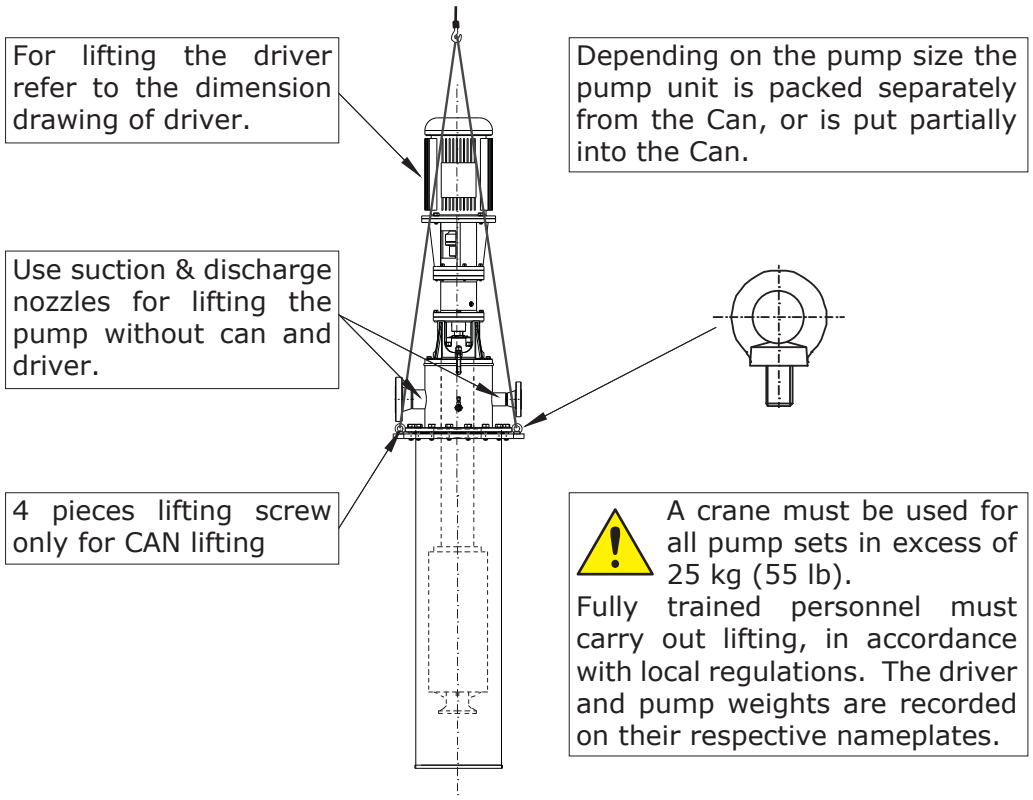
Follow the Manufacturer’s instructions for handling and storing the driver and any other special equipment.

3.2 Transport

The pump (set) could slip out of the suspension arrangement Danger to life from falling parts!
- Always transport the pump (set) in horizontal position.
- Never attach the suspension arrangement to the free shaft end or the motor eyebolt.
- Refer to the weights given in the general arrangement drawing.

- Observe the local accident prevention regulations.
- Use suitable permitted lifting tackle, e.g. self-tightening lifting tongs.

Incorrect transport of the pump Damage to the shaft seal!
For transport, lock the pump shaft with a suitable transport lock to prevent any movement of the shaft.
To transport the pump/pump set suspend it from the lifting tackle as shown below:



Note:

In some cases the pumps are not complete assembled. If Can and supporting flange are delivered separately, lifting shall be performed as follows:

Suction barrel (also referred as 'Can') is supplied together with supporting flange and has to be installed into the sump first. Suction barrel and supporting flange are delivered assembled together. Install 4 lifting screws (also referred as 'Eye Bolts') on the supporting flange and attach slings and straps to bring the suction barrel to a vertical position. Move the barrel for installation. Provide hand support to prevent the suction barrel from swaying during movement.

3.3 Storage and preservation

3.3.1 Temporary Storage

Normal packaging is designed to protect the pump during shipment and for dry, indoor storage. To avoid any damage during the storage period, the influence of any low or high frequency vibration must be totally inhibited. If the pump is delivered sealed in a plastic-wrapper, it is of max. importance to avoid any damage of that wrapper, because this will protect the pump against humidity. Therefore it must be checked if this wrapper has become cracked and if so, the wrapper must be renewed.

If a vertical pump will be stored in horizontal position, be sure to support the pump sufficiently to avoid any deformation or bending of the pump.
To avoid the presence of dust and humidity on the driver, it shall also be wrapped in the same way.

3.3.2 Long term storage

If a situation arises for a long-term storage, (more than 6 months) please contact ASK for special storage instructions and warranty related information.

3.4 Return to supplier

1. Drain the pump as per operating instructions.
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 fluids handled by the pump leave residues which might lead to corrosion damage when coming into contact with atmospheric humidity, or which might Ignite when coming into contact with oxygen, the pump set must also be neutralized, and anhydrous inert gas must be blown through the pump for drying purposes.
4. Always complete and enclose a certificate of decontamination when returning the pump set. It is imperative to indicate any safety and decontamination measures taken.

3.5 Disposal

Fluids posing a health hazard!
Hazardous to persons and the environment!
- Collect and properly dispose of flushing liquid 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

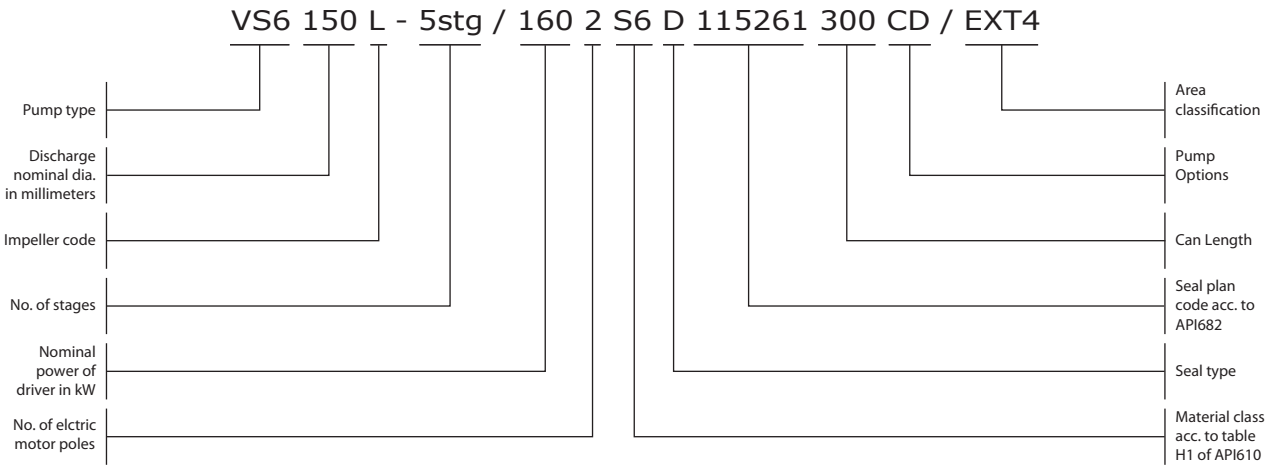
Vertical Barrel Pumps are single suction, multi stages, radially split, diffuser, vertical can pumps, primarily designed for plants handling liquids with low suction heads.

This pumps are according to API 610 type VS6. The wide range of available according to special condition. The inline design allows single pipe connection and requires minimal space. Altogether, this makes the VS6 the pump of choice for the most critical applications where space considerations or marginal NPSHA values preclude the use of a horizontal multistage pump.

Liquid is flowing through the suction flange of the headstock and through the Can to the impellers. The last stage impeller is discharging the liquid via the column pipes, to the discharge flange. The thrust is balanced by back wearing rings and balancing holes.

The headstock is equipped with a drain connection, which allows to flush the Can with Nitrogen before disassembly. A vent connection for the suction is standard.

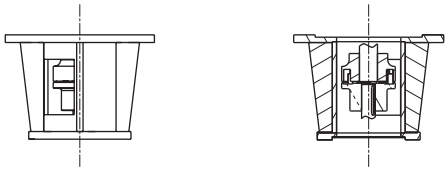
4.2 Designation



4.3 Main Parts

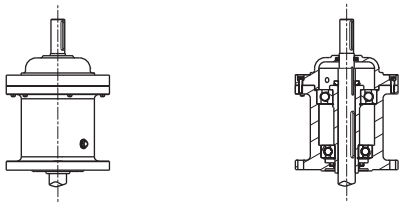
4.3.1 Motor support

The motor support connects the motor to the bearing housing, also it acts as coupling guard.



4.3.2 Bearing housing

The bearing housing supports the thrust bearings.

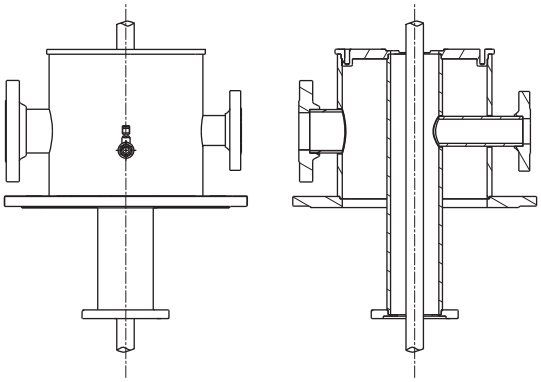


4.3.3 Bearing housing support

This part supports the bearing housing on top of pump head and connects them together, also it contains shaft sealing.

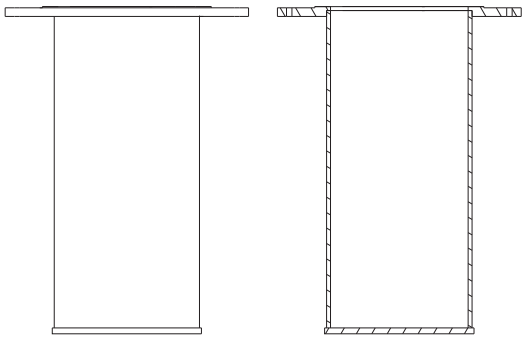
4.3.4 Pump head

Pump head has inline suction and discharge nozzle, including all the necessary vent and drain connections. It is a major part of the pump unit, which supports the column pipes with the hydraulics as well as the motor support and driver.



4.3.4 Suction can

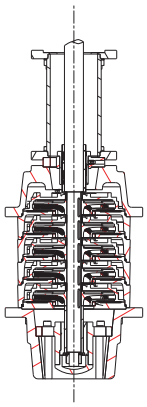
The Can is subjected to suction pressure and guides the fluid to the first stage impeller.



4.3.5 Hydraulics parts

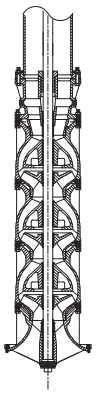
4.3.5.1 Radial flow hydraulics

This are ring section type hydraulics. Suction, stage and discharge casing are hold together by strong tie bolts, which allows a very compact and short design.
The radial impellers are hydraulically balanced by back wear rings and balancing holes. The diffusers are designed with 7 to 11 vanes to minimize the radial forces at part load operation. All impellers are slipped on the shaft and axially fixed by the impeller nut. The shaft is supported in the suction casing, in every diffuser and in the discharge casing.



4.3.5.2 Mixed flow hydraulics

The hydraulics consists of flanged bowls and a suction casing. The impellers are hydraulically balanced by back wear rings and balancing holes.
The diffusers are designed with 7 to 11 vanes to minimize the radial forces at part load operation. All impellers are slipped on the shaft and axially fixed by the impeller nut. The shaft is supported in the suction casing and in each bowl.



4.4 Performance and operating limits

In the interest of operator safety the unit must not be operated above the nameplate conditions. Such operation could result in unit failure causing injury to operating personnel. Consult instruction book for correct operation and maintenance of the pump and its supporting components.

5 Installation at Site

5.1 Safety regulations

Installing electric equipment (motors) in potentially explosive atmospheres
Risk of explosion!
- Comply with the applicable local explosion protection regulations.

- Verify the test certificate of the motor.
- Keep the test certificate close to the location of operation (e.g. in the foreman's office).

5.2 Location

When equipment has been in storage for greater than 6 months, a complete inspection should be conducted in accordance with section 3.3.2. The pump should be located to allow room for access, ventilation, maintenance and inspection with ample headroom for lifting and should be as close as practicable to the supply of liquid to be pumped.
Refer to the general arrangement drawing for the pump dimensions and details.

5.2.1 Inspection prior to installation

Six months prior to the scheduled installation date, a ASK representative is to be employed to conduct an inspection of the equipment and the facility. If any deterioration of equipment is noticed, the ASK representative may require a partial or complete dismantling of the equipment including restoration and replacement of some components.

5.2.1 Part Assemblies

With exception of the Can the pumps are delivered completely mounted and adjusted; also the shaft seal is in the correct position. So no further axial alignment of the rotor is necessary. If drivers and/or seal systems are delivered separately, refer to corresponding sectional drawing.
Axial alignment and rotor setting axial adjustment need to be distinguished. For correct axial adjustment of the rotor refer to section 5.4 and consult ASK.

5.2.2 General installation check-list

The following checks should be made before starting actual installation.

a) Make sure that motor nameplate ratings and the power supply system match correctly.
b) Check the sump depth and pump length matchup.
c) Check the installation equipment to be sure that it will safely handle the pump weight and size.
d) Check all pump connections (bolts, nuts etc.) for any shipping and handling related problems.

Always support shafting in at least three places when lifting or installing. No installation should be attempted without adequate equipment necessary for a successful installation.

Always check motor rotation before connecting driver to pump. Reserve rotation due to improper motor direction can cause extensive damage to the pump.

5.3 Foundation

The foundation shall be located on a place that allows a minimum of pipe work and that is easily accessible for inspection during operation. According to the environment the foundation may consist of concrete or of steel. It must be rigid and heavy enough to absorb normal vibrations and shocks. The flange of the Can must be supported on the whole surface. It should be at least 20–30 mm (0.8 – 1.2 in) higher than the surrounding to avoid the deposit of dust and humidity.

5.3.1 Vertical alignment

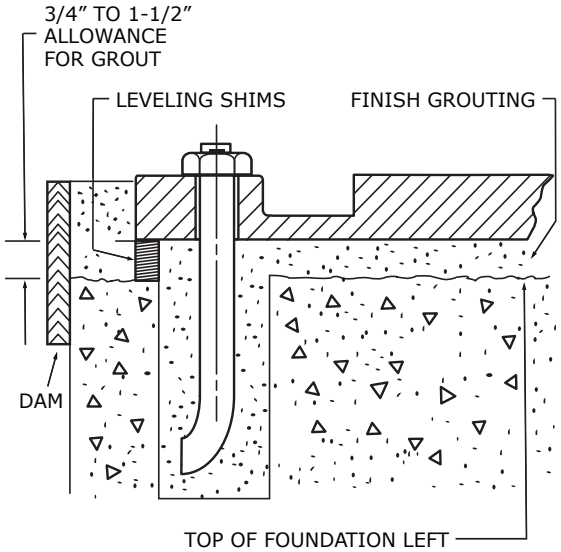
Vertical alignment is done with leveling screws. Use a spirit level for correct horizontal alignment of the baseplate.
The max. vertical misalignment is 0.5 mm/m pump length.

5.3.2 Steel foundation

When the pump unit is mounted directly on structural steel frame, it shall be well supported by structural beams. It is recommended to check the natural frequency of the steel frame, because it shall not coincide with the pump speed. The flange of the Can has to be fixed on a flat surface with studs or hex screws, the exact horizontal alignment is very important!

5.3.3 Concrete foundation

A concrete foundation must have an exact horizontal alignment and must be placed on solid ground. First a basic foundation shall be built with square shaped holes for embedding the foundation bolts. After putting the Can in the foundation the proper alignment can be obtained by adjusting it with shims under the flange. Now insert the foundation bolts and grout the space between the basic foundation and the Can with grouting cement (refer to illustration) It is very helpful to use a properly made and stable wooden frame around the Can. So the grouting cement will not flow a side. When the grouting is totally set and hardened the foundation bolts shall be tightened in a firm and symmetrical way.

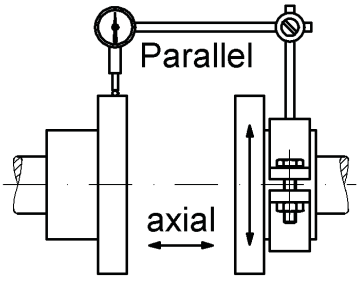


5.3.4 Final assembly for not complete assembled pumps

Pumps exceeding a total length of approximately 6 m (19.7 ft) are delivered in various components and must be assembled on site. The main parts are: hydraulic bowls section - various line shafts and column pipes - Pump head and bush bearings.
To install the pump in the Can, refer to the corresponding assembling drawing where the different lengths of column pipes and the position of the various column pipes are indicated and contact with our head office for more instructions.

5.4 Initial alignment

The adjustment of motor and pump must be checked (if necessary, make a new adjustment) before first start up of the unit. The motor flange is equipped with adjustment-screws on the motor support.
Ensure pump and driver are isolated electrically and the half couplings are disconnected. Align the motor to the pump, not the pump to the motor. Alignment of the motor is achieved by using the adjustment screws.



5.4.1 Permissible misalignment limits at working temperature

When checking parallel alignment, the total indicator read-out (TIR) shown is twice the value of the actual shaft displacement.

The pump is only pre-aligned! Carefully check and readjust alignment before start of the unit. Take out the spacer of the coupling and check the alignment of shafts end of pump and driver. The maximum parallel offset should not exceed 0.05 mm (0.002 in.) and the axially offset can be ± 2.5 mm (0.10 in.). The coupling spacer gap length shall be ± 0.25 mm (0.01 in.).

For more details refer to the manufacturer's procedure of alignment.

5.5 Piping

Protective covers are fitted to the pipe connections to prevent foreign particles or objects entering the pump during transportation and installation. Ensure that these covers are removed from the pump before connecting pipes.

5.5.1 Pipe work velocities

In order to minimize friction losses and hydraulic noise in the pipe work it is good practice to choose pipe work that is one or two sizes larger than the pump suction and discharge. Typically, main pipe velocities should not exceed 2 m/s (6 ft/sec) on the suction and 3 m/s (9 ft/sec) on discharge.

Take into account the available NPSH that must be higher than the required NPSH of the pump.

Never use the pump as a support for piping.

5.5.2 Maximum forces and moments allowed on pump flanges

(see corresponding general arrangement drawing)

Maximum forces and moments allowed on the pump flanges vary with the pump size and type. To minimize these forces and moments that may, if excessive, cause misalignment, hot bearings, worn couplings, vibration and possible failure of the pump
casing. The following points should be strictly followed.

a) Prevent excessive external pipe load.

b) Never draw piping into place by applying force to pump flange connections.

c) Do not mount expansion joints so that their force, due to internal pressure, acts on the pump flange.

Ensure piping and fittings are flushed before use.

Ensure that the piping arrangement has been provided to flush the pump before removal in cases of hazardous liquid pumps.

5.5.3 Auxiliary piping

5.5.3.1 Vent

The extent of venting requirements depends on the application and installation requirements.The following instructions may be used as a guide in so far as they apply to the pump as delivered. For type, position and dimensions of the vent connections please see GA drawing.

5.5.3.2 Drain

Normal pump leaks and gland leakage to be drained through a separate piping arrangement or back into the suction.

5.5.3.3 Pumps fitted with gland packing

The pumped liquid is allowed to flow through the gland packing at discharge pressure and drained out of the pump or re-circulated back into the suction. A separate flush supply may be required in some cases. The piping plans and flush supply are to be selected based on the application and operating parameters. In some special cases where the discharge pressure exceeds 6.5 bar (100 psi) a special flushing plan is recommended.

5.5.3.4 Pumps fitted with mechanical seals

Auxiliary piping to circulate the flushing liquid back into the suction is required. In case of external clean source requirements for pump applications such as high temperature service, contaminated fluids, oxidizing fluids, a special piping plan to carry the clean liquid into the seal chamber with adequate pressure is required and several piping plans are available to suit the specific pump application.

5.5.4 Final check

After connecting the piping to the pump, rotate the shaft several times by hand to ensure no pipe strain.
If pipe strain exists, correct piping.

5.6 Electrical connections

Electrical connections must be made by a qualified Electrician in accordance with relevant local national and international regulations.

It is important to be aware of the EUROPEAN DIRECTIVE on potentially explosive areas where compliance with IEC60079-14 is an additional requirement for making electrical connections.

It is important to be aware of the EUROPEAN DIRECTIVE on electromagnetic compatibility when wiring up and installing equipment on site. Attention must be paid to ensure that the techniques used during wiring/installation do not increase electromagnetic emissions or decrease the electromagnetic immunity of the equipment, wiring or any connected devices. If in any doubt contact ASK for advice.

The motor must be wired up in accordance with the motor manufacturer's instructions (normally supplied within the terminal box) including any temperature, earth leakage, current and other protective devices as appropriate. The identification nameplate should be checked to ensure the power supply is appropriate.

A device to provide emergency stopping must be fitted.
If not supplied pre-wired to the pump unit, the controller/starter electrical details will also be supplied within the controller/starter.

See section 6.3, Direction of rotation before connecting the motor to the electrical supply.

5.7 Final shaft alignment check

After connecting piping to the pump, rotate the shaft several times by hand to ensure there is no binding and all parts are free. Recheck the coupling alignment, as previously described, to ensure no pipe strain. If pipe strain exists, correct piping.

5.8 Protection Systems

The following protection systems are recommended particularly if the pump is installed in a potentially explosive area or is handling a hazardous liquid. If in doubt, consult ASK.

If there is any possibility of the system allowing the pump to run against a closed valve or below minimum continuous safe flow a protection device should be installed to ensure the temperature of the liquid does not rise to an unsafe level.

If there are any circumstances in which the system can allow the pump to run dry, or start up empty, a power monitor should be fitted to stop the pump or prevent it from being started. This is particularly relevant if the pump is handling a flammable liquid.

If leakage of product from the pump or its associated sealing system can cause a hazard it is recommended that an appropriate leakage detection system is installed.

To prevent excessive surface temperatures at the bearings, it is recommended that temperature and/or vibration monitoring is done on a regular basis.

6 Commissioning, Startup, Operation and Shutdown

These operations must be carried out by fully qualified personnel. Turn off power supply for safety while pump commissioning is in progress.

6.1 Pre-commissioning Procedure

The gland flush supply to be in place. Flush piping to be checked for leaks. Mechanical seals to be checked for leaks, flush flow and pressure.

a) The bearing housing must be filled with the indicated oil. Check also the oil level.

b) Check all vent connections for complete filling of the pump. The venting procedure can take from 10 minutes up to 2 hours, depending on the kind of fluid.

c) Check the direction of rotation of the pump (Coupling spacer dismantled). Should be counter clockwise when viewed from the driver end.

d) The pump rotor and the shaft seal must be in correct axial position.

e) Check the readiness of all auxiliary systems (seal sys., lubrication system etc.,) for start-up.

f) All pipe work, including the internal and the auxiliary pipe work, must be connected correctly and must be absolutely tight. Check the tightness of all connections of the auxiliary pipe work. The suction valve must be open, the discharge valve shall be closed or partially open as required.

g) Turn the pump by hand, if required with the help of a lever, to check the free rotation of the rotor. The rotor must turn uniformly and noiselessly. Some resistance may be felt due to the friction in the bearings and seals.

h) Check the readiness of the driver for startup. Refer to the manual for the driver to be sure that all precautions are in place to energize the motor.

6.2 Pump lubricants

6.2.1 Lubrication

The bearing housing shall be filled with proper lubricating oil prior to start up. If the pump will be started after a longer storage period, the bearing housing should be first flushed and cleaned with gasoline. It is not necessary to remove the preservation oil as this will mix up thoroughly with the lubrication oil. Lubrication is provided by the pumping effect of the rotating ball bearings. Maintaining the correct oil level (middle of the oil sight glass) ensures that the lower ball bearing is covered with oil.

6.2.2 Oil change

After first start up, the oil shall be changed after 200 service hours.
Every further oil change shall take place after about 2000 service hours or at least every 6 month.

6.2.3 Oil level

The correct oil level is in the middle of the oil sight glass and shall be checked when pump is not in operation.
Periodically check if the lubricating oil is mixed with any condensed water. Careful opening of the oil drain during a stop of the pump will show any water.

Note:
During operation the level will decrease due to circulation of the oil through the bearings.

A too high oil level will result in higher bearing temperatures and therefore poorer lubrication.

6.2.4 Oil quality

Oil used for lubrication should only be of high quality. The viscosity of the oil at working temperature must be at least 10 cSt. The pouring point of the oil must be in accordance with the lowest expected temperature of the bearing housing during a stop of the pump. For recommended lubricating oils refer to the lubrication table.

Having selected the corresponding oil quality the actual oil temperature at the bearing housing must be checked after two service hours of the pump.

Considering this measured oil temperature the actual viscosity must be determined by using the data sheet of the oil, to verify the minimum required viscosity of 10 cSt. Do not forget, the oil temperature in the bearing itself is about 10 °C (Δ 18 °F) higher than the oil temperature at the bearing housing. On the following table the oil viscosity is given at 40°C (104°F). Determining the correct lubricating oil one must take into consideration that all bearings will have higher temperatures during the first 20 service hours.

In constant operation the bearing temperature will decrease about 10 °C (50 °F). The oil temperature shall be lower than 85 °C (185 °F) after this running time. The bearing outer race temperature should not exceed 95°C (203°F). If the temperature is higher, the reason may be a wrong oil quality, wrong oil level or overload of the pump because of excessive wear.

If the humidity at the site is high, the bearings become easily rusty during stand still periods. To avoid that, we recommend to mix the lubricating oil with a corrosion inhibitor contact your lubrication oil supplier for proper additives inhibitors.

6.2.5 Lubrication Table

Centrifugal Pump Lubrication					
	Oil	**Oil Bath and Purge Oil Mist Lubrication**			**Pure Oil Mist Lubrication**
	Lubrication service	Ball bearing			
	Type	Mineral Oil (Petroleum Based)			Mineral Oil (Petroleum Based)
	Ambient temperature °C (°F)	-20 to 35 (-4 to 95)		35 to 60 (95 to 140)	-5 to 60 (23 to 140)
	Oil temperature range °C (°F)	-5 to 65 (23 to 149)	up to 85 (up to 185)	up to 100 (up to 212)	15 and above (59 and above)
	Viscosity mm²/s 40°C [cSt]	32	46	68	100
	First Oil Change	200 hours	200 hours	200 hours	200 hours
	Further Oil Changes	2000 hours or at least every 6 months	2000 hours or at least every 6 months	2000 hours or at least every 6 months	2000 hours or at least every 6 months
	Designation according to DIN51502 ISO VG	32	46	68	100

6.3 Direction of rotation

The sense of rotation of the pump is counter clockwise (CCW); looking from the coupling to the shaft end of the pump.

The rotation of the driver shall be checked!

6.4 Priming and auxiliary supplies

The pump must be completely primed prior to start up by using the vent connections as shown in the general arrangement drawing.

The venting procedure depends on the kind of fluid. To verify if the pump is filled with liquid check:

a) For non hazardous liquids close the vent valve after 5 minutes and reopen it slowly to proof if liquid escapes.

b) For hazardous liquids (Chemicals, non flashing hydrocarbons) vent lines are usually piped back to the suction tank or to the flare. Keep vent lines open at least for 10 minutes and check suction pressure und suction temperature against the specification.

c) For flashing hydrocarbons vent lines are usually piped back to the suction tank or to the flare. Keep vent lines open at least for 30 minutes before starting the pump and check suction pressure und suction temperature against the specification. For flashing hydrocarbons, the vent line shall remain continuously open during operation in order to prevent build up of vapour bubble or gas in the inlet area of the pump. Otherwise we recommend to start the pump with vent lines slightly open. If a constant bypass line with a 3 mm (0.12 in.) orifice is installed, it must be open at any time.

d) Auxiliary systems, e.g. barrier /buffer fluid systems, cooling circuits, shall be filled according to the user instructions.

6.5 Starting the pump

a) Start the driver according to the specification. (Refer to driver IOM)

Note:
Pumps are usually started against closed discharge valve

b) Check the discharge and suction pressure gauge to verify the pumps delivered head. Open the discharge valve slowly, until the pump reaches the specified operation point. The pump must operate smoothly, and the vibration must be below 5 mm/s (0.2 in./sec) (API 610 vibration limits).

The discharge valve must be opened within 30 sec. after start up. Longer operation against closed discharge valve will damage the pump. If a minimum flow valve is installed, take pressure gauge readings to verify the correct operation.

Note:
If the backpressure of the discharge pipe is sufficient, pumps can be started against open valve.

Ensure that your driver is capable deliver the higher torque required by starting against open valve.

To prevent the pump from reverse rotation after shut down, the installation of a check valve is recommended. Although the pump is not affected by reverse rotation because of special coupling design, it can be an issue with the driver.

Check the discharge and suction pressure gauge to verify the pumps delivered head. The pump must operate smoothly, and the vibration must be below 5 mm/s (0.2 in./sec) (API 610 vibration limits). If a minimum flow valve is installed, take pressure gauge readings to verify the correct operation.

c) Check the pipe system against any leakage.

d) Check the mechanical seal against any leakage.

Note:
Right after start up a minor leakage of the mechanical seal is quite normal. Normally this leakage disappears after few minutes of operation.

6.6 Operation

a) Verify that the pump is operating within the specified limits, min/max flow, pressure, temperature, vibration, power

b) The bearing housing temperature shall not exceed 80 °C (176 °F). If higher bearing temperature are observed, check the viscosity grade of the used lubrication oil.

Note:
If the pump is equipped with hydrodynamic thrust bearing refer to bearing manufacturer's IOM and to recommendation for maximum bearing temperature.

The minimum viscosity is 10 cSt at the expected oil temperature. (Oil temperature = bearing gland temperature + 10 °C (50 °F))

c) From time to time check the pump shaft seal. Leakage of 5ml/hour is also with a mechanical shaft seal unavoidable.

d) Check the correct venting of the Can and the headstock by opening the valve in the vent line for short time. When the condition of service is near the boiling point, a permanent vent line with a 3 mm (0.12 in.) orifice (to inhibit the exit of too much liquid) must be installed back to the suction tank. This will ensure that any suction and NPSH problems can be avoided during normal service.

e) Observe the power consumption of the pump to detect excessive wear.

6.7 Stopping and Shutdown

a) Close the outlet valve, but ensure that the pump runs in this condition for no more than a few seconds.

b) Stop the pump.

c) Switch off flushing and/or cooling/ heating liquid supplies at a time appropriate to the process.

d) For prolonged shutdowns and especially when ambient temperatures are likely to drop below freezing point, the pump and any cooling and flushing arrangements must be drained or otherwise protected.

Note:
For automatic start/stop operation of the pump, ensure that all steps described in section 6.4, 6.5 and 6.6 are implemented in the control logic.

6.8 Hydraulic, mechanical and electrical duty

This product has been supplied to meet the performance specifications of your purchase order, however it is understood that during the life of the product these may change. The following notes will help the user to decide how to evaluate the implications of any change. If in doubt contact ASK.

6.8.1 Specific gravity (SG)

Pump capacity and total head in meters (feet) do not change with SG, however pressure displayed on a pressure gauge is directly proportional to SG. Power absorbed is also directly proportional to SG. It is therefore important to check that any change in SG will not overload the pump driver or overpressurize the pump.

6.8.2 Viscosity

For a given flow rate the total head reduces with increased viscosity and increases with reduced viscosity. Also for a given flow rate the power absorbed increases with increased viscosity, and reduces with reduced viscosity. It is important that checks are made with ASK if changes in viscosity are planned.

6.8.3 Pump speed

Changing pump speed effects flow, total head, power absorbed, NPSHR, noise and vibration. Flow varies in direct proportion to pump speed. Head varies as speed ratio squared. Power varies as speed ratio cubed. If increasing speed it is important therefore to ensure the maximum pump working pressure is not exceeded, the driver is not overloaded, NPSHA>NPSHR, and that noise and vibration are within local requirements and regulations.

6.8.4 Net positive suction head (NPSHA)

NPSH available (NPSHA.) is a measure of the energy available in the pumped liquid, above its vapour pressure, at the pump suction branch. NPSH required (NPSHR.) is a measure of the energy required in the pumped liquid, above its vapour pressure, to prevent the pump from cavitating. It is important that NPSHA >NPSHR. The margin between NPSHA >NPSHR should be as large as possible. If any change in NPSHA is proposed, ensure these margins are not significantly eroded.

Refer to the pump performance curve to determine exact requirements particularly if flow has changed. If in doubt please consult ASK for advise and details of the minimum allowable margin for your application.

6.8.5 Pumped flow

Flow must not fall outside the minimum and maximum continuous safe flow shown on the pump performance curve and/or data sheet.

7 Maintenance

7.1 General

It is the plant operator's responsibility to ensure that all maintenance, inspection and assembly work is carried out by authorized and qualified personnel who have adequately familiarized themselves with the subject matter by studying this manual in detail.

Any work on the machine must be performed when it is at a standstill. It is imperative that the procedure for shutting down the machine is followed, as described in section 6.8.

On completion of work all guards and safety devices must be re-installed and made operative again.

Before restarting the machine, the relevant instructions listed in section 6, Commissioning, start up, operation and shut down must be observed.

Oil and grease leaks may make the ground slippery. Machine maintenance must always begin and finish by cleaning the ground and the exterior of the machine.

If platforms, stairs and guard rails are required for maintenance, they must be placed for easy access to areas where maintenance and inspection are to be carried out. The positioning of these accessories must not limit access or hinder the lifting of the part to be serviced.

When air or compressed inert gas is used in the maintenance process, the operator and anyone in the vicinity must be careful and have the appropriate
protection.

Do not spray air or compressed inert gas on skin.

Do not direct an air or gas jet towards other people.
Never use air or compressed inert gas to clean clothes.

Before working on the pump, take measures to prevent an uncontrolled start. Put a warning board on the starting device with the words:
"Machine under repair: do not start".

With electric drive equipment, lock the main switch open and withdraw any fuses. Put a warning board on the fuse box or main switch with the words:
"Machine under repair: do not connect".

Never clean equipment with inflammable solvents or carbon tetrachloride. Protect yourself against toxic fumes when using cleaning agents.

7.2 Maintenance schedule

It is recommended that a maintenance plan and schedule is adopted, in line with these User Instructions, to include the following:

a) Any auxiliary systems installed must be monitored, if necessary, to ensure they function correctly.

b) Gland packings must be adjusted correctly to give visible leakage and concentric alignment of the gland follower to prevent excessive temperature of the packing or follower.

c) Check for any leaks from gaskets and seals. The correct functioning of the shaft seal must be checked regularly.

d) Check bearing lubricant level, and if the hours run show a lubricant change is required.

e) Check that the duty condition is in the safe operating range for the pump.

f) Check vibration, noise level and surface temperature at the bearings to confirm satisfactory operation.

g) Check dirt and dust is removed from areas around close clearances, bearing housings and motors.

h) Check coupling alignment and re-align if necessary.

If any problems are found the following sequence of actions should take place:

a) Refer to section 9, Faults; causes and remedies, for fault diagnosis.

b) Ensure equipment complies with the recommendations in this manual.

c) Contact ASK if the problem persists.

7.2.1 Routine Inspection (daily/weekly)

The following checks should be made and the appropriate action taken to remedy any deviations.

a) Check operating behavior; ensure noise, vibration and bearing temperatures are normal.

b) Check that there are no abnormal fluid or lubricant leaks (static and dynamic seals) and that any sealant systems (if fitted) are full and operating normally.

c) Check that shaft seal leaks are within acceptable limits.

d) Check the level and condition of lubrication oil. On grease lubricated pumps, check running hours since last recharge of grease or complete grease change.

e) Check any auxiliary supplies eg. heating/cooling (if fitted) are operating correctly.

f) Refer to the manuals of any associated equipment if routine checks needed.

7.2.2 Periodic Inspection (every 6 Month)

a) Check foundation bolts for security of attachment and corrosion.

b) Check pump operation hours to determine if bearing lubricant shall be changed.

c) The coupling should be checked for correct alignment and worn driving elements.

7.3 Spare parts

7.3.1 Ordering of spares

When ordering spare parts we need the following information:

1. pump type and pump size
2. serial number of the pump
3. number of the required spare parts
4. reference number and name of the part as listed in the part list or in the sectional drawing.

The serial number of each pump is indicated on the name plate. If the material should be changed from the original delivered one, additionally indicate the exact material specification. If ordered impellers shall have smaller or larger outer diameter, indicate also with your order. Without a special remark the spare impellers will be delivered with the diameter of the original impellers.

If you need the wear rings oversized or undersized, please indicate, otherwise the wear rings will be delivered with standard size.

To ensure continuous satisfactory operation, replacement parts to the original design specification should be obtained from ASK.

7.3.2 Storage of spares

Spares should be stored in a clean dry area away from vibration. Inspection and retreatment of metallic surfaces (if necessary) with preservative is recommended at a 6 monthly interval.

7.4 Recommended spare parts

	Spares Recommended						
Part	Start up			Normal Maintenance			
No.of identical pumps	1 - 3	4 - 6	7+	1 - 3	4 - 6	7 - 9	10+
Element (if unspared) (*)				1	1	1	1
Rotor				1	1	1	1
Can							1
Pump Head							1
Motor support							1
Shaft (with key)				1	1	2	1
Impeller				1	1	2	3
Wear rings (set)	1	1	1	1	1	2	3
Bearings complete (antifriction,radial)	1	2	3	1	2	3	3
Bearings complete (antifriction,thrust)	1	2	3	1	2	3	3
Bush bearing (hydrodynamic,thrust) (set)	1	1	1	1	1	1	5
Mechanical seal complete (Cartridge)	1	2	3	1	2	3	3
Shaft sleeve	1	2	3	1	2	3	3
Gaskets, O-rings (set)	1	2	3	1	2	3	3
Bearing bushings and sleeves (set)	1	1	2	1	1	3	3
Stage bushings and sleeves (set)	1	1	2	1	1	3	3

(*) Vital service pumps are generally unspared, partially spared or multistage. When a vital machine is down, production loss or violation of environmental permits results. Element consist of assembled rotor plus stationary hydraulic parts (diffuser(s) or volute(s)).

7.5 Dismantling the pump set

7.5.1 General notes/Safety regulations

- Always have repair and maintenance work performed by specially trained, qualified personnel.

- Allow the pump set to cool down to ambient temperature.

- For any work on the motor, observe the instructions of the relevant motor manufacturer.
- For dismantling and reassembly observe the exploded view and the general assembly drawing.

- Properly shut down the pump set.
- Close the shut-off elements in the suction and discharge line.
- Drain the pump and release the pump pressure.

- Close any auxiliary connections.
- Allow the pump set to cool down to ambient temperature.

Note:
After a prolonged period of operation the individual parts 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 pull-off device.

7.5.2 Preparing the pump set

a) Disconnect the power supply (e.g. at the motor).
b) Disconnect and remove all auxiliary pipe work.
c) Unbolt the discharge and suction nozzles from the pipeline.

CAUTION

Before dismantling the pump for overhaul, ensure genuine Flowserve replacement parts are available.
Refer to sectional drawings for part numbers and identification.

7.5.3 Dismantling of radial flow impeller pump types

1) Completely drain the pump by using the drain connection. By pumping explosive or toxic media, flush it with Nitrogen.
2) remove the motor.
3) remove the motor support [815].
4) Pull off the coupling hub from the pump shaft [210.01] and take out the key.

Note:
If the pump is equipped with a rigid spacer coupling open the socket head cap screws and remove the spacer.

5) Loose hex head screws [901.03] and pull out the pump from its can.
6) Drain the oil from the bearing housing using the oil drain plug, Loose the socket head cap screws [912.01] & remove the bearing housing cover. Loose the chuck-nut [919] and remove the chuck-nut washer from the pump shaft. Loose the hex head screws [901.01], Pull off the bearing housing [330] in parallel with the shaft & take out the keys.
7) Remove the cover plate of bearing housing support.
8) Loose the set screws [915.01] and remove the tightening bush [925] from the pump shaft.
9) Loose the hex head screws [901.04], pull off the mechanical seal cartridge and remove the O-rings [412].
10) Loose the hex head screws [901.02], Pull off the bearing housing support [733] in a secure way in parallel with the shaft.
11) Open the hex head screws [901.5], disconnect the first column pipe from the Pump-head [635.02] and pull of the bush bearing assembly.

Note:
If the pump equipped with external flushing, remove the related pipes after step 11.

12) Pull out the complete bowl assembly together with shafts and column pipes. Disconnect the first column pipe.
13) Open the socket head cap screws [912.02] and slip upwards the intermediate coupling [D]. Remove the coupling split [122.01]. Now the shafts are uncoupled and you can proceed the same way with the next column pipe until the bowl assembly can be disconnected from the intermediate or top shaft.
14) Open the tie bolt and hex nuts and remove the suction piece [182].
15) Pull off the first impeller [230] from the pump shaft and remove the impeller key.
16) Pull off the first bowl [145], including the diffuser [102]. Now you can take off the inter-stage sleeve [220.05] and the next stage impeller.
17) Proceed with the next stage by repeating step 15 and 16, until the hydraulic section is completely dismantled.

Note:
For disassembly of column sections proceed with step 11-13.

7.6 Examination of parts

1) Check the intermediate bearing sleeves and bushings against any wear. The diametrical clearance between sleeves and bushings must not exceed twice the value in new condition.
2) Check the wear rings against any wear. The diametrical clearance between the ring and the impeller suction must not exceed twice the value in new condition.
3) Check all parts against corrosion and erosion.
4) Carefully check the coupling against any wear.
5) Rotate the angular contact bearing by hand, to check against abnormal sound. Check the bearing cages against any wear and the outer and inner race against running marks. Check the runout of the shafts. TIR (Total Indicated Runout) shall not exceed 0.04 mm/m (0.0005 in./ft) of length. TIR shall not exceed 0.08 mm (0.003 in.) over total shaft length.

7.7 Assembly

To assemble the pump consult the sectional drawing.

Note:
Ensure threads, gasket and O-ring mating faces are clean. Apply thread sealant to non-face sealing pipe thread fittings.

Note:
After complete assembly with pump head and bearing housing the rotor must be lifted!

8 Troubleshooting

FAULT SYMPTOM

Pump overheats and seizes											
⇓	**Bearings have short life**										
	⇓	**Pump vibrates or is noisy**									
		⇓	**Mechanical seal has short life**								
			⇓	**Mechanical seal leaks excessively**							
				⇓	**Pump requires excessive power**						
					⇓	**Pump loses prime after starting**					
						⇓	**Insufficient pressure developed**				
							⇓	**Insufficient capacity delivered**			
								⇓	**Pump does not deliver liquid**		
									⇓	**PROBABLE CAUSES**	**POSSIBLE REMEDIES**
										A. SYSTEM TROUBLES	
●									●	Pump not primed.	Check complete filling
		●				●		●	●	Pump or suction pipe not completely filled with liquid.	Check and complete filling
						●	●	●		Excessive amount of air or gas in liquid.	Check and purge from pipes
						●		●	●	Air or vapor pocket in suction line.	Check suction line design for pockets
						●		●		Air leaks into suction line.	Check airtight pipe then joints and gaskets
						●		●		Air leaks into pump through mechanical seal, sleeve joints, casing joint or pipe lugs.	Check airtight assembly then joints and gaskets
							●	●	●	Total head of system higher than differential head of pump.	Check pump-head and head losses in discharge pipe at the valve settings. Check back pressure is not too high
					●					Total head of system lower than pump design head.	Throttle at discharge valve or ask Flowserve if the impeller can be trimmed
					●					Specific gravity of liquid different from design.	Consult ASK

FAULT SYMPTOM

Pump overheats and seizes										
⇓	**Bearings have short life**									
	⇓	**Pump vibrates or is noisy**								
		⇓	**Mechanical seal has short life**							
			⇓	**Mechanical seal leaks excessively**						
				⇓	**Pump requires excessive power**					
					⇓	**Pump loses prime after starting**				
						⇓	**Insufficient pressure developed**			
							⇓	**Insufficient capacity delivered**		
								⇓	**Pump does not deliver liquid**	
									PROBABLE CAUSES	**POSSIBLE REMEDIES**
					●		●	●	Viscosity of liquid differs from that for which designed.	Consult ASK
●		●							Operation at very low capacity.	Measure value and check minimum permitted
	●	●			●				Operation at high capacity.	Measure value and check maximum permitted
									B. MECHANICAL TROUBLES	
●	●	●	●	●	●				Misalignment due to pipe strain.	Check the flange connections and eliminate strains using elastic couplings or a method permitted
		●							Improperly designed foundation.	Check setting of baseplate: tighten, adjust, grout base as required
	●	●	●	●	●				Shaft bent.	Check shaft runouts within acceptable values
●	●	●			●				Rotating part rubbing on stationary part internally.	Check for signs of this and consult ASK if necessary
●	●	●	●	●					Bearings worn	Replace bearings
					●		●	●	Wearing ring surfaces worn.	Replace worn wear ring/ surfaces
		●					●	●	Impeller damaged or eroded.	Replace impeller and check reason
				●					Leakage under sleeve due to joint failure.	Replace joint and check for damage
			●	●	●				Mechanical seal improperly installed.	Check alignment of faces or damaged parts and assembly method used
			●	●	●				Incorrect type of mechanical seal for operating conditions.	Consult ASK
●	●	●	●	●					Shaft running off centre because of worn bearings or misalignment.	Check misalignment and correct if necessary. If alignment satisfactory check bearings for excessive wear
●	●	●	●	●					Impeller out of balance resulting in vibration.	Check and consult ASK
			●	●	●				Abrasive solids in liquid pumped.	Check and consult ASK
			●	●					Mechanical seal was run dry.	Check mechanical seal condition and source of dry running and repair
			●	●					Internal misalignment due to improper repairs causing impeller to rub.	Check method of assembly, possible damage or state of cleanliness during assembly
●	●	●							Excessive thrust caused by a mechanical failure inside the pump.	Check wear condition of Impeller, its clearances and liquid passages
	●	●							Excessive grease in ball bearings.	Check method of regreasing
	●	●							Lack of lubrication for bearings.	Check hours run since last change of lubricant, the schedule and its basis
	●	●							Improper installation of bearings	Check method of assembly, possible damage or state of cleanliness during assembly and type of bearing used

FAULT SYMPTOM

Pump overheats and seizes										
⇓	**Bearings have short life**									
	⇓	**Pump vibrates or is noisy**								
		⇓	**Mechanical seal has short life**							
			⇓	**Mechanical seal leaks excessively**						
				⇓	**Pump requires excessive power**					
					⇓	**Pump loses prime after starting**				
						⇓	**Insufficient pressure developed**			
							⇓	**Insufficient capacity delivered**		
								⇓	**Pump does not deliver liquid**	
									PROBABLE CAUSES	**POSSIBLE REMEDIES**
	●	●							Damaged bearings due to contamination.	Check contamination source and replace damaged bearings
									C. ELECTRICAL TROUBLES	
		●			●		●	●	Wrong direction of rotation.	Reverse 2 phases on motor terminal box
	●	●						●	Motor running too slow,	Check motor terminal box connections

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