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Installation, operation, and maintenance instructions for Flowrox Vertical cantilever slurry pumps series (V)

NOTICE

These instructions must be read carefully and understood prior to the installation, use, and servicing of this product.

FLOWROX OY
P.O. Box 338
FI-53101 Lappeenranta, Finland
Tel. +358 (0)201 113 311 Fax +358 (0)201 113 300
E-mail: sales@flowrox.com
www.flowrox.com

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SAFETY INFORMATION

Carefully adhere to the safety information described herein relating to pump operation and maintenance, and the correct procedures to follow to avoid injuries to personnel and damage to equipment. All statutory and governmental health and safety requirements relating to this equipment must be complied with in addition to these instructions.

DO NOT APPLY HEAT TO THE IMPELLER HUB OR INLET EYE TO AID IN THE REMOVAL OF THE IMPELLER FROM THE SHAFT. APPLICATION OF HEAT MAY RESULT IN SHATTERING OR EXPLOSION OF THE IMPELLER OR RESULT IN INJURY OR EQUIPMENT DAMAGE.

CHECK MOTOR ROTATION PRIOR TO FITMENT OF POWER TRANSMISSION DEVICES INCLUDING VEE-BELTS, GEARBOXES, COUPLINGS, OR OTHERS. INCORRECT ROTATION OF THE MOTOR MAY CAUSE EQUIPMENT DAMAGE AND PERSONAL INJURY.

DO NOT OPERATE ANY PUMP FOR AN EXTENDED PERIOD OF TIME AT ZERO OR LOW FLOW CONDITIONS. THIS CAN RESULT IN VAPORIZATION OF THE PUMPING FLUID AND STEAM GENERATION. DANGEROUSLY HIGH PRESSURES AND TEMPERATURES CAN OCCUR CAUSING A POTENTIAL FAILURE OF THE PUMP CASING OR OTHER FAILURES DOWNSTREAM RESULTING IN SERIOUS DAMAGE TO EQUIPMENT AND PERSONAL INJURY.

SLURRY PUMPS SHOULD NOT BE OPERATED AT FLOW LESS THAN 25% OF THE BEST EFFICIENCY POINT FOR A GIVEN RPM. **PERSONAL INJURY AND EQUIPMENT DAMAGE COULD RESULT**.

DO NOT FEED VERY HOT LIQUID INTO A COLD PUMP OR VERY COLD LIQUID INTO A HOT PUMP. THERMAL SHOCK CAN CAUSE DAMAGE TO THE PRESSURE VESSEL OR RUPTURE OF THE PUMP CASING.

DO NOT START A PUMP THAT IS ROTATING IN REVERSE, SUCH AS BACKWARD ROTATION CAUSED BY SLURRY RUN BACK. PERSONAL INJURY AND DAMAGE TO EQUIPMENT COULD RESULT

ALL AUXILIARY EQUIPMENT (motors, belt drives, couplings, variable speed drives, etc.) standard safety precautions should be followed and appropriate instruction manuals consulted before and during installation, operations, and maintenance.

The FLOWROX SLURRY PUMP is both a PRESSURE VESSEL and a piece of ROTATING EQUIPMENT. All standard safety precautions for such equipment should be followed before and during installation, operation, and maintenance.

WORN PUMP COMPONENTS can have very sharp or jagged edges. Appropriate precautions should be taken in handling worn parts to prevent personal injury and damage to slings. Sufficiently rated metal chains or other appropriate lifting devices should be used for removing worn impellers as vane edges are likely to be extremely sharp.

Lifting mechanisms present on individual pump components should be used to life those components ONLY. Tapped holes (for eyebolts) and lugs (for shackles) on Flowrox Slurry parts are for lifting those individual parts. Appropriate separate, holistic means should be applied in lifting assembled components.

READ THE MANUAL – For the safety of operating personnel, please note that the information supplied in this manual only applies to the fitting of genuine Flowrox Slurry parts.

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1 GENERAL SAFETY INSTRUCTIONS

The symbols in Table 1 are used in this manual to highlight the parts requiring particular attention.

Table 1. Hazard severity panels.

⚠ DANGER!

DANGER indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.

⚠ WARNING!

WARNING indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.

⚠ CAUTION!

CAUTION indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.

NOTICE

NOTICE notifies people of important information that is not hazard related.

Prevent accidents and ensure the valve's appropriate operation by complying with the installation, safety, and maintenance instructions in this manual. Installation and maintenance of the valve must be carried out by persons with appropriate training. Electrical installation work of the actuator must be performed by a qualified electrician.

Access to the IOM-manual must be guaranteed at all times at the place of operation of the valve. It is required to observe the IOM-manual in all work tasks for the valve.

Use personal protective equipment when performing any checks or maintenance operation for the valve (goggles, helmet, clothing and gloves). Always follow the factory safety regulations.

In case of any discrepancies between translations, the English version shall prevail.

2 INTRODUCTION

Thank you for purchasing a quality Flowrox pump. Using this manual you should be able to obtain long, reliable service from your pump, and be able to confidently perform necessary maintenance and upkeep procedures.

The information in this manual has been checked and is believed to be accurate and reliable; however, no responsibility is assumed by Flowrox for its use or for any inaccuracies. Specifications are subject to change without notice. Flowrox does not assume any liability arising out of use or other application of any product described herein.

2.1 Contact information

To insure long, trouble-free service from your Flowrox pump, the instructions contained in this manual must be carefully followed. When ordering spare parts, it is advisable to provide the pump model, serial number, part description, and complete part number. We reserve the right to make changes or improvements in design or construction.

For additional information not covered in this manual contact:

Email: sales@flowrox.com
Tel: +358 (0)201 113 311
Fax: +358 (0)201 113 300

Customer Service Dept. FLOWROX OY
P.O. Box 338/ FI-53101 Lappeenranta, Finland

2.2 Applications and Features of Vertical Cantilever Slurry Pumps

These pumps are of heavy duty construction, and are designed for the continuous pumping of extremely abrasive and corrosive slurries. They feature a diverse range of material options for replaceable abrasion resistant casings and impellers.

The vertical cantilever slurry pump design is unique in that there are no submerged seals or bearings in the standard pump design. As such, no sealing below the mounting plate of the pump is required.

If problems occur during the operation of your Flowrox pump, first refer to the Fault Detection Chart provided in

Appendix A: Critical Speed Advisory for Cantilevered Pumps of this manual. Remember that the majority of pumping problems are a result of issues occurring in the system on the suction side of the pump. If the problem persists through on-site troubleshooting, contact your nearest Flowrox representative or the Flowrox head office at the contact information provided in Section 2.1.

Key Features of the Flowrox pump:

- Fully Cantilevered – Eliminates submerged bearings, packing, lip seals, and mechanical seals that other vertical slurry pumps typically require.
- Double-suction impellers allow fluid to enter from the top and bottom of the casing
- Cartridge type bearing assembly with oversized shaft and bearings
- Heavy-duty threaded impeller attachment
- Replaceable liners and casings of diverse material specification
- Minimum number of casing bolts for ease of removal of casing

NOTICE

Obey the instructions in this manual.

Make sure to obey local regulations.

3 PUMP IDENTIFICATION

Every Flowrox Pump has a nameplate attached to the bearing housing. The pump serial number and model number are stamped on the nameplate.

3.1 Pump model identification

The pump model number is made up of digits and letters arranged as follows:

The pump model identification code is made up of six basic groups of digits and letters arranged as follows:

Table 2. Pump model number.

Digit(s)	Letter	Digit(s)	Letters
(A)	(B)	(C)	(D)
Discharge Diameter (in)	Pump Series	Discharge Diameter (in)	Frame Size

(A): The distance diameter as expressed in inches (in), i.e. 1.5, 2.5, 4, 6, 8, or 10.
(B): Pump Series, identified by a single letter, i.e. V
(C): The discharge diameter as expressed in millimeters (in), e.g. 1.5, 2.5, 4, etc.
(D): Frame Size: VP, VQ, VR, VS, VT

Other alphanumeric groups can follow the above four groups of digits. The other groups are used to indicate unique modifiers or optional equipment. The following are examples of several pump model types and classifying groups.

Example: **4 V 4 VR**
4: Discharge Diameter (inches)
V: Vertical Cantilever
4: Discharge Diameter (inches)
VR: Bearing Frame

The pump model code is meant to provide a first-look understanding of the pump build, but the model number is not meant to replace a certified Component Diagram (or Bill of Materials), which are issued with every Flowrox pump. Always refer to the certified equipment documentation when ordering replacement parts or materials.

3.2 Part number identification

Every Flowrox Pump part has a unique name and identifying part number. This part number can be broken down into four distinct alphanumeric groups.

Flowrox Part Number Format:

Table 3. Pump part number.

Group1	Group2	Group3	Group4
(AAA)	(BBB)	(CC)	(DDD)
Pump Prefix	Generic Part Number	Special Identifier	Material Code

(AAA): Three-digit identifier, which corresponds to a frame size and model pump.
(BBB): Three-digit identifier, which is the "Generic part number" further illustrated in Table 4.
(CCC): Two-digit identifier, which is for qualifying special parts.
(DDD): Three-digit identifier, which is the unique material code associated with each part.

The "Generic Part Number" directly corresponds to a single type of part regardless of pump size or model. For example, the BACK LINER of every Vertical Cantilever slurry pump has a Generic Part Number of "040", while all Shafts have a Generic Part Number of "075".

For example: **08S 040 Z0 R09**
08S: For 4V4VR pump
040: Back Liner
Z0: Basic Part
R09: Natural Rubber

The additional letters and numbers added before and after the Generic Part Number further define a component part of a particular pump. This expanded marking is identified as the Part Number, and represents a unique identification for each component part. The Part Number is normally labeled or otherwise prominently marked on each part.
For example, Part Number 08S 040 Z0 R09 identifies the BACK LINER to fit the wet end of a 4V4VRR model pump:

Refer to the certified Component Diagram of the appropriate size of Flowrox Pump for complete identification and description of component parts. Part names and Generic Part Numbers are used in assembly instructions throughout this instruction manual. Flowrox Generic Part Numbers are listed in Table 4.

In all communications with Flowrox or its representatives, and particularly when ordering spare parts, it is recommended that the correct component names and Part Numbers obtained from certified component diagrams be used at all times to avoid supply of incorrect parts. The pump serial number and model should also be quoted if any doubt exists as to part identification.

Table 4. Spare Part Identification.

Generic Part Number	Part Name	Generic Part Number	Part Name
005	Bearing	**065**	Labyrinth locknut/lockwasher
006	Bearing assembly	**072**	Piston ring
007	Bearing drive end	**075**	Shaft
008	Bearing housing	**076**	Shaft key
009	Bearing seal ring	**078**	Lip seal
010	Bearing sleeve	**080**	Shaft sleeve ejector
012	Casing	**082**	Shaft spacer
015	Column	**084**	End cover gasket
016	Column clamp	**086**	Spacer
026	Discharge pipe	**087**	Strainer
027	Discharge pipe gasket	**093**	Throatbush
028	End cover	**094**	Throatbush stud
031	End cover bolts	**104**	Volute liner
036	Flinger	**106**	Casing seal
040	Back liner	**120**	Volute liner seal holder
059	Impeller seal O-ring	**122**	Impeller, torque-flow, 8-vane
060	Shaft O-ring	**124**	Impeller, double-suction, 5-vane
061	End cover ring	**222**	Mounting plate
064	Labyrinth		

4 STORAGE

The storage procedures listed below are to be followed by the purchaser. This is required in order to maintain the Flowrox Limited Warranty, when new or unused pumps are sitting idle for long periods prior to startup.
Any warranty period lasting longer than one-year from date of shipment must be approved in writing by the Flowrox head office. In any case, the following storage procedures will help to ensure your pump is ready to operate whenever it is placed into service.

4.1 Short Term Storage Procedure

For Periods of 18 Months or Less

- Indoor storage is recommended, especially for elastomer lined pumps
- Protect the equipment from temperature and humidity extremes and exposure to excessive dust, moisture, and vibration.
- Rotate the shaft several turns every three to five weeks.
- Every six months purge the labyrinth with grease to prevent dirt and/or moisture contamination of the bearings.
- Protect rubber-lined pumps from heat, sunlight, and exposure to ozone.
- The discharge flange openings are to be covered unless connected to piping.
- All external machined surfaces are factory coated with a rust preventative prior to shipment. Maintain the protective coating on these surfaces with CRC SP-400 or a comparable product.
- For outdoor or excessively unfavorable environment, cover the equipment with some type of protective tarpaulin that will allow proper air circulation.
- Prior to start-up, inspect bearing seals to ensure that they are satisfactory.
- Maintain written documentation of labyrinth purging and shaft rotation intervals to be made available to Flowrox upon request for warranty validation.

4.2 Long Term Storage Procedure

For periods greater than 18 months, but less than 36 months

- Prior to storage, thoroughly drain pumps of any and all water.
- Indoor storage is required
- Protect the equipment from temperature and humidity extremes, and exposure to excessive dust, moisture, and vibration.
- Rotate the shaft several turns every three to five weeks.
- Every six months purge the labyrinth with grease to prevent dirt and/or moisture contamination of the bearings.
- Protect rubber-lined pumps from heat, sunlight, and exposure to ozone.
- The suction and discharge flange openings are to be covered unless connected to piping.
- All external machined surfaces are factory coated with a rust preventative prior to shipment. Maintain the coating on these surfaces during storage.
- For outdoor or excessively unfavorable environment, cover the equipment with some type of protective tarpaulin that will allow proper air circulation.

- Prior to start-up, inspect bearing seals to ensure that they are satisfactory. After a storage period of 18 months or longer, new elastomeric bearing housing end cover seals may be required at customer expense.
- Maintain written documentation of labyrinth purging and shaft rotation intervals to be made available to Flowrox upon request.

Accessories

Consult the original manufacturer for specific recommendations on gear drives, electric motors, mechanical seals, etc. Depending on length of storage period, addition of rust inhibitors to oil, connection of space heaters or other requirements may exist to ensure the factory warranty remains valid.

For storage periods greater than 36 months, please contact Flowrox.

5 INSTALLATION

System Review

A review of the entire pumping system, including sumps, piping, valves, controls, etc., should be made prior to pump startup to prevent adverse effects on the pump.

5.1 Safety Regulations

5.1.1 Electrical

⚠ WARNING!

Make sure the equipment operated in explosive atmosphere meets the required classification.

5.1.2 Mechanical

Observe good industry practices and any relevant statutory regulations as they relate to the installation and operation of rotating equipment, pressure vessels and pumps as all are applicable.

5.2 Foundation

All structural work required must have been prepared in accordance with the dimensions stated in the relevant outline (OD-) or arrangement (AR-) drawings.

To obtain efficient pump service, you must install the pump on adequate foundations. Steel foundations should be rugged; concrete foundations should be heavy. Both should be designed to take all loads from the pump and motor, and to absorb any vibrations.

Keep in mind that an electric motor can exert more than twice the rated horsepower during start-up. All hold down bolts should be fully tightened and re-tightened after a few days of running time. The location selected for installation should allow adequate space to provide access for inspection and maintenance.

A concrete foundation shall have sufficient strength for the pump and be completely cured before installation. The mounting surface must be flat and level. Anchor bolts must be located according to the pump outline drawing (OD-).

5.3 Installing the baseplate and Pump

After placing the baseplate/mounting beams on the foundation, it must be leveled by shimming. Shims should be fitted between the baseplate and the foundation itself; they

should always be inserted to the left and right of the foundation bolts and in close proximity to these bolts. For a bolt-to-bolt clearance of more than 30 in. (800 mm), additional shims should be inserted halfway between the adjoining holes. All shims must lie perfectly flush.

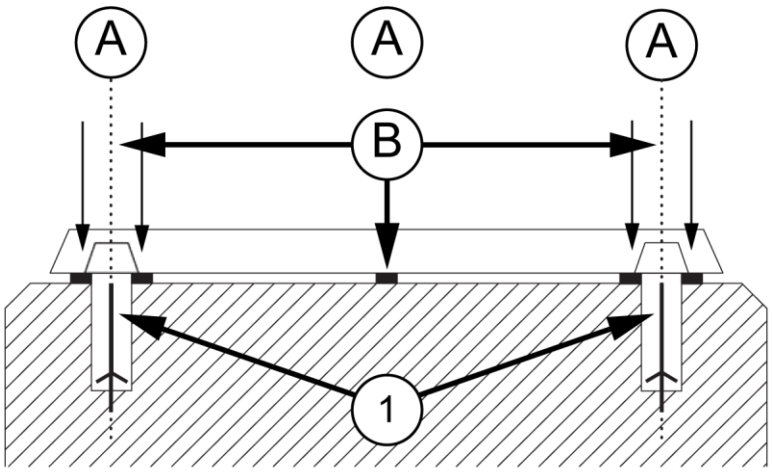

Figure 1. Foundation bolt illustration.

Part	Description	Part	Description
1	Foundation Bolts	B	≤ 800 mm (30 in.)
A	Shim		

5.3.1 Alignment

NOTICE

Make sure the pump foundation meets the Flowrox requirements.

⚠ CAUTION!

Make sure the equipment alignment meets the requirements.

Improper alignment causes to damage to the equipment.

The operator must obey the following instructions:

- Proper alignment must be taken into consideration when using an overhead motor mount accessory. Motor feet must be firmly supported at each mounting bolt location before the bolts are tightened. Shims should be used to fill any gaps and ensure solid mounting and vibration prevention.
- The vertical cantilever pump is typically mounted to sufficiently supported structural steel beams over a sump or pit designed to securely hold the weight of the complete pump assembly under full operating loads. The mounting plate may be through-bolted to the structural beams and fully tightened to the recommended torque rating for the size and grade of bolt used.

⚠ CAUTION!

All mounting bolts should be checked for tightness after a few days running time to ensure none have come free during initial run-in.

- For optimum performance, the pump should be mounted directly to the baseplate/ mounting beams without shims. The rest of the drive train is then aligned to the pump. For this reason, Flowrox motor mounting plate designs generally allow space for shimming under the motor, but not under the pump mounting plate itself. The only exception occurs in cases where regular removal and replacement of the entire pump is stipulated during the equipment design stage. In these cases, special instructions for alignment and shimming of the pump may be given on the pump assembly and/or general arrangement drawings.
- Coupling check and realignment must be done even if pump and motor are supplied completely assembled and aligned on a common base plate. The correct distance between the coupling halves as specified in the installation plan must be observed.
- The pump set is correctly aligned if a straightedge placed axially on both coupling halves is the same distance from each shaft at all points around the circumference. In addition, the distance between two coupling halves must remain the same all around the circumference. Use a feeler gauge, a wedge gauge, or a dial micrometer to verify.
- The radial and axial deviation (tolerance) between the two coupling halves should not exceed 0.1 mm (0.004 inch).
- For V-belt installations, the pulleys are correctly aligned if a straightedge placed vertically shows a deviation of no more than 0.04 in. (1 mm). Both pulleys must be parallel.

5.4 Connecting piping

NOTICE

Never use the pump itself as an anchorage point for the piping.

Permissible forces must not be exceeded (see Appendix C).

⚠ WARNING!

Make sure to isolate the equipment from the process.

The process media can be hazardous.

NOTICE

Appropriate Flowrox discharge pipe gaskets must be used at the lower pump flange connecting the casing and discharge pipe.

Make sure there is no damage to the discharge pipe gaskets during installation.

Replace damaged discharge pipe gaskets.

When connecting piping, the operator must obey the following instructions:

- Do not over tighten flange bolts to avoid damaging the gaskets and casing.
- No strain should be imposed on the pump casing either by the weight of pipes or by tightening badly fitted pipes. All pipe work attached to the pump must be the correct size and fully supported to carry the pipe and the weight of the product. The mating faces of the pipe flanges must made up squarely, with all bolt holes in line.
- When joining the pipe work to the pump, DO NOT USE excessive force as this could result in flange or casing damage. Do not install unrestrained expansion joints between the pump and the nearest point of anchor. Large reaction forces due to system pressure can cause damage to the pump.

5.4.1 Suction conditions

V Series Flowrox pumps are a double- suction design, meaning fluid can enter from both above and below the impeller. Ensure that no solids have settled in, around, or above the pump casing and impeller prior to starting the pump. Starting the pump with solids in or around the casing can cause damage to the pump or drive- train equipment.

The impeller of the pump must be covered in order to prime the pump.

5.4.2 Discharge (pressure) conditions

Suitable isolation should be fitted in the pump discharge piping as required by the installation.

Flowrox recommends the use of a manual or controlled pinch valve in order to control flow and provide resistance on startup if desired.
Flowback prevention devices such as swing-check valves or other similar solids-handling rated devices can prevent reverse rotation and potentially spinning off the impeller. This is typically most important at the initial startup of the pump, when negligible torque has been placed on the impeller/shaft assembly.

5.5 Safety guards

NOTICE

Appropriate guards for all rotating elements, couplings, vee-belts drives and exposed shafts must be supplied and assembled prior to use.

Make sure to obey local regulations.

5.6 Final check

Verify the alignment as described in Section 5.3.1. It must be easy to rotate the shaft by hand at the coupling or via the vee-belt drive. If the shaft does not rotate by hand, review Impeller Clearance and Alignment once again until the pump rotates freely.

NOTICE

See **Section 6.1.1** for performance of a motor rotation check prior to startup along with all other recommended commissioning steps.

5.6.1 Checking impeller clearance

Impeller clearance must be checked prior to start-up of the pump. Failure to do so may result in damage to the pump. All impellers are adjusted at the factory. Spacers are provided between the bearing housing and the top of the column to allow later adjustment of the impeller should it become necessary.
Refer to **Section 10.1.2** in this manual for procedural details.

5.6.2 Connection to power supply

⚠ WARNING!

Electrocution hazard

Risk of electric shock or equipment damage

Make sure the connection to the power supply is made by a licensed electrician

Motor protection device must be used

6 COMMISSIONG, STARTUP AND SHUTDOWN

NOTICE

Compliance with the following requirements is of paramount importance.

Damage resulting from non-compliance shall not be covered by the scope of warranty.

This manual applies to single stage pumps. Procedures for multi-stage pumps or vertical pumps with lower bearings should be obtained from the Flowrox head office.

6.1 Commissioning /Returning to service

6.1.1 Motor rotation check

⚠ CAUTION!

Risk of equipment damage

Make sure the pump rotates in the direction of the arrow on the pump

Read the manual

The operator must obey the following steps to check the motor rotation:

1. Remove all V-Belt sets or completely disconnect shaft coupling, as the case may be.
2. Start the motor, check rotation, and correct it if necessary to produce pump shaft rotation indicated by arrow on pump bearing housing.
3. Refit vee-belts or reconnect shaft coupling. When tensioning belts, maintain the shaft alignment.

6.1.2 Startup checklist

Make certain the motor is securely locked in the “OFF” position and pumping fluid on both suction and discharge sides of the pump are isolated prior to performing any work on the pump.

Before starting up the pump make sure that the following requirements are checked and fulfilled.

- If the pump has been in long term storage (more than 3 months), proper storage procedures were followed (see Section 4), including instructions for removing the pumps

from storage (see contract documents and/or contact your Flowrox representative). Failure to follow proper storage procedures will void your warranty.

- Remove any objects that may have entered the pump casing during shipment or installation.
- Check that all bolts are tight and that the impeller turns freely.
- Pump drive train final alignment is complete.
- All electrical and power supply connections are in order, including fuses and overload protection devices.
- All required auxiliary connections are made, tested, and functioning.
- All safety guards and equipment are in place.
- Any required instrumentation has been properly installed and is functioning.
- Bearing assembly lubrication is completed.

NOTICE

Grease lubricated bearing assemblies are factory lubricated.

Do not add additional grease at startup.

Consult with the factory on any questions regarding lubrication.

- Drive train direction of rotation has been verified to be correct prior to final installation of power transmission, and has not been altered prior to startup.
- The pump set is primed, i.e. the casing is fully covered by water.
- The desired operating conditions do not exceed those allowed by the pump. Consult with your Flowrox representative or the factory for verification of performance specifications.

6.2 Pump startup

- It is good practice to startup pumps on water before introducing solids or slurry into the pump. If the pump must start up on a slurry mixture, check to ensure that the lower pump casing and intake strainers are not plugged or encased by a heavy concentration of solids. If necessary, use a high pressure hose to agitate the solids in the sump before starting the pump.
- The pump should be started with the discharge valve approximately ninety percent closed, provided a discharge valve is available.
- Overloading of the motor or vee-belt drive may occur when the pump is discharging into an empty system, when the delivery head will be lower, or the throughput is in excess of that for which the pump is designed. Careful regulation of the discharge valve until the system is fully charged will prevent this.
- If a pressure gauge is available in the discharge line, observe and allow pressure to build up with the valve ninety percent closed. If a gauge is not available, allow ten to fifteen seconds before adjusting the discharge valve.

- Gradually open the discharge valve to a fully open position, or to the position required to obtain the desired flow and/or discharge pressure.
- Continue to observe the pump, noting if excessive vibration is present.
- Purge the drive end labyrinth seal with grease.

6.2.1 Checking flow rate

Check flow rate by inspecting meters or pipe discharge.

NOTICE

Check flow rate by inspecting meters or pipe discharge.

Do not at any time operate the pump at flow rates below 25% of the flow at the best efficiency point (BEP) for a given RPM.

6.2.2 Monitoring the bearings

Monitor the bearing temperatures for the first few hours of operation. One of two things will happen:

- If the end play and the amounts of grease used are correct and all components are in good order, there should be little temperature rise during this period. Pump shaft speed does play a factor in this.
- Should one or both bearings begin to heat up during this period, the following limitations apply:
  - ✓ Above 70 °C (165°F) - Monitor temperature continuously
  - ✓ Above 85 °C (185°F) - Stop pump and allow bearing assembly to cool down.
  - ✓ Above 90 °C (200°F) - Stop pump and consult factory

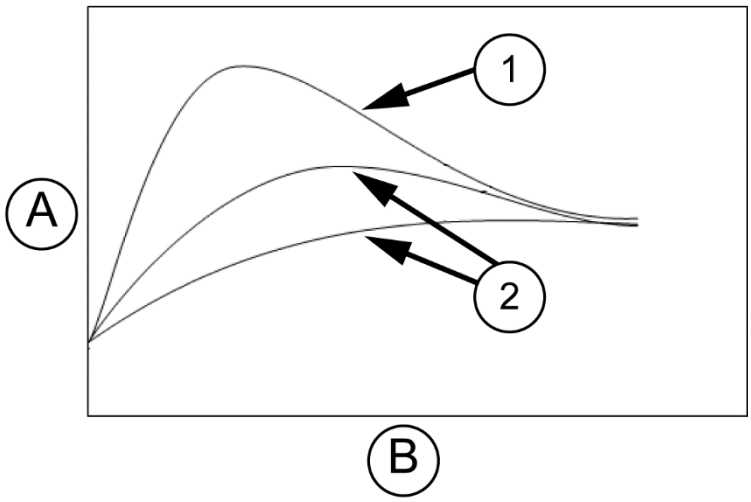

Figure 2. Time versus Temperature Characteristics of a Grease Lubricated Bearing Assembly

Part	Description	Part	Description
1	Initial start	A	Temperature
2	Subsequent starts	B	Time

The temperatures indicated are taken at the bearing housing surface. If bearing thermocouples are used, allowable operating temperature is higher than indicated.

Often a short heat-up time is caused by an excessive amount of grease in the bearings. Allow to cool and start up again. If high temperatures persist, stop, disassemble, and inspect components. Watch for foreign matter in grease and in component parts. For pumps fitted with bearing thermocouples, temperature set points will be higher. Contact factory for assistance.

6.2.3 Negative torque

Startup, shutdown, filling and draining procedures must be designed to prevent any possibility of negative torque being experienced on the pump shaft. Negative torque can cause the impeller to unscrew, leading to severe damage throughout the rotating assembly and drive train.

NOTICE

Stop the unit and re-tighten all bolts once the pump and bearing assembly stabilize at normal operating temperature during the initial commissioning or in the event of system leaks.

Check the coupling alignment and re-align if necessary.

6.3 Pump shutdown

If possible, allow the pump to pump water for a short period before shutdown. When shutting the pump down, the discharge line will drain back through the pump and flush out the majority of any solids caught in the intake strainers. In most situations the sump should be agitated to ensure solids do not settle out in the bottom of the sump or around the pump casing. If agitated, the agitation should not introduce entrained air into the intake flow of the pump.

- Switch off the drive, making sure that the unit runs smoothly down to a complete stop. Variable Frequency Drive (VFD) and other controllers must not use any braking function to slow the pump.
- Close any auxiliary connections.
- Where temperatures may drop below freezing, the pump and system must be drained or otherwise protected against freezing.

NOTICE

Check flow rate by inspecting meters or pipe discharge.

Do not at any time operate the pump at flow rates below 25% of the flow at the best efficiency point (BEP) for a given RPM.

6.3.1 Prolonged shutdown

The pump remains installed - operation check run

In order to make sure that the pump is always ready for instant start-up and to prevent the formation of deposits within the pump and the pump intake area, start up the pump set regularly once a month or once every 3 months for a short time (24pprox.. 5 minutes) during prolonged shutdown periods. Prior to an operation check run ensure that there is sufficient liquid available for operating the pump.

The pump is dismantled and stored

Before putting the pump into storage, carry out all checks specified in Section 4. It is advisable to close the nozzles (for ex. with plastic caps or similar).

7 PUMP OPERATION

⚠ CAUTION!

Hot surface hazard

High temperature handled medium can make the pump surface hot

Risk of burns to personnel

7.1 Operational checks

1. After the pump has run for several hours after initial startup, shut it down to check the following:
   - Vee-belts tension
   - Piping connections
   - Pump fasteners including hold-down bolts
   - Lower and upper strainers. If plugged, clean out strainer openings.
2. Purge the drive end bearing seal with grease weekly. In excessively dirty environments, the seal should be greased twice weekly. Table 5 in this manual shows the recommended grease purging intervals for your pump.
3. Grease the pump bearings according to the recommended intervals shown in Table 5. The table serves as a guideline for most applications. Actual operating conditions may require different intervals than those indicated in this manual.
4. When operators are on duty, periodic daily inspections to the equipment should be made. Any irregularities in operation or performance of the pump must be reported immediately.
   Rough running and vibration of the pump may also occur if high induced suction causes cavitation within the pump.

7.2 Operating faults

A more exhaustive Fault Detection Chart is provided in

Appendix A: Critical Speed Advisory for Cantilevered Pumps for your review. The following operating faults are described in greater detail due to the commonality of their occurrence. The vast majority of operating faults relative to slurry pumps are systemic in nature, and are not due to a fault in the pump itself.

7.2.1 Reverse rotation

⚠ CAUTION!

Make sure to start the pump in the correct rotation.

Stop and disassembly the pump in case it has been started in reverse rotation.

If the pump is started in reverse rotation from the indicating arrow cast on the bearing housing, there is high likelihood that the impeller has spun free from the shaft. The pump cannot be restarted without disassembly and evaluation of all equipment and parts.

The pump wet-end must be disassembled and the failure condition resolved. Check all parts for damage, and contact the factory or your authorized Flowrox dealer for support.

7.2.2 Restricted suction condition

⚠ WARNING!

Hot surface and hot media hazard

The pump surface and pumped media may become hot

Violent bursting of the pump may occur

Make sure the intake and discharge are open before the pump is turned on

Turn off the pump immediately in case the pump is blocked by solids

If the pump fails to prime, a blocked suction inlet may be the cause. It is possible for a piece of foreign material to be drawn across the strainer creating a partial obstruction. Such an obstruction may not be sufficient to stop operation completely, but can result in a reduced output from the pump. This type of obstruction can also cause a drop in discharge pressure and motor amps. Rough running and vibration of the pump may also occur due to cavitation

within the pump.

The operation of centrifugal pumps on slurry applications can increase this potential hazard due to the nature of the material being pumped. The additional hazard believed to be presented by slurry applications stem from the possibility of solids blocking the pump discharge and remaining undetected.

This situation has been known in some instances to lead to the intake side of the pump also becoming blocked with solids. The continued operation of the pump under these circumstances can be extremely dangerous. If you have an installation that may be prone to this occurrence, we suggest you adopt measures to prevent this blockage situation.

7.2.3 Blocked impeller

Oversized particles entering the suction pipe may become lodged in the eye of the impeller, restricting the output of the pump. Such an obstruction will usually result in reduced horsepower draw and a drop in discharge pressure. The out-of-balance effects resulting from this condition may cause pump vibration. Shutdown and partial disassembly are typically required to resolve this issue.

7.2.4 Restricted discharge condition

A blocked or restricted discharge line may be caused by an abnormally high concentration of coarse particles in the pump discharge pipe. It can also be caused by the velocity in a section of the discharge pipe dropping below that of the Critical Settling Velocity. This is normally accompanied by a drop in motor amps.

Discharge pipes running at angles other than horizontal or vertical can result in settling and potential blockage.

Discharge piping systems that include lined pipe have been known to restrict flow due to complete or partial liner failures:

- Rubber or other elastomer lined pipe may delaminate from the surrounding hard pipe and move into the flow path.
- Ceramic lined pipes can fracture from shock loads, and ceramic pieces can migrate down the line to block the line.

7.2.5 Low pit or tank level

Pumps will lose prime if the water level in the tank falls sufficiently low enough to allow air to be drawn into the pump suction. This air must be allowed to dissipate or clear from the eye of the pump impeller before the pump can re-prime.

8 GENERAL MAINTENANCE

Flowrox pumps are designed for heavy duty use, and when correctly installed and maintained will give long, trouble-free service. The following information should help to offer guidance on obtaining the longest life possible from your Flowrox vertical slurry pump.

8.1 Inspections

When operators are on duty, periodic daily inspections to the equipment should be made. Any irregularities in operation or performance of the pump must be reported immediately.

8.1.1 Loosing bolts and fasteners

Although pump impellers are balanced before they leave the manufacturing facility, precise balance cannot be achieved in operation because of the uneven wear that can occur. Pumps are therefore subject to vibration while running and this vibration can result in loosening of some bolts. A routine maintenance program should be established requiring a check at regular intervals to ensure that all nuts are tight. If any location is found where bolts are consistently loosening, use suitable locking devices.

If any pipe supports are found to be broken or loose, re- tighten or repair these immediately. Investigate to find the root cause of the failure of the support, and reinforce to prevent future occurrence.

8.1.2 Power transmission

8.1.2.1 Couplings

Periodically inspect the coupling for abnormal wear on any component of the coupling. All fasteners should remain torqued, and the bushings firmly fixed to each motor and pump shaft.

If an elastomeric coupling is employed, check to ensure the elastomer integrity has not been compromised and that there are no cracks or tears in the coupling body.

8.1.2.2 Vee-belt drives

Vee-belts will require re-tensioning over time. Periodically check the belts against the manufacturer specification. Over-tightening can result in premature bearing failure due to excessive torque loads on the shaft(s). Squealing or slipping belts may require either tightening or complete replacement. When replacing belts, replace all belts at the same time ensuring that they are matched sets. Unmatched belts may have slight differences in overall length from the manufacturer that will affect the uniformity of the tightness on the belts once pulled up on the sheaves.

8.1.3 Strainers

Periodically check openings on top and bottom strainers on the wet-end of the pump for blockages. Blocked suction strainers can cause cavitation and reduced flow through the slurry pump, which will reduce the overall life of many pump components.

8.2 Spare parts

Spare parts for Flowrox vertical pumps consist mainly of liners, impellers, bearings, seals, and supporting hardware. Depending on the expected life of each part, keep the necessary number of spares to ensure maximum use and minimum downtime of the pump. For critical installations a spare pump or spare bearing assembly may be warranted.

Wear rate of a solids handling pump is a function of the severity of pumping duty, abrasive properties of the pump material, and the speed of the pump; therefore, the life of the wear parts will vary from one installation to another.

Wear parts are replaced when the pump performance no longer satisfies the user requirements.

Flowrox recommends that the pump be opened at regular intervals to determine the wear rate of the parts, to estimate the life cycle of the wear parts for parts inventory.

Maintaining at least one spare bearing assembly for each pump size installed is recommended, and one additional spare for every ten (or less) pumps of the same size.

Refer to **Section 3.2** for identifying parts.

8.3 Bearing lubrication

Judgment and experience are the final determining factors in establishing proper lubrication procedures. The information set forth in this manual is meant as a first guide and general best practices for the majority of applications and industries in which Flowrox pumps are applied.

8.3.1 Grease requirements

It is advisable to carefully observe the operation of a bearing right after start-up to note any cleanliness and unusual bearing temperatures.

A correctly assembled and pre-greased bearing assembly will have long trouble-free life as long as it is protected from water and foreign material entering the bearing housing, and properly maintained.

The bearing housing must be opened and inspected at least every 12 months; this inspection will determine either the next inspection or the specific time to provide an overhaul to the bearing assembly.

Grease nipples should be cleaned before applying grease to prevent dirt from entering the bearings.
Excess Grease – Adding too much grease will increase bearing temperature, due to the churning of the grease. Often, adding more grease will damage the bearings.

8.3.2 Recommended grease type

The lubricating grease used in roller bearings should have the following characteristics:
Lithium complex soap thickener grease with oxidation inhibitor and EP additives.

- N.L.G.I. Consistency No. 2
- Drop Point > 260°C (500°F)
- Work Penetration @ 25°C (77 °F) (ASTM) 265 to 295

Mobil grease XHP 222 is a type which has been found to be satisfactory.

8.3.3 Lubrication intervals

The frequency and amount of lubrication to be added periodically depends upon the combination of a number of factors:

- Speed and size of the bearing
- Duration and extent of on-off operation
- Environmental conditions such as ambient and operating temperatures
- Wash down habits or presence of splashing fluid and other contaminants

The suggested lubrication intervals and quantities are given in Table 5. The recommended initial grease quantity installed during assembly is given in Table 6. Table 5 is based on normal operating conditions and is intended to be a guideline only. Normal operating conditions are defined as:

- Clean environment
- Pump under cover or protected from the weather (rain, snow, ice, dust, etc.)
- Normal ambient temperatures 50° to 95°F (10° to 35°C)
- No heavy washing down
- Normal operating conditions - below full rating Tabulated figures of Table 5 are based on bearing temperatures of 158°F (70°C) measured at the housing surface. Higher operating temperatures will require more frequent lubrication intervals
- Very dirty or damp atmospheric conditions that vary from the normal operating conditions listed above may require that the recommendations be adjusted.

8.3.4 Labyrinth grease purging

To improve the sealing properties of the labyrinth at the drive end of the bearing assembly, a grease nipple and radially drilled hole in the end cover allows you to force grease through the labyrinth (see Figure 3). The grease purges out grit and moisture. Fewer contaminants entering the bearing assembly will result in longer bearing life, and ultimately a cost savings.

The lower end of the bearing assembly is protected from the entry of grit and moisture by a seal mounted behind an elastomer shaft flinger. The bearing seal also prevents excessive grease loss from the bottom of the bearing housing.

It is an essential maintenance requirement that you pay careful attention to labyrinth purging. Suggested intervals for grease purging of the labyrinth are provided in Table 7 below. These intervals are based on normal conditions and are intended only as a guide. Very dirty or damp atmospheric conditions would require the recommendations be adjusted to a level that prevents contaminants from entering the bearing assembly. The color and condition of the purged grease may be used as a guide to adjusting the intervals.

NOTICE

Location of bearing grease fittings are located inboard of bearing seal fitting.

See Figure 3 for reference.

8.3.5 Bearing failures

Dirt and water cause 90% of bearing failures. Dirt finds its way into the bearings due to carelessness before or during assembly, or after the unit has been placed in operation. Dirt is made up of diamond hard particles which when mixed with grease form a lapping compound which will erode and destroy your bearings.

Water will wash away or dilute the grease, causing a bearing failure from insufficient lubrication. Water finds its way into your bearing housing primarily for two reasons:

- Improper bearing seal (labyrinth) maintenance
- Flooding of containment area where pump is located

Table 5. Suggested Lubrication Quantity & Interval for both Wet and Drive End Bearings

Bearing Frame	Wet end		Lubrication Interval in Hours-Based on Bearing RPM									
	Ounces	Grams	400	600	800	1000	1200	1400	1600	1800	2000	2200
P	0.7	20				1700	1400	1200	1000	900	800	600
Q	1	28			1800	1400	1000	800	650	450		
R	1.8	50	3200	2000	1400	1000	600	450	350			
S	2.3	66	2800	1500	900	500	300	200				
T	4.4	125	1800	900	400	250						

Bearing Frame	Drive end		Lubrication Interval in Hours-Based on Bearing RPM									
	Ounces	Grams	400	600	800	1000	1200	1400	1600	1800	2000	2200
P	0.5	14				1700	1400	1200	1000	900	800	600
Q	0.6	17			1800	1400	1000	800	650	450		
R	1.2	33	3200	2000	1400	1000	600	450	350			
S	1.8	50	2800	1500	900	500	300	200				
T	1.5	42	1800	900	400	250						

Table 6. Initial Grease Quantity

Bearing Frame	Wet end	
	Ounces	Grams
P	5.3	150
Q	12.4	350
R	23	650
S	28.2	800
T	84	2400

Bearing Frame	Drive end	
	Ounces	Grams
P	2.8	80
Q	5.5	160
R	12	350
S	19	550
T	28	800

Table 7. Grease Purging Intervals

	Type of Operation		
	24 Hr Day	16 Hr Day	8 Hr Day
Drive End Labyrinth	4 Shots per 120 hours	4 Shots Weekly	2 Shots Weekly

NOTICE

Shots are from a standard, hand operated grease gun.

One shot adds roughly one gram of grease.

8.4 Impeller clearance adjustment

The purpose of impeller adjustment is to maintain pump efficiency due to natural wear, by reducing the clearance between the face of the impeller and the pump suction side liner or casing.

Spacer shims are provided between the bearing housing and the top of the column to set the impeller float within the casing. Refer to Section 10.1.2 of the pump assembly instructions for setting this clearance appropriately. Refer to those instructions when making follow-on adjustments after sufficient wear has been realized.

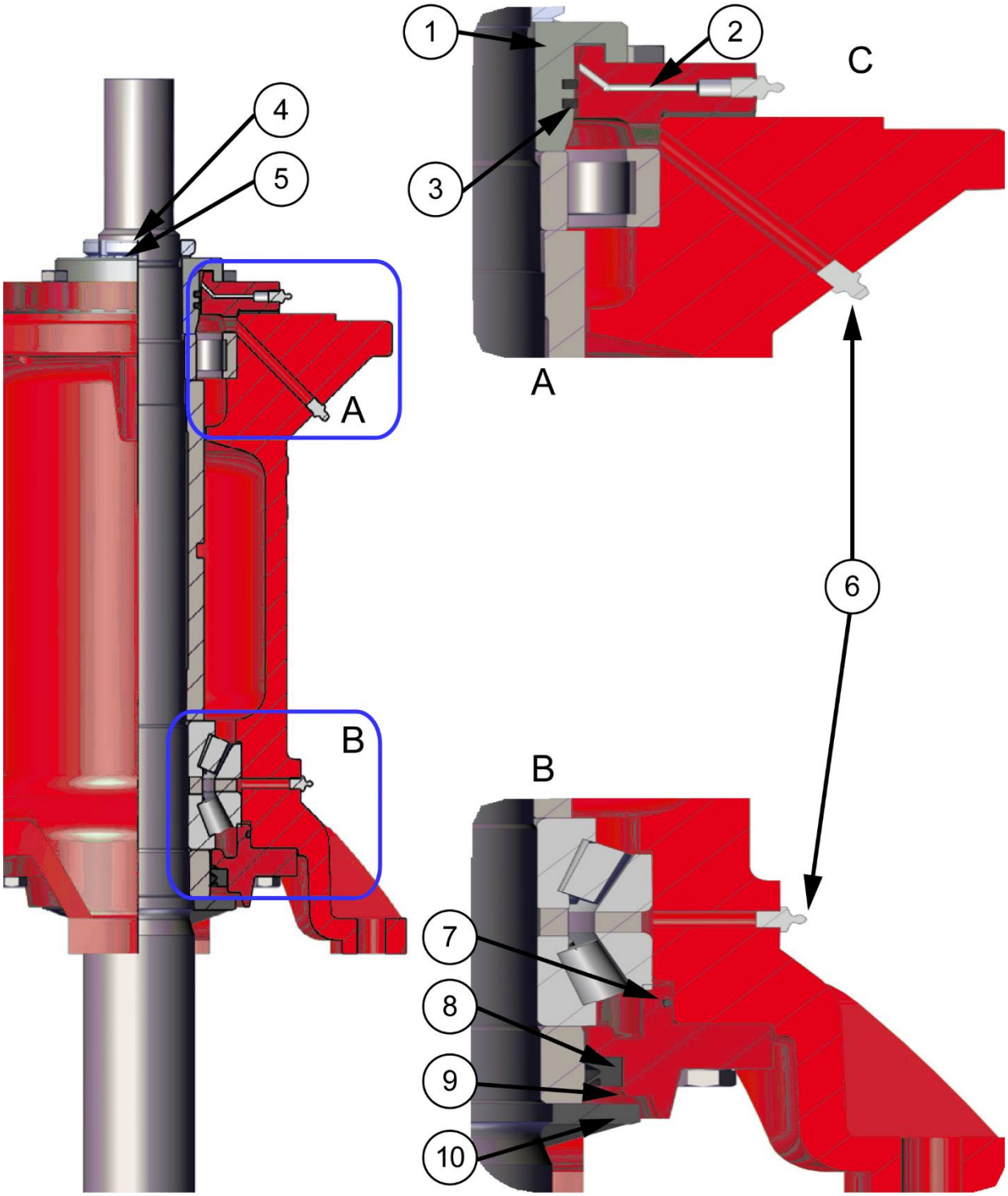

Figure 3. Bearing Housing Grease Fittings

Part	Description	Part	Description
1	Labyrinth (064)	8	Bearing seal (009)
2	End cover (028)	9	End cover (028)
3	Piston rings (072)	10	Flinger (036)
4	Locknut (065)	A	Detail A
5	Lockwasher (065)	B	Detail B
6	Bearing grease fitting	C	Labyrinth grease purge
7	O-ring (061)		

9 BEARING ASSEMBLY INSTRUCTIONS

Flowrox Vertical Bearing Assemblies are designed for heavy-duty use and can handle large overhung loads. The shaft sizes and overhangs have been carefully selected to ensure, in most cases, the normal operating speed range is below the shaft first critical speed range. Information on critical speeds can be found in

Appendix A: Critical Speed Advisory for Cantilevered Pumps.
Some important features of these assemblies are:

- The drive end shaft is metric with metric keys.
- No setting or adjusting of bearing end play is required. Vertical Bearing assemblies are fitted with a two-row tapered roller bearing at the lower end. These two-row bearings are factory set with the required amount of end play.
- Grease purged labyrinth is standard to assist in exclusion of dirt and moisture from assemblies.
- Motor supports to suit a range of motor sizes are available for direct as well as belt drives.

9.1 General notes

When bearing assemblies have been dismantled for complete overhaul all parts should be thoroughly inspected.

9.1.1 Cleaning

Used parts should be thoroughly cleaned and repainted where required. Mating faces and holes should be free of dust, burrs, and dirt and be given a coat of grease.
Always use lint-free rags when cleaning bearing assembly components.

It is preferable to replace all small bolts and setscrews, and to coat them with graphite grease prior to assembly.
It is recommended that all rubber seals should be replaced during overhauls as rubber will harden and the seals will lose effectiveness.

When installing new bearings, clean the bearing housing, end covers, shaft, and all components of the assembly to ensure that no dirt or contaminated grease remains in the bearing housing or threaded holes for zerk fittings.

Use an appropriate solvent to clean all components down to bare metal, and blow out with compressed air. Follow with a clean lint-free rag to ensure no contaminants or solvent remains on the surfaces. Cover the bearing housing with a clean plastic bag or rag following cleaning to prevent contamination prior to use in the rebuild.

Do not wash out the lubricant that the bearing is greased with at the factory. Any lubricant you add must be absolutely clean. Follow the procedures listed below to ensure that the grease will be clean.

- Use the grease quantities and type shown in Section 8.3.
- Always keep the cover on the grease can to prevent dirt from getting in.
- Make certain the tool you use to take grease from the can is clean.
  - ✓ Avoid using a wooden paddle.
  - ✓ Use a steel blade or putty knife that can be wiped off smooth and clean.
- If you use a grease gun to introduce grease into the bearing chamber, make certain the gun is clean – especially the nozzle and fittings.

CLEANLINESS IS KEY TO LONGEVITY

More than 90% of all roller bearing failures are due to dirt finding its way into the bearing. Dirt is composed of myriads of diamond hard particles that, when mixed with the lubricants, make a lapping compound. The revolving action of the rollers in operation will gradually grind away the original bearing parts, destroying the fit and efficiency of the bearing.

The critical period in the life of a bearing occurs when it leaves the stockroom for the assembly bench. This is the time when it is going to be removed from its box and protective covering. From this point on it is at the mercy of the person handling it.

When you are handling bearings, keep your hands and your tools clean. Keep plenty of clean, preferably lint-free, rags available and use them often. Do not use waste paper because lint and short strands adhere too readily to oiled/ greased surfaces. Keep your hands and work area wiped clean.

9.1.2 Initial parts inspections

9.1.2.1 New shafts

New shafts ship from the factory with a coating of corrosion protection. Maintain this corrosion protection on the shaft until it is ready for use in a bearing assembly rebuild. This coating should be removed with a solvent prior to assembly.
Ensure that the Flowrox locknut, if required for the assembly, threads (left-hand thread) onto the shaft before beginning assembly. If the locknut does not thread properly onto the shaft, stop work and contact the factory or authorized dealer.

9.1.2.2 Used shafts

Shaft inspection drawings are available from the factory or authorized dealer, and all used shafts should be inspected for proper fit and total-indicated-runout (TIR). Remove any burs or sharp edges. If fits or runout are out of tolerance, stop work and contact the factory or authorized dealer for a replacement shaft.

Previously used shafts should be cleaned and polished prior to re-use. Shafts should be coated with an appropriate corrosion inhibitor if the shaft is to be stored for any period of time beyond 24 hours before the repair is to take place. This coating is to be removed once the rebuild begins.

9.1.2.3 Bearing housing

Inspect the inside and outside of the bearing housing for corrosion. Verify that machined mates on the inside where bearing cones fit and outside where the housing mates to the pump base are not corroded. Corrosion inside the housing will cause loss of fit on the bearing cone, and corrosion on the mounting feet of the housing can cause misalignment between the bearing assembly and the lower end of the pump. When in doubt, consult the factory or authorized dealer for proper fits, or replacement parts.

9.2 Assembly instructions

The following instructions apply for all standard Flowrox V Series bearing assemblies. Some pump assemblies which have a lower bearing design will have alternate assembly instructions

provided in a supplement to this manual. Consult the factory regarding your particular pump if you should have any questions.

9.2.1 Fitting of Shaft Sleeve Ejector, Lower Bearing, Bearing Sleeve and Upper Bearing Inner Ring to Shaft

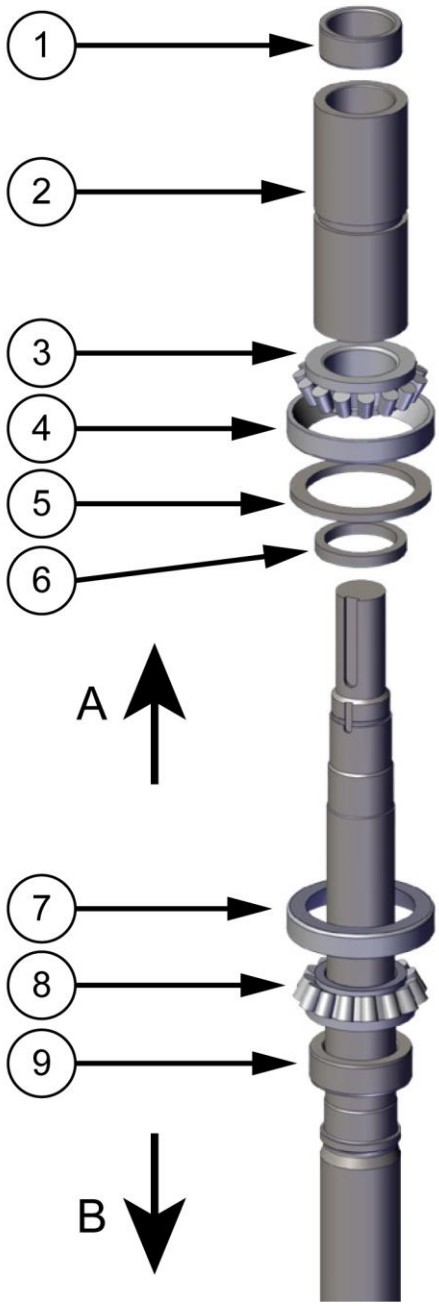

Figure 4. Fitting Shaft Sleeve Ejector, Lower Bearing, Bearing Sleeve and Upper Bearing Inner Ring to Shaft

Part	Description	Part	Description
1	Bearing onner ring (007)	5	Cup spacer
2	Bearing sleeve (010)	6	Cone spacer
3	Bearing cone	7	Bearing cup

Part	Description	Part	Description
4	Bearing cup	8	Bearing cone
9	Shaft sleeve ejector (080)	B	Impeller end
A	Drive end		

Refer to Figure 4.

1. Check the part number of SHAFT (075) against the Flowrox Component Diagram of the pump to make certain it is the correct part.

NOTICE

- Type “M”, metal wetted-parts, Pumps have a bare metal shaft.
- Type “E*”, rubber or other elastomer molded wetted-parts, Pumps have an elastomer coated shaft

*”E” will be replaced by a letter representative of the wetted materials, e.g. “R” for Natural Rubber, etc.

2. Check the SHAFT (075) for straightness and remove any burrs or sharp edges.
3. Check that the LABYRINTH LOCKNUT (065) fits the shaft thread, and also check that the BEARING SLEEVE (010) is a good sliding fit on the shaft.
4. Stand and support the shaft in a vertical position with the drive end at the top as shown in Figure 4. This can be done by threading the shaft into a stationary impeller which is fixed or held on a level surface. If the length of the shaft makes this impractical, the next assembly operations may be done with the shaft supported horizontally.
5. Clean all components and remove any preservative coating from new parts. DO NOT remove the factory applied lubricant from the bearings. Leave bearings in their wrappers until later in the assembly process. Lightly oil or grease the top end of the shaft.
6. Oil or lightly grease the bore of the SHAFT SLEEVE EJECTOR (080), and place over the drive end of the shaft. Position the shaft sleeve ejector so it is tight against the shaft shoulder. The bore is toleranced so that it may have a slight interference fit over the shaft journal. A preheat (not to exceed 210°F (100 °C)) will ease installation. Once cool, use a pipe to position hard against the shaft shoulder.
7. Fit one cone of BEARING (005) with large diameter against shaft sleeve ejector. Because the bearing bore is an interference fit with the shaft journal, it is advisable to preheat the bearing inner rings or cones (preheat should not exceed 210°F (100 °C)). It is best to use an induction heater or oven to heat the bearings.
8. With the Shaft in the vertical position, slip on the heated cone and press or tap up to the Shaft Sleeve Ejector.

NOTICE

To ensure that the inner cone fits tight against the Shaft Sleeve Ejector, you can use a length of pipe that fits over the shaft and bears on the cone of the bearing without damaging the rollers or cage. This allows the bearing to be tapped down hard with a lead hammer. When the bearing slips into position against the shaft sleeve ejector, wait 20 to 30 seconds for the bearing to cool

before tapping it down with the pipe.

9. Fit the cone spacer of BEARING (005) on the shaft. The spacer fits against the smaller end of the bearing cone. Slide the cup up against the cone. For some bearing assemblies, the cup consists of three separate pieces. The bearing is the same as if the cup was in one piece, except that the two cups are separated by a spacer.

⚠ CAUTION!

Make sure the two cones marked 'A' are assembled together.

Incorrect assembly will cause premature bearing failure.

NOTICE

One of the two cones will have an etched 'A' postscript to its serial number. It must be mated with the cup that has the etched 'A' serial number postscript. The other cup and cone set will not have a serial number postscript.

10. Fit the second cone of the bearing on the shaft. The smaller diameter end of the cone fits against the cone spacer.

NOTICE

- Cones and spacers should be located hard against one another and finally against the shaft shoulder. This should be further checked after bearing cools. Using the setting pipe as before, drive the bearing down onto the shaft sleeve ejector.
- Bearings (005 & 007) are provided with spacers and as such are pre-set assemblies. The spacers are finished to size for each bearing assembly and component parts from one assembly are NOT interchangeable with a similar assembly. In some large bearing assemblies, an identifying serial number is marked on each cup, cone and spacer to ensure that these parts do not become mixed before use. Keep all parts with the same serial number together. Some small pre-set assemblies are not marked with a serial number, but they are still NOT interchangeable. Component parts should be assembled as they are received.

11. Oil or lightly grease the shaft above the fitted lower bearing and slip the BEARING SLEEVE (010) over the shaft. Let the sleeve rest against the lower bearing. Check to make certain the sleeve is seated squarely against the bearing.
12. Apply oil or light grease to the upper bearing journal.
13. Fit the inner ring of BEARING (007) to the drive end of the shaft so it is against the BEARING SLEEVE (010). It is advisable to preheat the bearing inner ring (preheat not to exceed 210°F (100 °C)). It is best to use an induction heater or oven to heat the bearings. Make certain the bearing is seated squarely against the sleeve. Spray the lower bearing with dewatering fluid to remove all moisture.

Tap down hard onto the sleeve using pipe as before.
For “T” frame vertical bearing assemblies, fit two (2) inner rings to drive end of shaft against bearing sleeve.

14. Work the recommended grease by hand into the lower bearing. Work the grease from both sides until grease appears through holes in the cup. The recommended initial quantity of grease is indicated in Table 6.
15. Lightly grease the upper bearing inner ring and bearing sleeve. Cover the shaft and bearings to keep off dust and dirt while you are preparing the BEARING HOUSING (008).

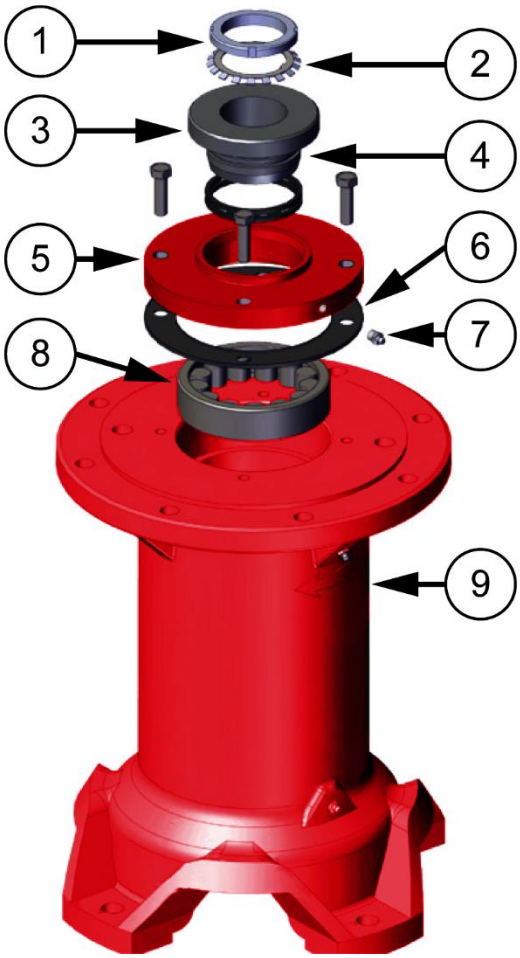

Figure 5. Fitting Upper Bearing Outer Ring and End Cover to Bearing Housing.

Part	Description	Part	Description
1	Locknut (065)	6	End cover gasket (084)
2	Lockwasher (065)	7	End cover zerk
3	Labyrinth (064)	8	Upper bearing outer ring (007)
4	Piston rings (072)	9	Bearing housing (008)
5	End cover (028)		

9.2.2 Fitting Upper Bearing Outer Ring and End Cover to Bearing Housing

Refer to Figure 5.

1. Thoroughly clean the BEARING HOUSING (008) inside and outside. Make certain that no

dirt is lodged in the large cavity in the center of the housing and that the grease holes are clean. Check the bearing bores for concentricity, removing any burs or hard edges.

2. Install the grease nipples into the BEARING HOUSING (008) and UPPER END COVER (028 Z0). Check to make certain that grease flows freely through the fittings and holes.
3. Apply light oil or grease to the drive end of the BEARING HOUSING (008).
4. Stand the housing with the drive end up. Fit the outer ring of BEARING (007) and evenly tap it against the housing shoulder using a soft hammer.
   An alternate method of bearing installation is to use the UPPER END COVER (028 Z0) with longer set screws to push the bearing outer ring into position.
5. Work the recommended bearing grease into the bearing in the housing, filling spaces between the bearing rollers. Force grease into the bearing cage until it is completely filled.
   Leave space in the housing below the bearing free of grease to allow sufficient space for excess grease to be expelled from the bearing rollers without causing undue churning of the grease. The recommended initial quantity of grease is indicated in Table 6.
6. Fill the space between the drive end UPPER END COVER (028 Z0) and the bearing with grease. This will ensure that there is sufficient grease in contact with the bearing.
7. Place the drive end END COVER (028 Z0) with the END COVER GASKET (084) into the housing. Orient the labyrinth grease zerk in line with the zerks on the BEARING HOUSING (See Figure 3). Then insert END COVER SET SCREWS (031) and tighten evenly.

9.2.3 Fitting Shaft, Lower End Cover, Bearing Seal and Shaft Flinger to Bearing Housing

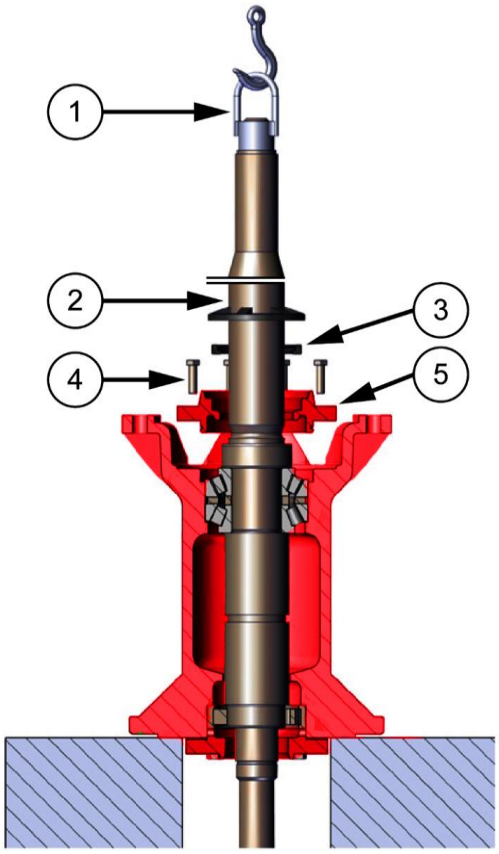

Figure 6. Fitting Shaft, Lower End Cover, Bearing Seal and Shaft Flinger to Bearing Housing.

Part	Description	Part	Description
1	Shaft lifting nut	2	Flinger (036)
3	End cover seal (009)	5	End cover (028)
4	End cover bolts (050)		

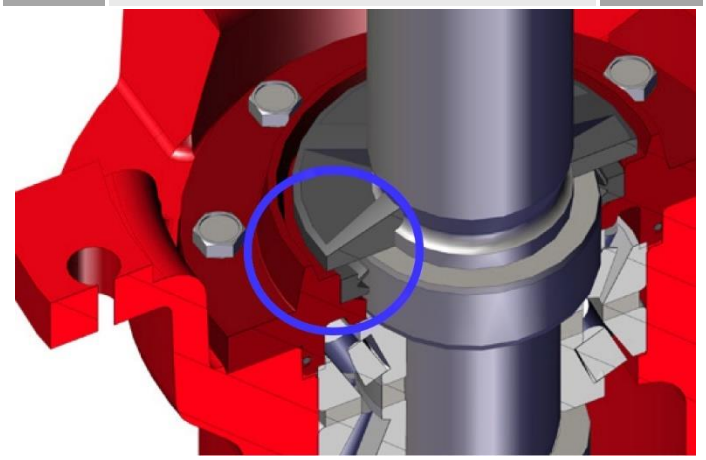

Figure 7. Shaft Flinger, Wet End Bearing and End Cover.

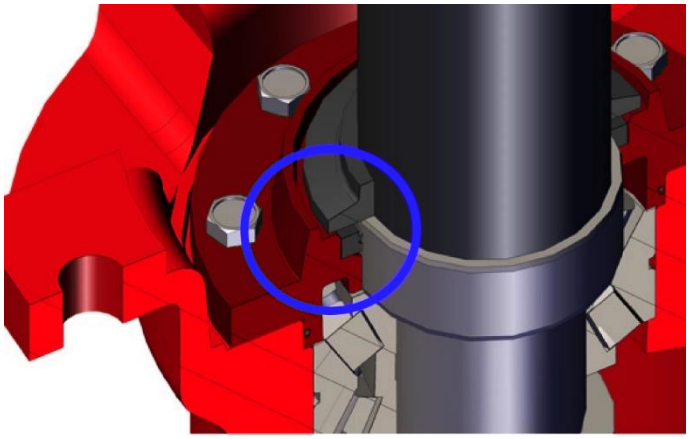

Figure 8. Rubber Lined Shaft with Flinger, Wet End Bearing and End Cover.

Refer to Figure 6

Fitting the assembled shaft to the bearing housing can be done either horizontally or vertically. The method described is for vertical assembly.

1. Place the bearing housing on two wooden blocks, high enough for the fitted shaft to clear ground level, with the fitted drive end cover down. Clean and lightly grease both the drive end races and the housing wet end bore.
2. Screw the SHAFT LIFTING NUT on the wet end of the shaft. Carefully lower the shaft into the bearing housing. Tap the wet end bearing until it rests firmly against the bearing housing shoulder (See Figure 7). The shaft should slide into position – if the fit is tight or hangs, check that the shaft is not fouling.
3. Leave the space under the bearing and the LOWER END COVER (028 E2) free of grease to allow sufficient space for excess grease to be expelled from the bearing rollers without causing undue churning of the grease. Place the END COVER O-RING (061) on the LOWER END COVER (028 E2). (See Figure 3)
4. Slip end cover over the shaft and into the bearing housing. Insert END COVER SET SCREWS and tighten evenly to lock the lower bearing cup in position. Do not over-tighten.

NOTICE

There should be a space between the housing and the end cover.

5. Fit BEARING SEAL (009) into the recess in the lower end cover. The seal lip faces out as shown in Figure 3. Alternative lower end cover seal arrangements are possible. Consult your certified component diagram for your particular bill of materials and installation sequence.
6. Install FLINGER (036) on shaft – this procedure varies as follows:
   a. **Rubber Covered Shaft**
      Slide FLINGER (36) along the shaft until the large diameter on the flinger fits into the recess in the lower end cover as shown in Figure 8.
   b. **Bare Metal Shaft**
      Slide the FLINGER (036) along the shaft until the large diameter on the flinger fits into the recess in the lower end cover, and the fingers on the internal diameter of the flinger seat on the shaft recess as shown in Figure 7.

9.2.4 Fitting Piston Rings, Labyrinth, and Labyrinth Locknut to Drive End

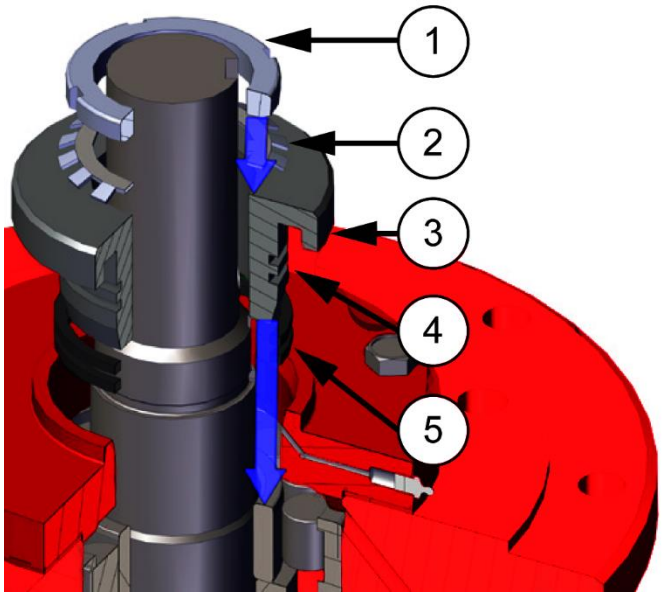

Figure 9. Fitting Labyrinth, Piston Rings, Lockwasher, and the Locknut.

Part	Description	Part	Description
1	Locknut (065)	4	Piston ring grooves
2	Lockwasher (065)	5	Piston rings (072)
3	Labyrinth (064)		

Refer to Figure 9.

1. Turn the bearing assembly horizontally. Smear PISTON RINGS (072) with grease and fit two rings to the grooves of the LABYRINTH (064). Position the piston ring gaps so they are diametrically opposite
2. Clamp the piston ring hooks to each other to compress each into its respective groove in the labyrinth.
3. Slide the labyrinth over the shaft and push it into the top end cover until it bottoms out.
4. Fit the labyrinth LOCKWASHER (065 LW) to the end of the shaft.
5. Screw the LABYRINTH LOCKNUT (065 LN) onto the shaft and tighten using the assembly tools SHAFT WRENCH (301) and appropriate C-SPANNER wrench. Lock the nut with a convenient tab on the lockwasher.
6. Pump grease into the labyrinth until grease comes out between the labyrinth and end cover, which ensures a completely purged fill in the labyrinth seal.

The Bearing Assembly now takes Flowrox Basic Part Number (006) and should be ready for assembly of the remaining pump components.

9.3 Final Bearing Assembly Checks

9.3.1 Checking Bearing Fitted End Play

Although the specified bearings are complete assemblies fitted together and require no adjustment or float-setting, you should check the fitted end play against the values shown in Table 8.

Table 8. Allowable Fitted End Play

Bearing Frame	Fitting End Play (Inches)	Fitting End Play (mm)
P	.003-.006	.074-.160
Q	.004-.008	.114-.208
R	.003-.008	.084-.210
S	.002-.008	.064-.206
T	.005-.010	.127-.259

Measuring the Fitted End Play

1. Stand the bearing assembly drive end down on two wooden blocks. The entire assembly must be located in a position where it can be reached by a hoist. Screw the SHAFT LIFTING NUT onto the impeller end of the shaft.
2. Attach a dial indicator to the assembly so the relative axial movement between the shaft and housing can be accurately measured. A dial indicator with a magnetic base is suggested.

3. Using a hoist, move the shaft up and down by lifting the entire assembly off the support and lowering it back onto the support. Repeat this procedure several times until the readings become consistent.

Note the total movement and check to see if it is within the values given in Table 8. If the movement is outside these limits, review the bearing assembly procedure. Disassembly may be required. Consult the factory if the appropriate fitted end play cannot be reached.

9.3.2 Testing (optional)

1. In some instances, you may wish to test run the assembly before placing the unit in service or in store. Testing can be carried out by mounting the assembly on a test rig stand. To obtain the required speed, connect the shaft to a small motor, either through a coupling or with pulleys.
2. One hour is ample time to test. One or two things will happen:
   a. If the end play and the amount of grease used are correct, and all components are in good working order, there should be little or no heating after the one hour period.
   b. If one or both of the bearings heat quickly and excessive stop the test and allow the assembly to cool down.
3. Excessive heating occurs when the assembly surface temperature exceeds 90 °C (200° F).
4. Often a short heat-up time is caused by an excessive amount of grease in the bearings. Allow the assembly to cool, then restart the test. If the bearing assembly heats up again, stop the test.
5. If heating persists, stop, disassemble and inspect all components. Watch for foreign matter in the grease and in component parts.

9.3.3 Maintenance: Standby Pumps

Where stand-by pumps are standing idle for long periods, manually turn their shafts a quarter-turn at least once per week. In this way, all rollers in turn are made to carry static loads and external vibrations.

10 PUMP ASSEMBLY

Before you begin…

Referring to a Certified Component Diagram for the particular pump being assembled will be of assistance in following the instructions outlined here.

All parts dismantled during pump overhaul should be inspected to assess suitability for re-use, and identification of new parts should be checked.

Parts suitable for re-use should be cleaned and painted when appropriate. Mating faces should be free of rust, dirt, and burrs, and have a coating of anti-seize compound or grease applied prior to assembly.

Small fasteners should preferably be replaced, and all threads coated with graphite grease or similar anti-seize compound before assembly.

Replacement of all elastomer seals is recommended at major overhauls, as these materials tend to deteriorate with use. Exposure to direct and continuous sunlight will accelerate material degradation.

10.1 Assembly of Metal Wet-end Pumps (Type "M")

10.1.1 Fitting Column and Mounting Plate to Bearing Assembly

1. Completely assemble the BEARING ASSEMBLY (006) according to assembly instructions outlined in Section 9 of this manual.

2. METAL UPPER STRAINER ONLY: If using a metal top suction STRAINER, slide the strainer from the top of the COLUMN (015) to land on the bottom. Ensure the strainer has complete coverage behind each of the three top suction ports.
   RUBBER UPPER STRAINERS (087) will be installed later if they are specified in lieu of METAL UPPER STRAINER.

3. Fit the bearing assembly into COLUMN (015) and align the two parts as shown in Figure 11. Take particular note of the orientation of the grease nipples relative to the casing mounting lugs on the column bottom. Failure to do so will make it impossible to properly position the discharge pipe through the mounting plate.

NOTICE

For V Series pumps fitted with lower bearings refer to the Flowrox "V Series LB Supplement" for additional instructions on mounting the specified LOWER BEARING ASSEMBLY to the pump. These steps will generally be performed following the mounting of the BEARING ASSEMBLY (006) the COLUMN (015).

4. Fit a SPACER SET (086) between the BEARING HOUSING (008) feet and the top of the column. These spacers are used to adjust the impeller and can be added or removed depending on the requirements of the assembly for setting impeller clearance.
5. Standard impellers are normally adjusted toward the bottom suction, usually within 1/8” or closer to the casing.
6. Insert the column bolts and tighten evenly.
7. Place two halves of MOUNTING PLATE (222) around the column and orient to suit the discharge pipe position.
8. Bolt the mounting plate to the column using COLUMN STUDS AND NUTS.

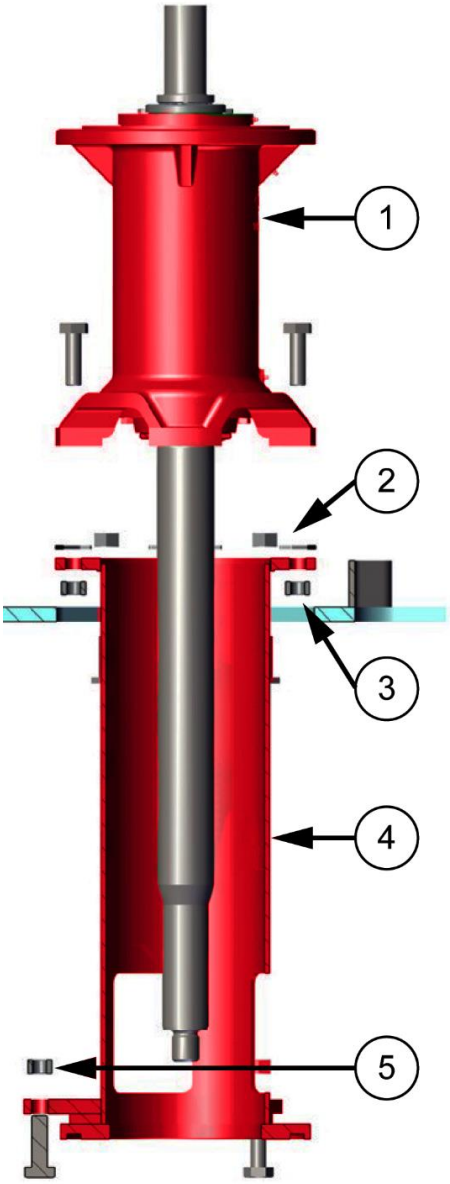

Figure 10. Fitting the Bearing Assembly into the Column and Mounting Plate.

Part	Description	Part	Description
1	Bearing assembly (006)	2	Spacer set (086)
3	Mounting plate (222)	5	Casing mounting lug
4	Column (015)		

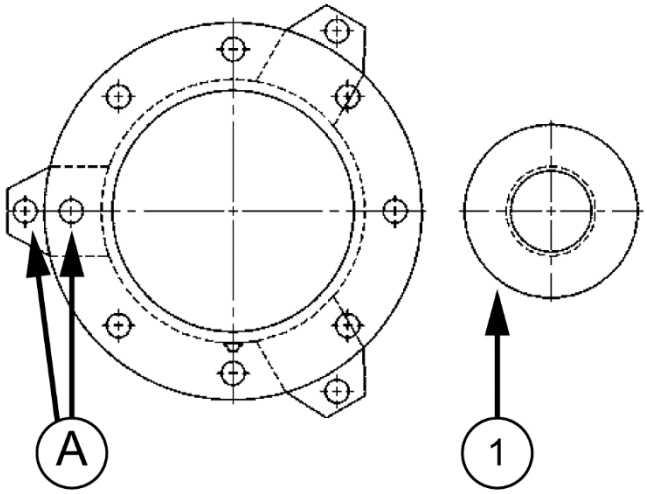

Figure 11. Bearing Assembly and Column Alignment.

Part	Description	Part	Description
1	Discharge pipe	A	Note position of hole in top of column flange relative to lug on bottom of column

10.1.2 Fitting Back Liner, Impeller, Casing, and Suction Strainer

Assembly of the wet-end pump components is made easier if the unit is able to be supported vertically, with the impeller end of the shaft facing upwards. Otherwise, assembly can proceed horizontally with each component supported as necessary in the fitting process.

1. Insert the BACK LINER SEAL (106) (the part may also be described as VOLUTE LINER SEAL in your component diagram) into the groove in the end of the column. The open side lips of the seal should be facing out.
   If the pump calls for a metal screen upper strainer, this should have been installed in the procedure steps detailed in Section 10.1.1.
2. Lower the BACK LINER (040) over the shaft and onto the end of the column. Make certain the back liner engages in the column and lies evenly on the seal.

NOTICE

If assembling horizontally, clamp the Back Liner (040) to the column before moving on to the next step.

3. Fit IMPELLER O-RING (059) into the groove on the end of the shaft.
4. Apply grease to the impeller thread on the end of the shaft. Take care to not over-grease the threads (remove any excess), as too much grease may prevent the impeller from screwing hard home on the shaft.

5. Screw the IMPELLER (part number as specified on component diagram) onto the shaft. Hold the shaft with SHAFT WRENCH (301) and turn the impeller with a bar between the vanes of the impeller to tighten it on the shaft. Take care when installing elastomer impellers not to damage the elastomer.
6. Position the CASING (012) on the end of the column as shown in Figure 12, aligning the casing discharge neck with the upper discharge pipe mount on the MOUNTING PLATE. Make sure the impeller turns freely. If not, add or remove the SPACERS (086) at the top of the column until impeller just clears the bottom suction of the casing.
7. Fit the three (3) column bolts and tighten evenly. Please reference Table 9 for appropriate torque values.

NOTICE

The column bolts should be tightened only sufficiently to compress back liner seal and bring casing and end of column faces in metal-to-metal contact.

⚠ CAUTION!

Do not overtighten.
Overtightening can damage and break the bolt retaining tabs on the casing.

8. Attach the Lower Strainer (087) to the Casing (012) and bolt together using Intake Flange Bolts.

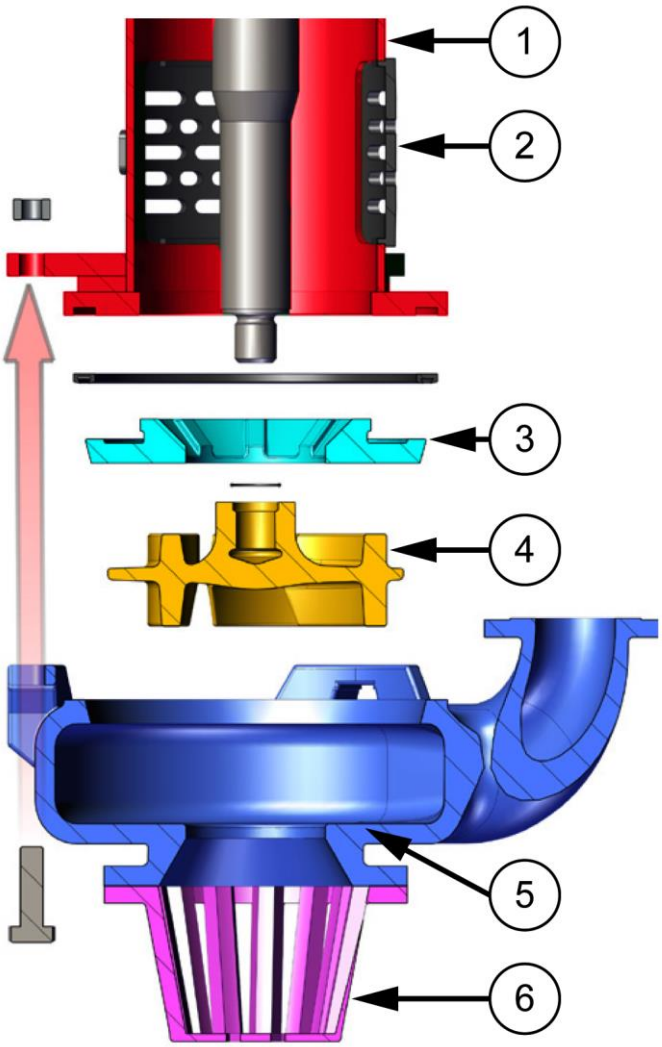

Figure 12. Alignment Fitting Back Liner, Impeller, Casing, and Suction Strainer.

Part	Description	Part	Description
1	Column (015)	4	Impeller
2	Upper strainer (087)	5	Casing (012)
3	Back liner (040)	6	Lower strainer (087)

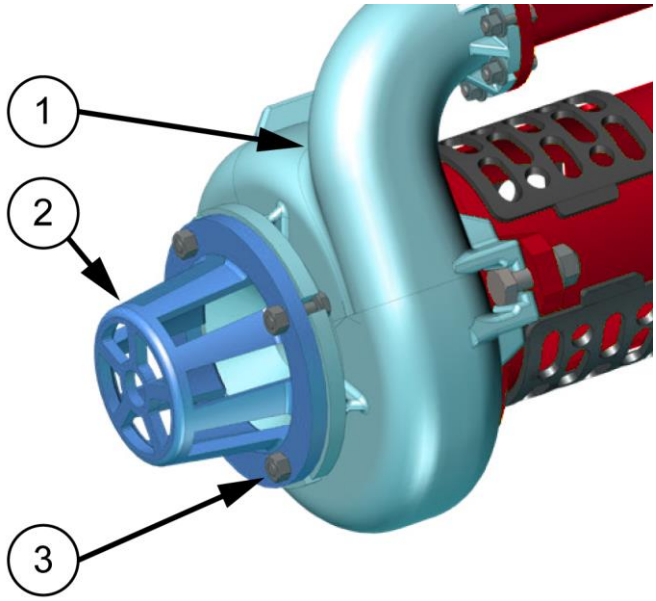

Figure 13. Fitting Discharge Pipe and Upper Strainers.

Part	Description
1	Casing (012)
2	Lower strainer (087)
3	Lower strainer bolts

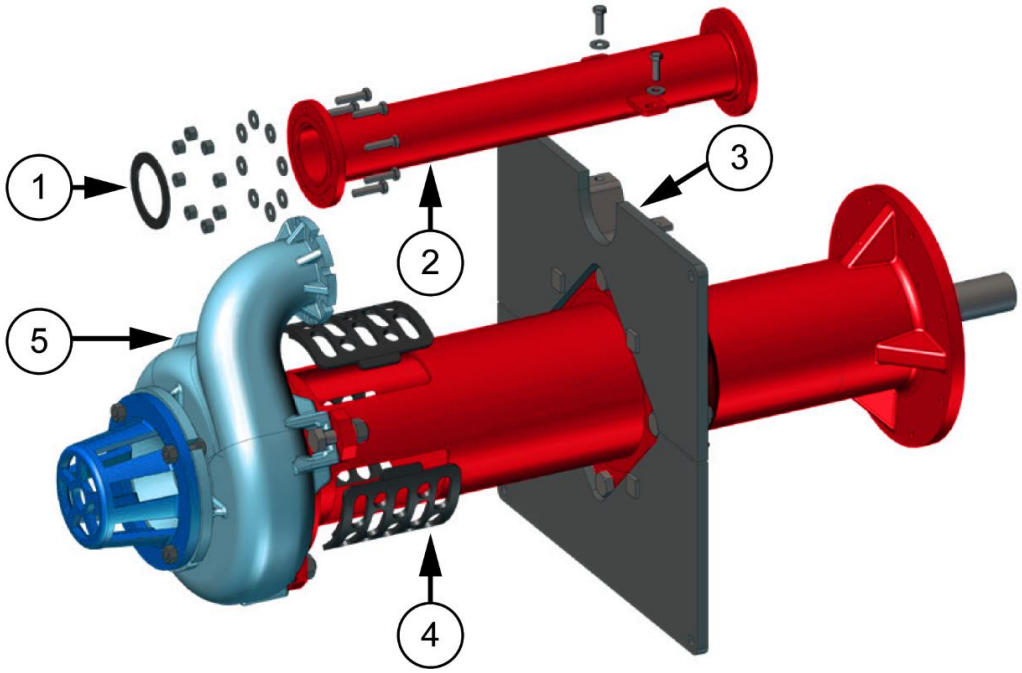

Figure 14. Fitting Discharge Pipe and Upper Strainers.

Part	Description	Part	Description
1	Discharge pipe gasket (027)	4	Upper strainers (087)
2	Discharge pipe (026)	5	Casing (012)
3	Mounting plate		

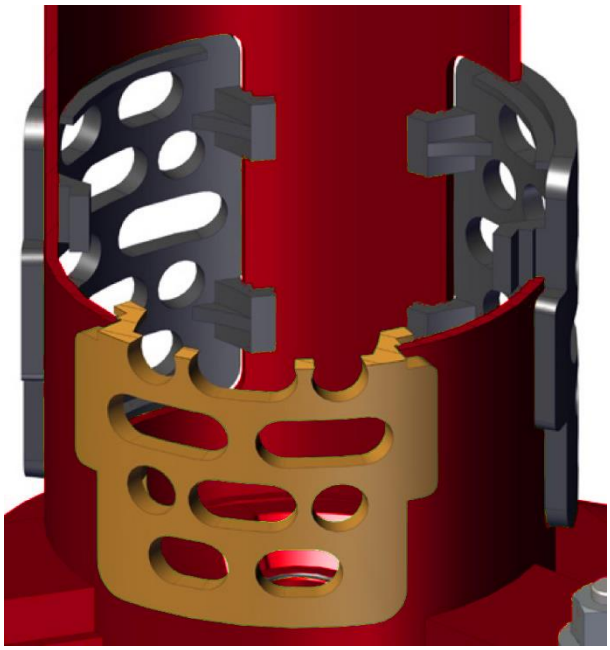

Figure 15. Fitting Upper Elastomer Strainers.

Table 9. Maximum Torque Values for Column Bolts

Models	Ft/Lbs	NM
1.5 V 1.5 VP M	50	68
2.5 V 2.5 VQ M	75	102
4 V 4 VR M	108	146
6 V 6 VS M	133	180
8 V 8 VS M	167	225
10 V 10 VT M	210	285
1.5 V 1.5 VP R	50	68
2.5 V 2.5 VQ R	75	102
4 V 4 VR R	108	146
6 V 6 VS R	133	180

10.1.3 Fitting Strainers and Discharge Pipe

If the pump is vertically oriented at this point, place the pump horizontally with the discharge pipe on top as shown in Figure 14.

1. Position DISCHARGE PIPE GASKET (027) on the CASING (012) discharge (contact cement or similar rubber adhesive will hold the gasket in place while the discharge pipe is being fitted).

2. Fit DISCHARGE PIPE (026), ensuring gasket does not move, and install discharge pipe bolts. Tighten evenly.

NOTICE

Some models have a SPLIT DISCHARGE FLANGE, which mates the casing to the discharge pipe.

In this case attach two pieces of the SPLIT DISCHARGE FLANGE around the casing discharge and join together using DISCHARGE FLANGE BOLTS.

Fit SPLIT DISCHARGE FLANGE to DISCHARGE PIPE (026) and install discharge pipe bolts. Tighten evenly.

3. Insert the DISCHARGE PIPE RETAINING BOLTS and NUTS to attach the top end of the discharge pipe to the mounting plate. Tighten the bolts.
4. If the three individual UPPER STRAINERS (087) are used, install into the column openings (cutouts) in the column as shown in Figure 15. Bend strainers slightly and fit into cutout in column, such that the four molded strainer lugs clip into the sides of the column cutout and hold strainer firmly.

NOTICE

Two steps are provided on the strainer retaining lugs: the lower step is for metal columns(this instruction set), and the higher step is for elastomer covered columns (assembly of which is detailed in Section 10.2).

10.1.4 Fitting Optional Attachments

The optional attachments, assembly of which is described below, may be specified on various V Series pump models. Consult the factory and your certified component diagram for the presence or lack of such attachments.

10.1.4.1 Suction Extension (Tailpipe)

Refer to Figure 16.

- Fit SUCTION GASKET (113) between casing suction and TAILPIPE.
- Install TAILPIPE to CASING (012) and bolt together using INTAKE FLANGE BOLTS. Tighten evenly.
- Fit LOWER STRAINER (087) to TAILPIPE using STRAINER BOLTS. Tighten evenly.

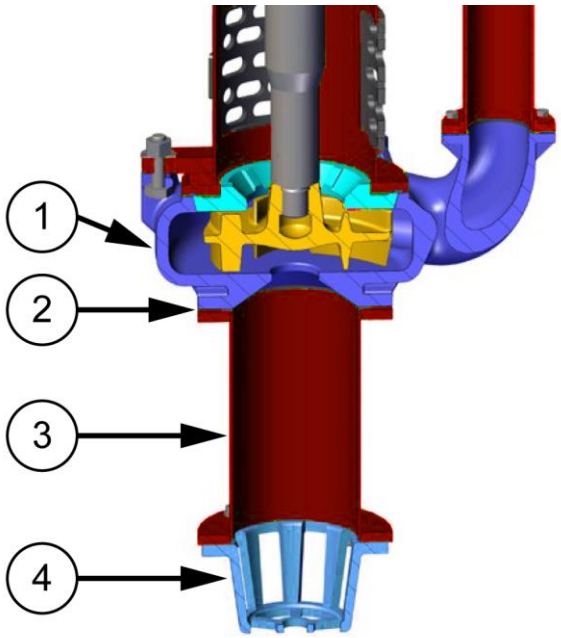

Figure 16. Tail pipe extension.

Part	Description	Part	Description
1	Casing (012)	3	Tailpipe
2	Suction gasket (113)	4	Lower strainer (087)

10.1.4.2 Fitting Agitator Assembly

Refer to Figure 17.

- Fit shaft O-ring into groove on end of AGITATOR SHAFT (046 AG).
- Apply graphite thread lubricant or other anti-seize compound to the agitator shaft thread. Screw AGITATOR SHAFT (046 AG) to end of shaft (075) through the center bore of the IMPELLER.
- Apply grease to agitator thread on the agitator shaft. Take care to not overgrease the threads (remove any excess), as too much grease may prevent the impeller from screwing hard home on the shaft.
- Screw PUMP AGITATOR (136 AG) onto end of AGITATOR SHAFT (046 AG). Tighten with spanner or suitable means until AGITATOR (136 AG) is flat on the shaft shoulder.
- Fit AGITATOR STRAINER BASE (087 AG) to CASING (012) and bolt together using appropriate bolts and washers. Tighten evenly.

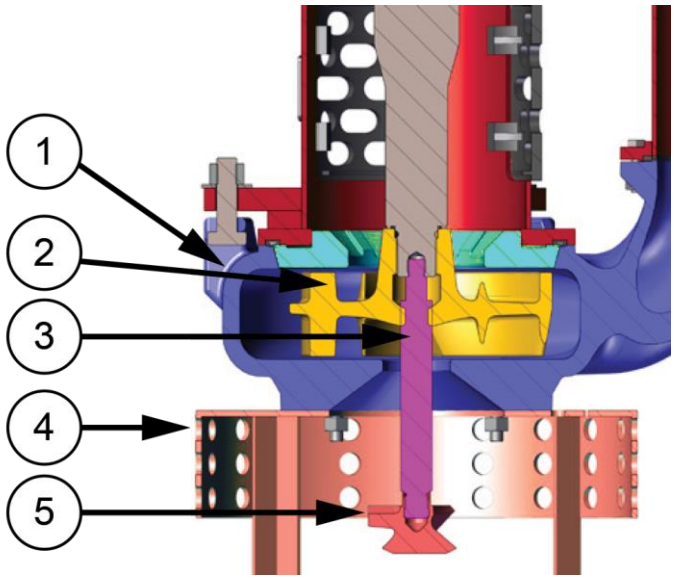

Figure 17. Fitting Agitator Assembly.

Part	Description	Part	Description
1	Casing (012)	4	Strainer base (087 AG)
2	Impeller	5	Pump agitator (136 AG)
3	Agitator shaft (046 AG)		

THE PUMP IS NOW COMPLETE AND READY FOR INSTALLATION OF DRIVE COMPONENTS.

10.2 Assembly of Elastomer Wet-end Pumps (Type "E")

NOTICE

Actual wetted materials of construction will be identified with a representative letter designation in the pump model number, i.e. NATURAL RUBBER – "R", HYPALON – "H", BUTYL – "B", etc). If in doubt, contact your Flowrox Slurry representative or the factory.

10.2.1 Fitting Column and Mounting Plate to Bearing Assembly

Follow instructions for Type "M" pumps in Section 10.1.1 on Fitting of Strainer to Column, Column and Mounting Plate to Bearing Assembly EXCEPT the orientation of the column and bearing housing, which should be completed as follows indicated in the below Section 10.2.1.1 for base models 1.5V1.5VPE and 2.5V2.5VQE and Section 10.2.1.2 for all larger base models.

10.2.1.1 Orientation of Components for 1.5V1.5VPE and 2.5V2.5VQE Base Models

Please refer to *Figure 18.* Types 1.5V1.5VPE and 2.5V2.5VQE Standard Components Orientation Viewed from Drive End

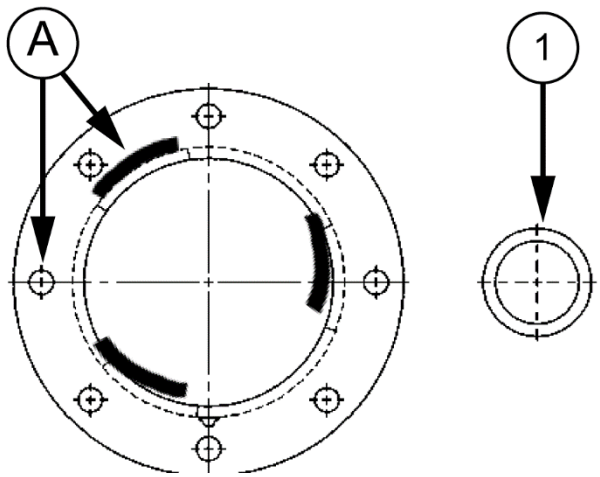

Figure 18. 1.5V1.5VPE and 2.5V2.5VQE Standard Component Orientation.

Part	Description	Part	Description
1	Discharge pipe	A	Note position hole in tip of column flange relative to upper strainer cut outs on side of column

10.2.1.2 Orientation of Components for 4V4VRE Base Model and Larger Sizes

Please refer to *Figure 19.* Types 4V4VRE and Larger Standard Components Orientation Viewed from Drive End.

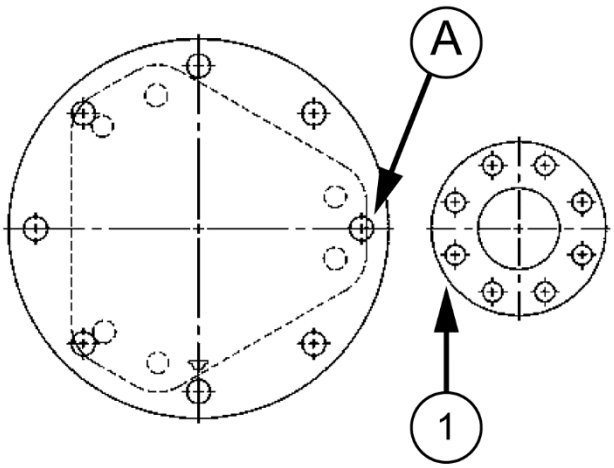

Figure 19. 4V4VRE and Larger Standard Component Orientation.

Part	Description	Part	Description
1	Discharge pipe	A	Note position of hole in top flange relative to holes in bottom flange

10.2.2 Fitting Back Liner, Impeller, Casing, Discharge Pipe, and Column Clamp

10.2.2.1 Procedure for Base Models 1.5V1.5VPE and 2.5V2.5VQE.

Please refer to *Figure 20*. Elastomer wet-end assembly for base models 1.5V1.5VPE and 2.5V2.5VQE

1. Position the pump horizontally so that the clamp for the discharge pipe is at the top. Place support beneath column to allow free access and working space at the pump end of the column.
2. Fit the BACK LINER (040) to the column end orienting the liner for correct discharge pipe position. The spigot on the back liner must fully engage on the inside of the rubber covered COLUMN (015).
3. Fit the IMPELLER O-RING (059) into the groove on the end of the shaft.
4. Liberally grease the impeller thread on the end of the shaft. Take care to not overgrease the threads (remove any excess), as too much grease may prevent the impeller from screwing hard home on the shaft.
5. Screw the impeller onto the shaft. Hold the shaft while turning the impeller with a bar placed between the vanes of the impeller. Be careful not to over tighten or to mar the surface of the impeller vanes.
6. Fit the DISCHARGE PIPE (026) into the back liner so that the shoulder on the pipe is against the top surface of the back liner.
7. Lift the CASING (012) and hold it against the back liner. Align the discharge of the casing to match the discharge pipe. Make certain that the impeller turns freely. If it does not, adjust the SPACERS (086) at the top of the column.
8. Fit the two halves of the COLUMN CLAMP (016) around the column and the discharge pipe.
9. Fit the COLUMN CLAMP SOCKET HEAD CAP SCREWS to the SOCKET HEAD PROTECTORS (029). Insert the cap screws through the column clamp and back liner, and screw into the casing.

NOTICE

Tighten all cap screws evenly and in sequence to ensure an even compression of the elastomer.

Check the following:

- The impeller turns freely.
- The pump head is held firmly on the column.

10. Fit “snap-on” caps onto the SOCKET HEAD PROTECTORS (029).
11. Fit discharge pipe retaining screw and nut to fix the top end of the discharge pipe to the mounting plate tabs. Tighten evenly.

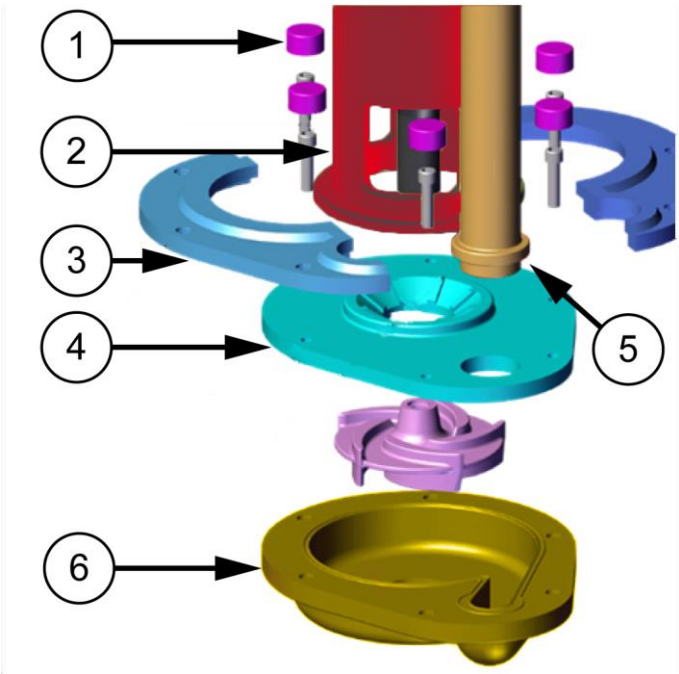

Figure 20. 1.5V1.5VPE and 2.5V2.5VQE, Fitting Back Liner, Impeller, Casing, Discharge Pipe, and Column Clamp.

Part	Description	Part	Description
1	Socket head projectors (029)	4	Back liner (040)
2	Column (015)	5	Dischanger pipe (026)
3	Column clamp (016)	6	Casing (012)

10.2.2.2 Procedure for Base Models 4V4VRE and Larger

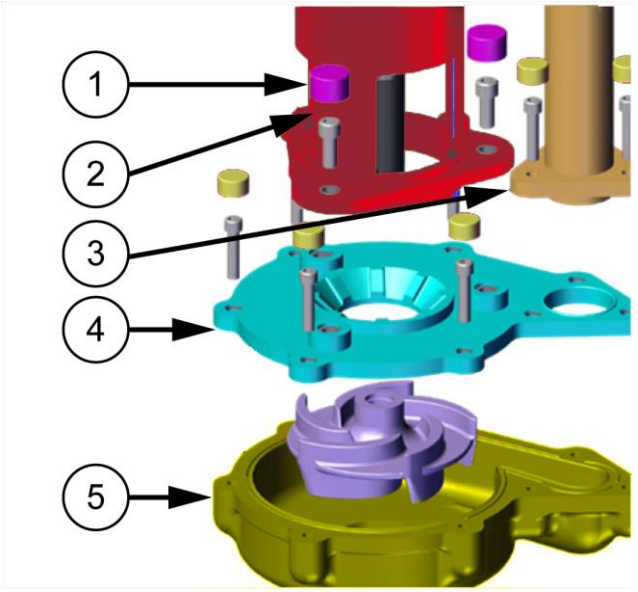

Figure 21. 4V4VRE and Larger, Fitting Back Liner, Impeller, Casing, Discharge Pipe, and Column Clamp.

Part	Description	Part	Description
1	Socket head projectors (029)	4	Back liner (040)
2	Column (015)	5	Casing (012)
3	Dischanger pipe (026)		

Please refer to *Figure 21*. Elastomer wet-end assembly for base models 4V4VRE and larger

1. Assembly of the pump components is most easily done by inverting the unit so it is supported vertically with the impeller end of the shaft facing upwards.
2. Lower the BACK LINER (040) over the shaft and onto the end of the column. Make certain the BACK LINER (040) spigot fully engages on the inside of the elastomer covered COLUMN (015).
3. Fit the COLUMN HEAD CAP SCREWS to the SOCKET HEAD PROTECTORS (029). Insert the cap screws through the flange on the end of the column, and screw into the BACK LINER (040).

NOTICE

Tighten all cap screws evenly and in sequence to ensure even compression of the elastomer.

4. Fit the IMPELLER O-RING (059) into the groove on the end of the shaft.
5. Liberally grease the impeller thread on the end of the shaft. Take care to not overgrease the threads (remove any excess), as too much grease may prevent the impeller from screwing hard home on the shaft.
6. Screw the IMPELLER onto the shaft. Hold the shaft while turning the impeller with a bar placed between the vanes of the impeller. Be careful not to over tighten or mar the elastomer surface of the impeller.
7. Lift the CASING (012) and position on BACK LINER (040).
8. Make certain that the impeller turns freely. If the impeller does not turn freely, adjust the SPACER (086) at the top of the column. Also check the alignment for the discharge pipe.
9. Fit the CASING SOCKET HEAD CAP SCREWS to the SOCKET HEAD PROTECTORS (029). Insert the cap screws through the back liner and screw into the CASING (012).

NOTICE

Tighten all the cap screws evenly and in sequence to ensure even compression of the elastomer.

Check that the impeller turns freely at this point.

10. Fit the “snap-on” caps onto all the socket head protectors.
11. Position the pump horizontally so the discharge is at the top.
12. Fit the end of the DISCHARGE PIPE (026) into the BACK LINER (040). Use the casing socket head cap screws and socket head protectors to fasten the end of the discharge pipe to the casing.
13. Attach the top end of the discharge pipe to the mounting plate bracket using DISCHARGE PIPE RETAINING BOLTS. Tighten evenly.

10.2.3 Fitting Strainers, All Pump Sizes

Please refer to *Figure 22.* Fitting Strainers to All Elastomer-Lined V Series Pumps

1. Fit three elastomer UPPER STRAINERS (087) to cutouts in the column.
2. Bend the strainer slightly and fit it into the cutout so that the four strainer lugs clip onto the sides of the column cutout. This will hold the strainer firmly in the column.
3. Stretch the top of the LOWER STRAINER (087) and clip over the lower suction opening in the casing.

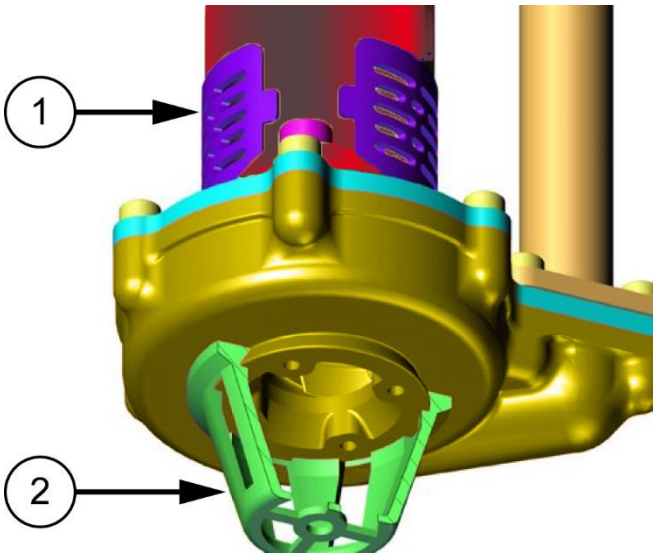

Figure 22. Fitting Upper and Lower Strainers on Elastomer Pumps.

Part	Description	Part	Description
1	Upper strainer (087)	2	Lower strainer (087)

THE PUMP IS NOW COMPLETE AND READY FOR THE INSTALLATION OF DRIVE COMPONENTS

Appendix A: Critical Speed Advisory for Cantilevered Pumps

First Critical Speeds

All pumps have a critical speed or natural frequency of vibration. This critical speed is analogous to the vibration frequency of a tuning fork. The critical speed is dependent on such factors as shaft stiffness (diameter and length) and overhanging mass. Vertical cantilever pumps (Flowrox's an all others') have relatively long, slender shafts which can result in critical speeds within the normal pump operating range. Operation at the critical speed must be avoided or destructive levels of vibration may occur. In selecting a suitable pump, its RPM must not exceed 80% of the first critical speed to avoid a band of vibration between -20% to +20% of the first critical.

Operation at RPMs higher than those given is not recommended due to possible bearing or shaft failure and excessive vibration. Often duty points in a smaller pump that fall within the critical speed range for the required set dimension can be applied on larger size pumps, which have different critical speed ranges at the desired set dimension.

Note: RPM's marked with an * are limited due to bearing speed restrictions. For 1.5V1.5VP, 2.5V2.5VQ, 4V4VR, 6V6VS, 8V8VS and 10V10VT, "D" dimensions given are measured from mounting plate to bottom of casing mounted suction strainer.

The agitator option (when available) lowers the critical speed an average of 200 RPM.

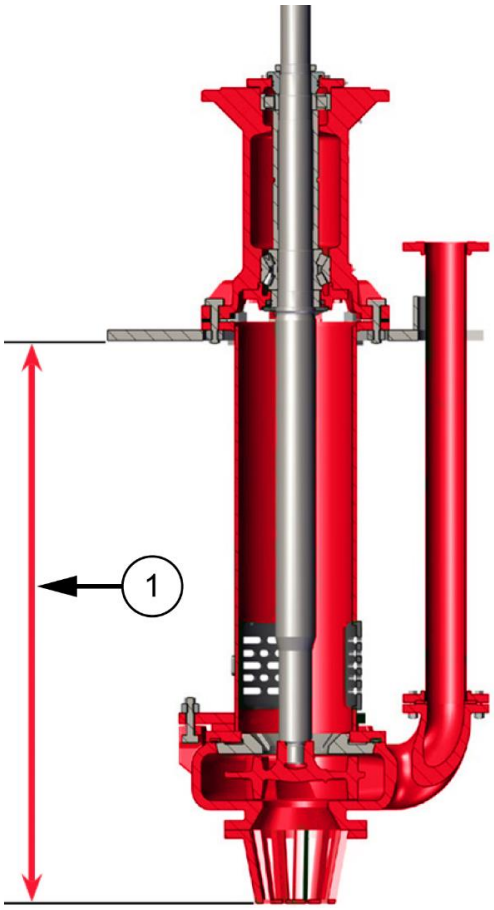

Figure 23. D dimension.

Part	Description
1	"D" Set Dimension

V Series Critical Speed Data

Table 10. Critical Speed Data

Pump/Type Suffix -M: Metal, -R: Elastomer		"D" Depth	"D" Code	First Critical Speed	
Model		[mm]		-20% RPM	Actual RPM
1.5V1.5VPM	STD	900	E	1615	2019
	OPT	1200	G	997	1246
	MAX	1500	J	678	848
1.5V1.5VPR	STD	900	E	1817	2271
	OPT	1200	G	1099	1374
	MAX	1500	J	738	922
2.5V2.5VQM	STD	900	E	1782	2228
	OPT	1200	G	1160	1450
	MAX	1500	J	782	977
2.5V2.5VQR	STD	900	E	2130	2662
	OPT	1200	G	1313	1641
	MAX	1500	J	984	1117
4V4VRM	STD	1200	G	1446	1807
	OPT	1500	J	998	1248
	MAX	1800	L	735	919
4V4VRR	STD	1200	G	1840	2300
	OPT	1500	J	1238	1547
	MAX	1800	L	893	1116
6V6VSM	STD	1500	J	1230	1537
	OPT	1800	L	909	1136
	MAX	2100	N	702	878
6V6VSR	STD	1500	J	1400*	2038
	OPT	1800	L	1174	1468
	MAX	2100	N	889	1111
8V8VSM	STD	1500	J	1125	1406
	OPT	1800	L	839	1049
	MAX	2100	N	654	817
10V10VTM	STD	1800	L	1000*	1394
	OPT	2100	N	867	1084
	MAX	2400	Q	698	872

* RPM limited by bearing speed restrictions

"D" code used as a qualifier on shaft, column and discharge pipe part numbers.

Please note that other critical speeds may exist for alternative bills of materials including torque flow impellers or lower bearing designs, which preclude critical speed considerations.

Consult the factory with questions.

Appendix B: Fault Detection Chart

Table 11. Fault list

FAULTS		SYMPTOMS								
=Probable Faults		Discharge failure	Reduced discharge delivery	Insufficient pressure	Pump loses prime	Excessive horsepower	Vibration and noise from pump	Short life of bearings	Overheating or seizure of pump	Hopper overflows
INTAKE	Pump not Primed.	■							■	■
	Pump or intake pipe not completely filled with liquid.	■	■		■		■			
	Suction lift to high.	■	■		■		■			
	Insufficient margin between intake pressure and vapor pressure.	■	■				■		■	
	Excessive amount of air or gas in liquid.		■	■	■					■
	Air pocket in intake line.	■	■		■					
	Air leaks into intake line.		■		■					
	Air leaks into pump through stuffing box.		■		■					
	Foot valve too small.		■				■			
	Foot valve partially clogged.		■				■			
	Intake pipe insufficiently submerged.	■	■		■		■			■
	Blocked intake.	■	■		■					■
	Intake pipe diameter too small or length of intake pipe too long.	■	■		■					■
SYSTEM FAULTS	Speed too low.	■	■	■						■
	Speed too high.		■			■				
	Wrong direction of rotation.	■	■	■		■				■
	Total head of system higher than design head.	■	■	■		■				■
	Total head of system lower than design head.					■				
	Specific gravity of liquid different from design.					■				■
	Viscosity of liquid differs from that for which designed.		■	■		■				
	Operation at very low capacity.						■		■	
	Entrained air in pump. Pump hopper requires baffles.	■	■	■	■					■
	Badly installed pipe line or gaskets partly blocking pipe.	■	■	■	■		■			■

Appendix B: Fault Detection Chart

Table 11. Fault list

FAULTS ■ =Probable Faults		SYMPTOMS								
		Discharge failure	Reduced discharge delivery	Insufficient pressure	Pump loses prime	Excessive horsepower	Vibration and noise from pump	Short life of bearings	Overheating or seizure of pump	Hopper overflows
MECHANICAL FAULTS	Misalignment.					■	■	■	■	
	Foundations not rigid.						■			
	Shaft bent.					■	■	■		
	Rotating part rubbing on stationary part.					■	■	■	■	
	Bearing worn.						■	■	■	
	Impeller damaged or worn.	■	■	■			■			
	Casing gasket defective, permitting internal leakage.	■	■	■						■
	Shaft sleeves worn or scored at the packing.									
	Shaft running off-center because of worn bearings or misalignment.						■	■	■	
	Impeller out of balance, resulting in vibration.						■	■	■	
	Gland too tight, resulting in no flow of liquid to lubricate packing.					■				
	Foreign matter in impeller.	■	■	■	■		■			■
	Dirt or grit in sealing liquid, leading to scoring shaft sleeve.									
	Excessive thrust cased by a mechanical failure inside the pump.						■	■	■	
	Excessive amount of lubrication in bearing housing causing high temperature.						■	■	■	
	Lack of lubrication.						■	■	■	
	Improper installation of bearings.						■	■	■	
	Dirt getting into bearings.						■	■		
	Rusting of bearing due to water getting into housing.						■	■		

Appendix C: Allowable Nozzle Loads

Hold-down capability criterion

1. The load must not cause the pump to move horizontally relative to the rigid baseplate.
2. The load must not cause the pump to move vertically relative to the rigid baseplate.
3. The maximum tensile stress in the hold-down bolts must not exceed 90% of ASTM A307 Grade A fastener yield strength (275.8 MPa).S_{sa}=275.8×0.9=248.2 “MPA” “(36,000psi)”
4. The maximum shear stress in the hold-down bolts must not exceed 90% of ASTM A307 Grade A fastener yield strength (275.8 MPa). S_{sa} =275.8×0.25=68.95 “MPA” “(10,000psi)”

NOTICE

Discharge nozzle coordinate system always moves with nozzle angle, (Fz always indirection of flow.)

Table 12. Allowable combined nozzle loads for Flowrox pumps - Metric Units (US Units)

Branch Size	Discharge					
	Fxd kg (lb)	Fyd kg (lb)	Fzd kg (lb)	Mxd N*m (ft*lb)	Myd N*m (ft*lb)	Mzd N*m (ft*lb)
2	726 (1600)	581 (1280)	1474 (3250)	3579 (2640)	3579 (2640)	5423 (4000)
3	798 (1760)	640 (1410)	1547 (3410)	3932 (2900)	3932 (2900)	5952 (4390)
4	875 (1930)	703 (1550)	1624 (3580)	4284 (3160)	4284 (3160)	6494 (4790)
6	1030 (2270)	826 (1820)	1778 (3920)	4989 (3680)	4989 (3680)	7565 (5580)
8	1193 (2630)	953 (2100)	1941 (4280)	5694 (4200)	5694 (4200)	8623 (6360)
10	1365 (3010)	1093 (2410)	2114 (4660)	6372 (4700)	6372 (4700)	9667 (7130)
12	1551 (3420)	1243 (2740)	2300 (5070)	7064 (5210)	7064 (5210)	10711 (7900)
14	1764 (3890)	1411 (3110)	2513 (5540)	7742 (5710)	7742 (5710)	11728 (8650)
16	2014 (4440)	1610 (3550)	2762 (6090)	8406 (6200)	8406 (6200)	12257 (9040)
18	2318 (5110)	1855 (4090)	3066 (6760)	9070 (6690)	9070 (6690)	13748 (10140)
20	2676 (5900)	2141 (4720)	3252 (7170)	9721 (7170)	9721 (7170)	14738 (10870)
22	3030 (6680)	2427 (5350)	3778 (8330)	10372 (7650)	10372 (7650)	15727 (11600)
24	3334 (7350)	2672 (5890)	4082 (9000)	11009 (8120)	11009 (8120)	16690 (12310)
26	3583 (7900)	2871 (6330)	4332 (9550)	11646 (8590)	11646 (8590)	17653 (13020)
28	3960 (8730)	3039 (6700)	4545 (10020)	12270 (9050)	12270 (9050)	18602 (13720)

Appendix C: Allowable Nozzle Loads

Table 12. Allowable combined nozzle loads for Flowrox pumps – Metric Units (US Units)

Branch Size	Discharge					
	Fxd kg (lb)	Fyd kg (lb)	Fzd kg (lb)	Mxd N*m (ft*lb)	Myd N*m (ft*lb)	Mzd N*m (ft*lb)
30	3983 (8780)	3189 (7030)	4731 (10430)	12894 (9510)	12894 (9510)	19537 (14410)
32	4155 (9160)	3329 (7340)	4903 (10810)	13504 (9960)	13504 (9960)	20473 (15100)
34	4318 (9520)	3456 (7620)	5067 (11170)	14114 (10410)	14114 (10410)	21381 (15770)
36	4472 (9860)	3579 (7890)	5221 (11510)	14711 (10850)	14711 (10850)	22290 (16440)

NOTICE

Coordinate system per *Figure 24*.

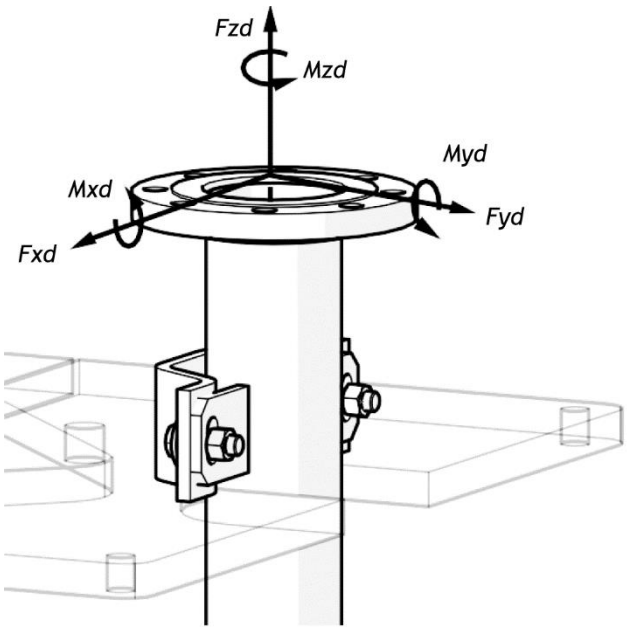

Figure 24. Direction of forces and moments being applied to discharge pipe.

FLOWROX OY
P.O. Box 338
FI-53101 Lappeenranta, Finland
Tel. +358 (0)201 113 311 Fax +358 (0)201 113 300
E-mail: sales@flowrox.com
www.flowrox.com