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Installation, operation, and maintenance instructions for Flowrox Horizontal centrifugal slurry pumps series (S)

NOTICE

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

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Directive conformance declarations

FLOWROX OY
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hereby declares that the **Flowrox Centrifugal slurry pump** delivered complies with the following applicable regulations:

European Union Machinery Directive, 2006/42/EC
Finnish Government Decree on Machine Safety, 400/2008, Machine Decree (koneasetus)

Directives, decrees, and standards applied:

SFS- EN 809+A1 (2009), Pumps and pump units for liquids. Common safety requirements.
SFS- EN ISO 12100:2010, Safety of machinery. General principles for design. Risk assessment and risk reduction.
SFS-EN ISO 7010, Graphical symbols. Safety colours and safety signs.
SFS-ISO 3864, Graphical symbols – Safety colours and safety signs
SFS- EN ISO 13732-1 (2008), Ergonomics of the thermal environment. Methods for the assessment of human responses to contact with surfaces. Part1: Hot surfaces
SFS- EN ISO 20361 (2009), Liquid pumps and pump units. Noise test code. Grades 2 and 3 of accuracy

On behalf of Flowrox Oy
In Lappeenranta, 13 November 2019

Jukka Koskela
President and CEO

Mechanical warranty for Centrifugal slurry pumps

The warranty is valid for 12 months from the delivery date, excluding the following:

- wear parts, such as gaskets, bearings, seals, impellers and liners
- pumps that the first buyer has resold without a written agreement with the vendor regarding the remaining portion of the warranty period
- direct or consequential damage caused by structural changes made to the pump or by the use of parts that are not approved by the original manufacturer

The purchaser must file a claim for all compensation related to the pump guarantee within 30 days after the fault has been detected. For the claim form, see Appendix F.

If the terms indicated in the claim form are not complied with, the purchaser loses his or her right to the guarantee.

The guarantee compensates for new parts if any damaged parts must be replaced. Terms of delivery: packed at the factory, with no other costs covered.

The supplier shall reimburse the customer for the value of the parts, excluding the freight charges, packaging costs, and other expenses, upon the following conditions:

- The pump must have been used only for its intended purpose.
- All claims regarding a faulty part require that the part in question, along with a description of the operation conditions and operation methods used, be delivered to Flowrox Oy for chemical and mechanical analysis
- Any reimbursement for a faulty part shall be made only after the part's examination.

Flowrox Oy's conditions of sale are described in Appendix E.

1 General safety instructions

The symbols in the following table are used in this manual to highlight the parts requiring particular attention.

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.

The safety signs used in this manual comply with the ISO 7010 standard.

General warning

Explosion hazard

Hot surface hazard

Electrical hazard

General mandatory action

Refer to instruction manual/booklet

Disconnect mains plug from electrical outlet

Switch off and lock out

Wear ear protection

Wear high visibility vest

Wear safety boots

Wear safety harness

Wear eye protection

Wear safety helmet

Wear protective clothing

Wear safety gloves

Prevent accidents and ensure the pump's appropriate operation by complying with the safety instructions indicated in this manual. Installation and maintenance of the pump must be carried out by persons with appropriate training.

The safety aspects have been considered as much as possible in the design of the pump.

The pump has been connected to high voltage. The connection box must not be opened when the drive unit is connected. Electrical work must be carried out by professional electricians.

The pump can produce and maintain high pressure. This must be noted when one opens the pipe connections etc. The pipeline can contain high pressure even after the pump has stopped.

Unauthorised personnel are not allowed near the pump when it is in operation. The maintenance and servicing of the pump must be carried out by persons with appropriate training.

Pumps must always be equipped with the safety equipment required by national regulations as appropriate to the place of use. Regardless of national regulations, the pump unit power supply must be equipped with at least the following electrical safety devices:

- emergency switch
- main switch
- motor overload protector
- fuses

⚠ CAUTION!

Adequate protective clothing must be used when performing assembly, operation and maintenance of the pump.

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.

⚠ WARNING!

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 resulting in injury or equipment damage.

⚠ WARNING!

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.

⚠ DANGER!

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.

⚠ WARNING!

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.

⚠ WARNING!

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

NOTICE

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 Centrifugal 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 parts are for lifting those individual parts. Appropriate separate, holistic means should be applied in lifting assembled components.

NOTICE

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 parts.

2 INTRODUCTION

Thank you for purchasing a quality Flowrox Centrifugal slurry 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.

To insure long, trouble-free service from your Flowrox Centrifugal slurry 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.

2.1 Application and Features of Horizontal Flowrox Centrifugal slurry pumps

These pumps are of heavy duty construction, both split- case and unlined, 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 casing liners and impellers. Metal and molded elastomer parts are interchangeable within a common casing except in the case of unlined units.

A range of seal options are available for these slurry pumps, and all have been tested to withstand the rigorous nature of pumping highly abrasive fluids. These include fully flushed packed gland seals, centrifugal expeller seals, proprietary Low-Flow Gland seals, and others. Third-party mechanical seals may also be fitted when specialized applications or requirements demand this type of seal.

If problems occur during the operation of your Flowrox Centrifugal slurry pump, first refer to the Fault Detection Chart provided in Appendix A 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.

Key Features of the Flowrox Centrifugal slurry pump:

- Simple, single-point impeller adjustment for
- increased efficiency and life
- Cartridge type bearing assembly with oversized shaft and bearings
- Heavy-duty threaded impeller attachment
- Through-bolt design throughout pump
- Replaceable liners of diverse material specification
- Slip-fit shaft sleeves
- Impeller release collars on larger pumps for ease of removal of impeller
- 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 Identification of Pump Models and Parts

Every Flowrox Centrifugal slurry pump has a nameplate attached to the bearing housing and pump base. The pump serial number and identification code are stamped on the nameplate.

3.1 Pump Model Identification

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

Digit(s)	Letter	Digit(s)	Letter(s)
(A)	**(B)**	**(C)**	**(D)**
Intake Diameter (in)	Pump Series	Discharge Diameter (in)	Bearing frame

(A) The intake diameter as expressed in inches (in), e.g. 1.5, 2, 4, 8, 12, etc.

(B) Pump Series/type of wet end, identified by a single letter, i.e. S

(C) The discharge diameter as expressed in inches (in), e.g. 4, 8, 10, etc.

(D) The bearing frame of the pump consists of the base and the bearing assembly. The size/capacity is indicated by one or two letters such as B, C, E, S, T, CC, DD, etc.

The following is an example of an S Series pump model:

16 S 14 T

16 = Intake Diameter in inches (in)
S = S Series Pump
14 = Discharge in inches (in)
T = T 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 Centrifugal slurry pump. Always refer to the certified equipment documentation when ordering replacement parts.

3.2 Part Number Identification

Every Flowrox Centrifugal slurry 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:

(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 1.

(CC) 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 Throatbush of every Flowrox Centrifugal slurry pump has a Generic Part Number of “093”, while all Shafts have a Generic Part Number of “075”.

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 05E 023 Z0 R09 identifies the Cover Plate Liner to fit the casing of the 6SE4 Flowrox Pump:

05E	023	Z0	R09
For 6S4 pump	Cover plate liner	Basic Part	Natural Rubber

Refer to the Component Diagram of the appropriate size of Flowrox Centrifugal slurry 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 1.

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 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 1. Spare Part Identification

Generic Part Number	Part Name	Generic Part Number	Part Name
002	Adjusting Bolt	048	Gland Guard
004	Base	052	Grease Retainer
005	Bearing	059	Impeller Seal O-Ring
006	Bearing Assembly	060	Shaft O-Ring
007	Bearing Drive End	061	Clamp Ring Nut
008	Bearing Housing	062	Intake Joint Ring
009	Bearing Seal Ring	063	Keeper Plate
010	Bearing Sleeve	064	Labyrinth
012	Casing	065	Labyrinth Locknut
013	Clamp Bolts	066	Lantern Restrictor
014	Clamp Ring Washer	067	Lantern Ring
017	Cotter	070	Neck Ring
018	Cover Plate	071	Gland Packing
019	Cover Plate Bolts	072	Piston Rings
020	Cover Plate Liner (Integrated Throatbush)	073	Release Collar
023	Cover Plate Liner	074	Seal Ring
025	Discharge Joint Ring	075	Shaft
028	End Cover	076	Shaft Key
031	End Cover Bolts	078	Lip Seal
032	Expeller	079	Shaft Sleeve
033	Expeller Ring	082	Shaft Spacer
036	Flinger	084	Bearing Shims
037	Frame Plate (Also Adapter Plate)	093	Throatbush
038	Frame Plate Bolts	094	Throatbush Stud
039	Frame Plate Liner	104	Volute Liner
040	Frame Plate Liner Insert	106	Volute Liner Seal
042	Frame Plate Liner Insert Stud	111	Long Shaft Sleeve
043	Adapter Plate Stud	112	Stepped Washer
044	Gland Bolt	116	Clamp Ring Bolt
045	Gland	118	Clamp Ring
047	Grease Cup Adapter	120	Volute Liner Seal Holder

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

1. 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 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 protective coating on these surfaces with CRC SP-400 or a comparable product.
- For outdoor or excessively unfavorable environments, cover the equipment with some type of protective tarpaulin that will allow proper air circulation.

2. Prior to start-up, inspect the packing to insure that it is 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

1. 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.

2. Prior to start-up, inspect the packing to insure that it is satisfactory. After a storage period of 18 months or longer, repacking with fresh die-formed packing is 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

Electrical

⚠ WARNING!

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

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 certified outline (OD-) or arrangement (AR-) drawings. Structural and site work should not be performed without factory "Certified" prints for any given installation.

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-). This can be done when

the concrete is poured, or by drilling holes in existing foundations and grouting the bolts in place.

5.3 Installing the Baseplate and Pump

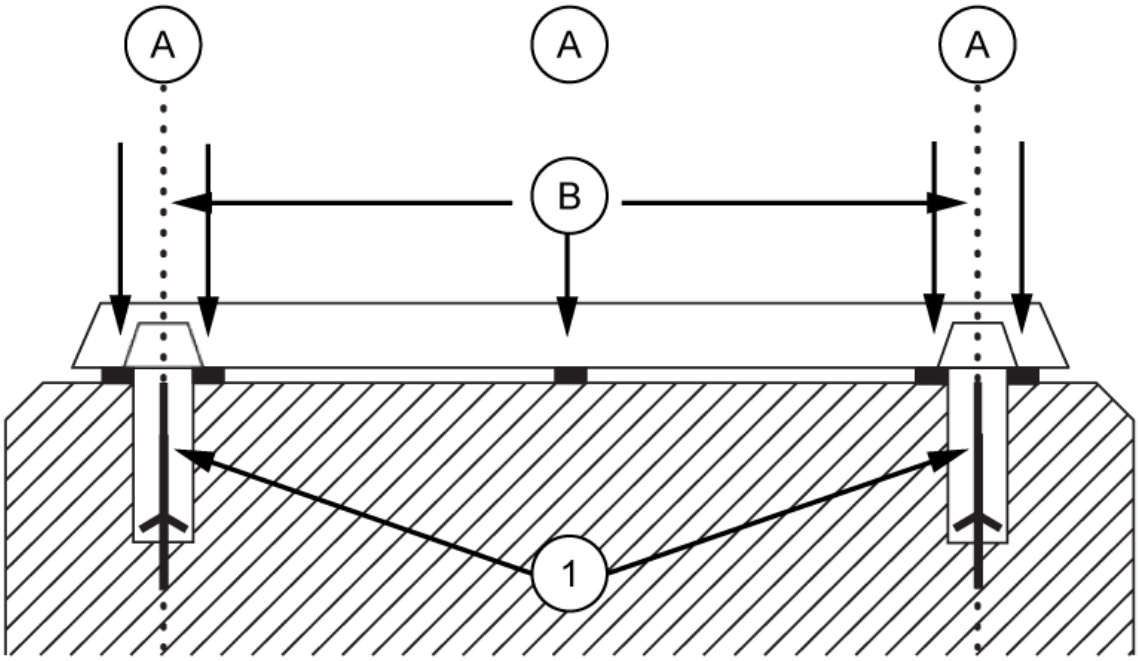

Figure 1. Foundation Bolt Illustration

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

After placing the baseplate 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 800 mm (30 in.), additional shims should be inserted halfway between the adjoining holes. All shims must lie perfectly flush.

Insert the foundation bolts and set them into the foundation using concrete. When the mortar has set, tighten the foundation bolts evenly and firmly and grout the baseplate using low shrinkage grout.

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.

1. 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.
2. For optimum performance, the pump should be mounted directly to the baseplate without shims. The rest of the drive train is then aligned to the pump. For this reason, Flowrox baseplate designs generally allow space for shimming under the gear reducer and motor, but not under the pump 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.
3. 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.
4. 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 the two coupling halves must remain the same all around the circumference. Use a feeler gauge, a wedge gauge or a dial micrometer to verify.
5. The radial and axial deviation (tolerance) between the two coupling halves should not exceed 0.1 mm (0.004 inch).
6. For Vee-belt installations, the pulleys are correctly aligned if a straightedge placed vertically shows a deviation of no more than 1.0 mm (0.04 in.).

7. 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.

Permissible forces are mentioned in **APPENDIX D**.

⚠ WARNING!

Make sure to isolate the equipment from the process.

The process media can be hazardous.

NOTICE

Appropriate Flowrox joint rings must be used at pump flanges.

Make sure there is no damage to the rings during installation.

Replace damaged joint rings.

1. To avoid damaging the joint rings, do not over tighten flange bolts.
2. 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.
3. 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.

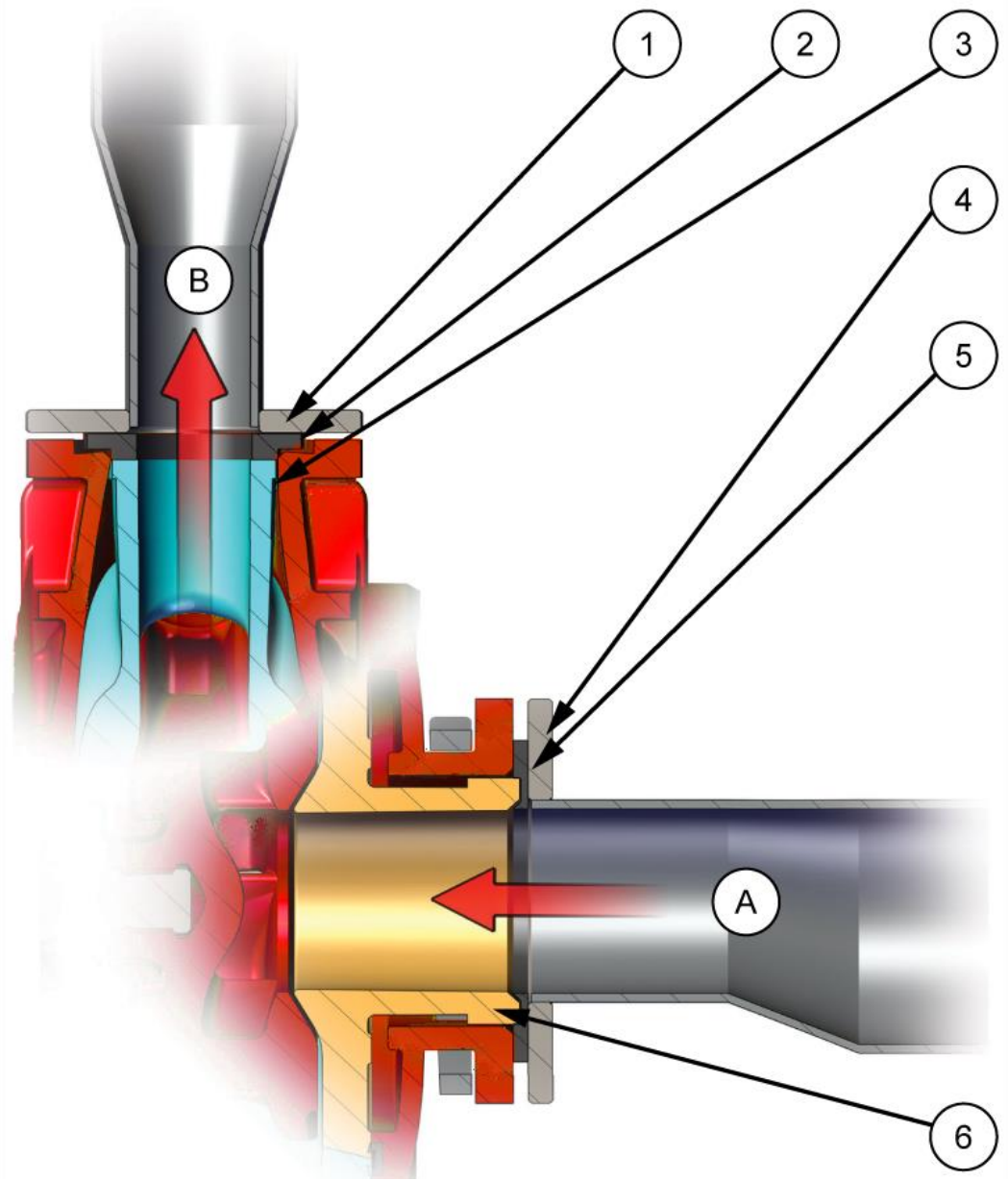

Figure 2. Standard Joint Ring Assembly

Part	Description	Part	Description
1	Pipe Flange	5	Joint Ring
2	Joint Ring	6	Throatbush
3	Volute Liner	A	Suction
4	Pipe Flange	B	Discharge

Suction Conditions

- All pipe joints must be airtight to ensure priming of the pump.
- Suction pipes should be as short as possible, generally 5X pipe diameter.

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.

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.

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.

Refer to **Section 8.4** in this manual for procedural details.

5.7 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 Commissioning, 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 instruction set applies to single stage pumps. Procedures for multi-stage pumps 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

1. Remove all Vee-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 casing.

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.

1. 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.

2. Remove any objects that may have entered the pump casing during shipment or installation.

3. Check that all bolts are tight and that the impeller turns freely. Some bolts may come loose in transit from the factory.

4. Pump drive train final alignment is complete.

5. All electrical and power supply connections are in order, including fuses and overload protection devices.

6. All required auxiliary connections, such as shaft seal water, oil coolers, etc are made, tested, and functioning.

7. All safety guards and equipment are in place.

8. Any required instrumentation has been properly installed and is functioning.

9. Bearing assembly lubrication is complete (**NOTE**: Grease lubricated bearing assemblies are factory lubricated. Do not add additional grease at startup. If oil lubricated, fill reservoir to proper level prior to operating pump. Consult with the factory on any questions regarding lubrication.)

10. Shaft seal is ready for operation.

11. 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.

12. The pump set is primed.

13. 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.

6.1.3 Shaft Seal Commissioning

6.1.3.1 Gland Seal Commissioning

Prior to commissioning, the gland packing supplied with the pump must be adjusted. Precut packing rings sets from Flowrox are recommended. For alternate brands, refer to packing manufacturer's instructions regarding installation and use.

For gland flush supply, use suitable non-aggressive clean water not liable to form deposits and not containing suspended solids. Hardness should average 5 with a neutral pH value. It should be conditioned and neutral with regards to mechanical corrosion.

The pressure of the gland seal water should exceed the discharge pressure of the pump to ensure that gland seal water is ALWAYS flushing through the stuffing box and lubricating the packing. Typically this is **0.7 bar (10 psi) above the discharge pressure**. Excessive differential pressure can damage the pump and seal components.

Gland water flow rates should roughly conform to the values given in Appendix C – Gland Seal Water Flow rates. Process conditions may warrant more or less flush water flowrates depending on seal arrangement and/or aggressiveness of slurry. Use best judgement when adjusting seal water. A clear, controlled drip should be seen coming out of the gland when properly adjusted.

An inlet temperature of 10 °C – 30 °C (50 °F – 85 °F) should produce a maximum outlet temperature 45 °C (115 °F) when the gland is properly adjusted.

6.1.3.2 Centrifugal (Expeller) Seal Commissioning

The standard expeller seal is fitted with grease lubricated packing for running dry, without flush water. Ensure the gland bolts are snugged down, but not overtightened. The seal may leak slightly while the pump is not operating and is not isolated, but the leaking will subside once the pump begins operating.

A non-standard expeller seal may use water flush, in which case the same instructions for "Stuffing Box Commissioning" put forth in **Section 6.1.3.1** should be applied.

6.1.3.3 Mechanical Seal Commissioning

Mechanical seals are high precision devices which require special care for their proper operation. The instruction manual for the seal should be consulted for special storage, start-up, and maintenance requirements.

⚠ CAUTION!

Make sure that seal water is turned on prior to pump startup if it is required for lubrication and cooling of seal faces.

Seal failure will occur if the seal water is not operating prior to pump startup.

Mechanical seals require safety checks prior to startup such as removing seal assembly fixtures, checking axial alignment, checking torques, etc. Refer to the mechanical seal operating manual for all required safety checks.

6.2 Pump Startup

1. 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.
2. The pump should be started with the discharge valve approximately ninety percent closed, provided a discharge valve is available.
3. 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.
4. 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.
5. Gradually open the discharge valve to a fully open position, or to the position required to obtain the desired flow and/or discharge pressure.
6. Continue to observe the pump, noting if excessive vibration is present.
7. Purge the wet and drive end labyrinth seal with grease.

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.

Check gland leakage. If leakage is excessive, tighten gland nuts until flow is reduced to required level. If leakage is insufficient and the gland shows signs of heating, loosen the gland nuts. If the gland continues to heat up, the pump should be stopped and the gland allowed to cool. Do not loosen the gland nuts to the extent that the gland follower is allowed to disengage the stuffing box.

NOTE: It is normal for gland leakage water to be hotter than the supply because it is conducting away the heat generated by friction in the gland. At low pressures (single stage operation), very little leakage is required, and it is possible to operate with only a small amount of water issuing from the gland.

Generally, gland heating is only experienced on initial startup on gland sealed pumps. When initial heat-up of the gland is encountered, it is usually only necessary to startup/stop/cool and start the pump two or three times before the packing beds in correctly and the seal operates satisfactorily. It is preferable at start-up to have too much leakage than not enough.

6.2.1 Monitoring grease Lubricated Bearing Assembly on Start Up

Grease lubricated bearing assemblies are factory lubricated. Do not add additional grease at startup. It is common for grease lubricated bearing assemblies to run warm during their initial start-up and run in period.

The graph below shows typical time verses temperature characteristics of a new grease lubricated bearing assembly.

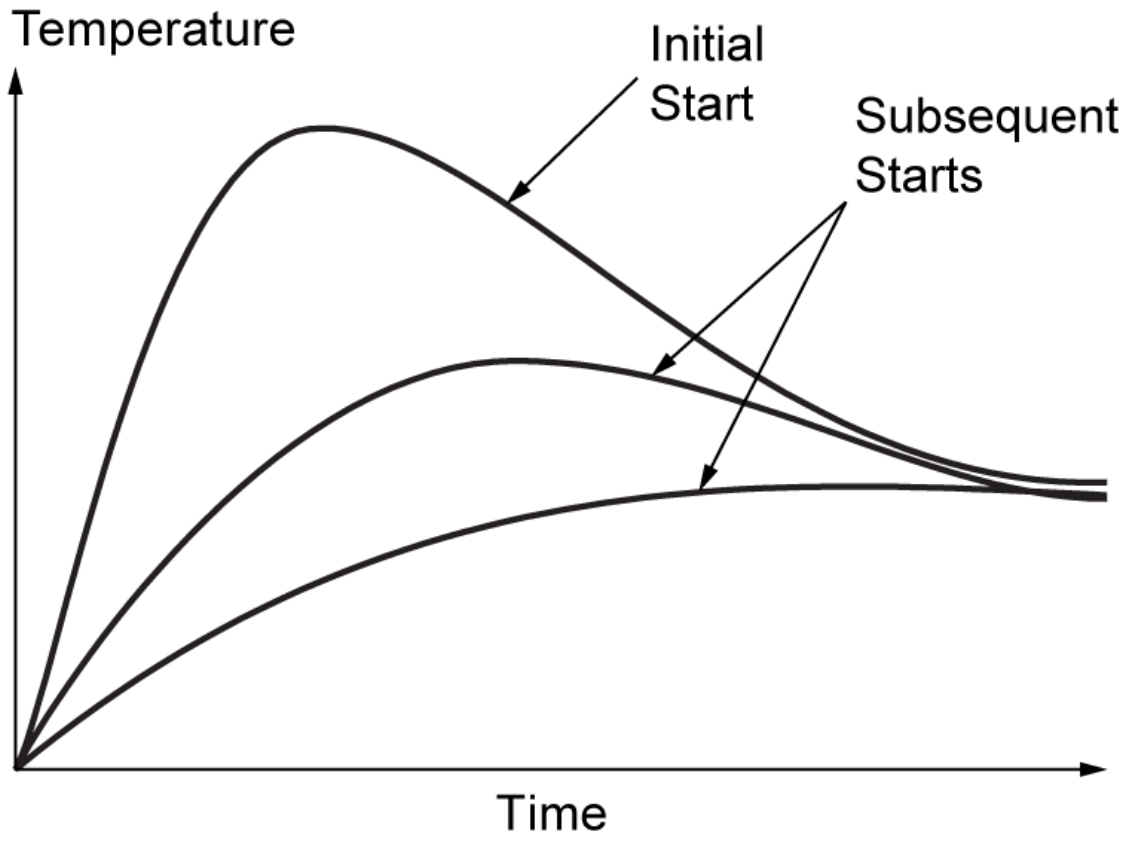

Figure 3. Time versus Temperature Characteristics of a Grease Lubricated Bearing Assembly.

The most common causes for high initial bearing assembly temperatures are:

1. Customer adding grease to the assembly during initial start-up.
2. Belt drive tension being high for the initial runs.
3. Off duty point operation.
4. Initial charge of grease being high to improve likelihood of bearings surviving the initial storage period.

Recommended Grease Start-up and Run in Procedure

1. Do not add grease at any time during initial start- up and run in. If grease is added or the wrong type of grease is added the warranty may be affected.
2. Check belt tension to ensure it is as recommended. Use a belt tension gauge to set the belt tension.
3. Operate the pump at or near the duty operating point. Off duty point operation can cause bearing overloading.
4. After initial start monitor the bearing housing surface temperature. A graph similar to Figure 3 above should be created. Allow the temperature to rise to 95 °C (200 °F). Shut the pump down and allow the assembly to cool to ambient temperature. 4 hours is usually adequate.
5. Restart the pump and monitor the bearing housing surface temperature. If the

temperature is leveling off as shown by the graph, allow the assembly to continue to operate up to 95 °C (200 °F) before shutting down. Grease characteristics must be equal to those indicated in Section 8.3.1.2 or operation at this temperature may cause bearing failure.

6. Allow assembly to cool and repeat step 5). It may take several start and stop sequences to have the housing temperature reach its peak and begin dropping.
7. If assembly continues to heat, recheck belt tension, operating point and speed.

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 95 °C (200 °F) - Stop pump and consult factory

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.

After the pump has run for 8-10 hours, gland bolts can be adjusted to provide optimum leakage. If heating of the gland persists, the packing should be removed and replaced.

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.

Startup and shutdown procedures must be designed to prevent any possibility of water hammer. Water hammer can place excessive loads on the piping and pump components, resulting in damage to the pump flanges, the mechanical end and/or the mechanical seal.

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.

6.2.2 Priming the Pump

Before startup, the pump, suction line and (if applicable) the tank must be vented and primed with the liquid to be pumped. Any valve in the suction line must be fully open. Open all auxiliary connections (flushing, sealing, cooling liquid, etc.) and check the through flow.

Dry-running will result in significant wear on the gland packing and shaft sleeve or failure of the mechanical seal.

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.

1. 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. Diesel power trains should disengage the clutch and allow the pump to coast to a stop.
2. Close any auxiliary connections. Pressurized bearing lubrication systems must remain running until all rotation has stopped. If the any part of the system uses a cooling liquid supply, turn that off only after the pump has cooled down. Where liquid filled shaft seals are used, consult seal maintenance manual for specific shutdown procedures.
3. Where temperatures may drop below freezing, the pump and system must be drained or otherwise protected against freezing.

In the event of shutdown where a significant static discharge head exists in the system, the impeller can begin to run backwards as the flow reverses in the pipeline. This creates a positive torque on the shaft so the impeller connection will not unscrew. Until the flow stops, do not close any main line valves. A change in fluid velocity can create a negative torque on the impeller and unscrew it from the shaft. This can damage wet end pump parts as well as bearings, seals and other components.

6.3.1 Prolonged Shutdown

6.3.1.1 The pump remains installed - operation check run

NOTICE

Make sure to start up the pump set regularly during prolonged shutdown periods.

The pump is always ready for instant start-up and clean of deposits when it is run for 5 minutes once a month or once every 3 months. Prior to an operation check run ensure that there is sufficient liquid available for operating the pump.

6.3.1.2 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

After the pump has run for several hours after initial startup, shut it down to check the following:

1. Vee-belts tension
2. Piping connections
3. Pump fasteners including hold-down bolts

Purge the drive end labyrinth bearing seal with grease weekly. In excessively dirty environments, the seal should be greased twice weekly. Table 3 in this manual shows the recommended grease purging intervals for your pump.

Grease the pump bearings according to the recommended intervals shown in Table 2. The table serves as a guideline for most applications. Actual operating conditions may require different intervals than those indicated in this manual.

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** 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 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.

7.2.2 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.

7.2.3 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

7.2.4 Low 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 Centrifugal slurry pumps are designed for heavy duty use and when correctly installed, and maintained will give long, trouble-free service.

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 Loose 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 Gearboxes

Periodically inspect gearboxes and check for excessive vibration and heat. Consult the gearbox manufacturer’s manual for specifications and tolerances.

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

If strainers are used, periodically check their openings for blockages. Clean out any blockages found.

Blocked suction strainers can cause cavitation and reduced flow through the slurry pump, which will reduce the overall life of many pump components.

8.1.4 Wearing Parts Replacement

The wear rate of a solids handling pump is a function of the severity of the pumping duty and of the abrasive properties of the material handled. Therefore, the life of wearing parts, such as impellers and casings, varies from pump to pump and from one installation to another.

Wearing parts must be replaced when the performance of a given pump no longer satisfies the requirements of a particular installation.

Where a pump is used on a particular duty for the first time and especially where failure of a wearing part during service could have serious consequences, the pump should be opened at regular intervals. Inspect the pump and estimate the wear rate to establish the remaining life of the wearing parts.

8.1.5 Shaft Seal Care

8.1.5.1 Gland Seals

In gland sealed pumps, periodically check the gland seal water flow and pressure. Always maintain a small amount of clean water leakage by regularly adjusting the gland. When gland adjustment is no longer possible, remove and replace packing.

Do not over-tighten the gland into the packing so much so that the seal water no longer leaks around the gland. This will cause the packing and sleeve to overheat, and require replacement of one or both parts soon thereafter.

8.1.5.2 Centrifugal (Expeller) Seals

Grease lubrication of an EXPELLER RING is required on pumps fitted with a centrifugal seal. Lubricate the static seal chamber sparingly but regularly (See **Section 8.3.3**).

8.1.5.3 Mechanical Seals

Follow all third-party manufacturer instructions for mechanical seal care.

8.2 Spare Parts

Spare parts consist mainly of liners, impellers, bearings, shaft sleeves, seals, and shaft seal parts. Depending on the expected life of each part, keep the necessary number of spares to ensure maximum use of the pump.

Wear rate of a solids handling pump is a function of the severity of pumping duty, abrasive properties of the pumped 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.

Reference **Section 3.2** for identifying parts.

8.3 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 Centrifugal slurry pumps are applied.

8.3.1 Bearing Lubrication

8.3.1.1 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 times adding more grease will damage the bearings.

8.3.1.2 Recommended Grease Type

It is recommended that grease used for lubricating both the roller bearings, the labyrinth seals and the packed gland of a centrifugal pump seal should have the following characteristics:

Lithium complex grease with EP additives and oxidation inhibitors. Mobile grease® XHP 222 is a type which has been found to be satisfactory.

N.L.G.I. Consistency No.: 2
Drop Point: >170 °C (338 °F)
Work Penetration @ 25 °C ASTM 265 – 295

8.3.1.3 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
- Washdown habits or presence of splashing fluid and other contaminants

The suggested lubrication intervals and quantities are given in Table 2.

Table 2 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 10 °C to 35 °C (50 °F to 95 °F)
- No heavy washing down

Very dirty or damp atmospheric conditions that vary from the normal operating conditions listed above may require that the recommendations be adjusted.

NOTE: All bearing assemblies are equipped with a grease purge fitting located in both END COVERS, at the very end of each bearing. These grease fitting purge the bearing seals and do not add lubricant to the bearings (See Figure 4**). Just inboard of this fitting on both sides of the bearing housing, an additional grease zerk is provided. These inboard zerks should be used for inserting bearing lubricant (See Table 2 for quantities and frequency). Use only recommended, clean grease.**

Table 2. Suggested Lubrication Interval (Hours).

	Bearing Frame Size	ADD		BEARING RPM											
		GRAM	OZ.	200	300	400	600	800	1000	1200	1500	2000	2500	3000	4000
Both Ends	B	6	0.2					3000	2400	1800	1500	1000	800	650	300
	C	9	0.3				3600	2400	1800	1600	1200	900	580		
	D	14	0.5				2500	2000	1500	1200	800	500			
	E	24	0.8		5000	3600	2200	1600	1100	800	500				
	F	35	1.2	7000	4200	2000	1800	1200	700	400					
	G	60	2.1	5000	3600	2400	1200	600							
Pump End	P, CC	20	0.7				2900	2200	1700	1400	1100	800	500		
	Q, DD	28	1				2300	1800	1400	1000	700	400			
	R, EE	50	1.8			3000	2000	1400	1000	600	400				
	S, FF	66	2.3		3800	2800	1500	900	500	300					
	T, GG	125	4.4	4800	3000	1800	900	400							
	U	245	8.6	4000	2400	1500	500								
Drive End	P, CC	14	0.5				2900	2200	1700	1400	1100	800	500		
	Q, DD	17	0.6				2300	1800	1400	1000	700	400			
	R, EE	33	1.2			3000	2000	1400	1000	600	400				
	S, FF	50	1.8		3800	2800	1500	900	500	300					
	T, GG	42	1.5	4800	3000	1800	900	400							
	U	95	3.4	4000	2400	1500	500								

Note: Grease additions are best spaced over the intervals given. One shot from a standard grease gun is approx. one gram.

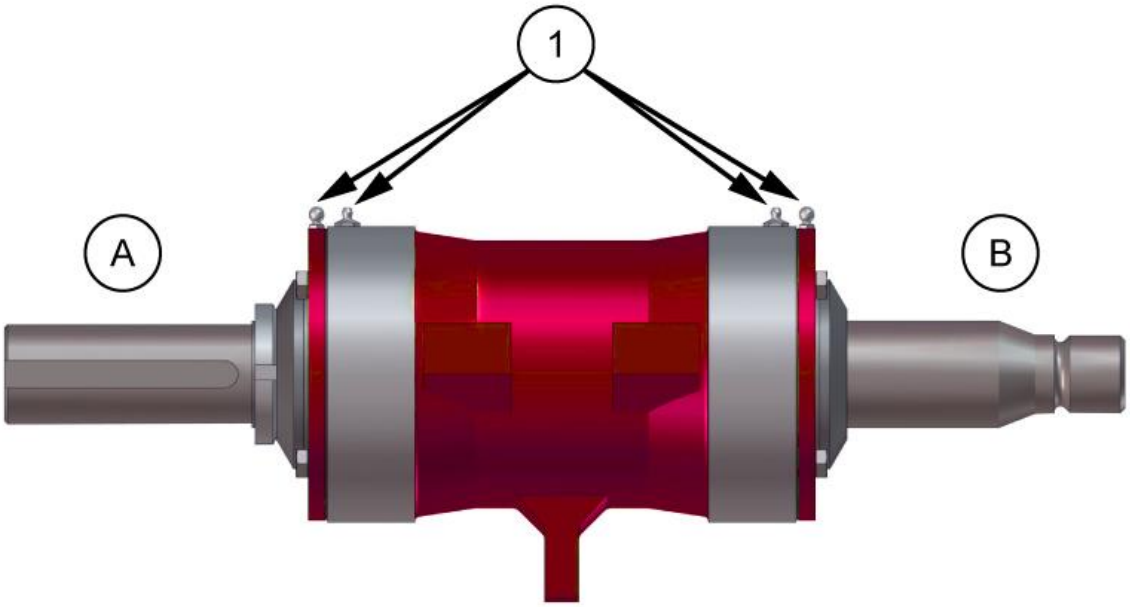

Figure 4. Bearing Assembly.

Part	Description	Part	Description
1	Grease Fittings	B	Impeller End
A	Drive End		

8.3.1.4 Bearing Failures

Dirt and water cause of 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
- Improper pump sealing (packing, expeller, mechanical seal) maintenance

8.3.2 Bearing Seal Lubrication

It is an essential maintenance requirement that you pay careful attention to LABYRINTH lubrication and LABYRINTH purging.

To improve the sealing properties of the labyrinth at both ends of the bearing assembly, a grease nipple and a radial drilled hole in the end cover allows you to force grease through the labyrinth.

The grease purges out grit and moisture. Fewer contaminants entering the bearing assembly will result in longer bearing life and ultimately a cost savings.

Suggested intervals for grease purging of the labyrinth are provided in Table 3. 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.

8.3.3 Expeller Ring Grease Lubrication

Table 3. Labyrinth Seal Grease Purging Intervals.

	Type of Operation		
	24hr/day	16hr/day	8hr/day
Pump End	Four shots per 12hr	Four shots daily	Two shots daily
Drive End	Four shots per 120hr	Four shots weekly	Two shots weekly

If your pump is fitted with an EXPELLER, the EXPELLER RING will be fitted with a GREASE CUP (See Figure 5).

At 12 hour intervals the grease cup cap should be tightened to force a small amount of grease into the seal. Monitor the grease level as often as possible to insure that grease is available at all times.

You may opt to remove the factory supplied GREASE CUP, and replace it with another means of introducing grease lubrication to the seal area, such as a grease zerk, or a third-party automatic lubrication system.

Use the same grease that is used to lubricate the bearings.

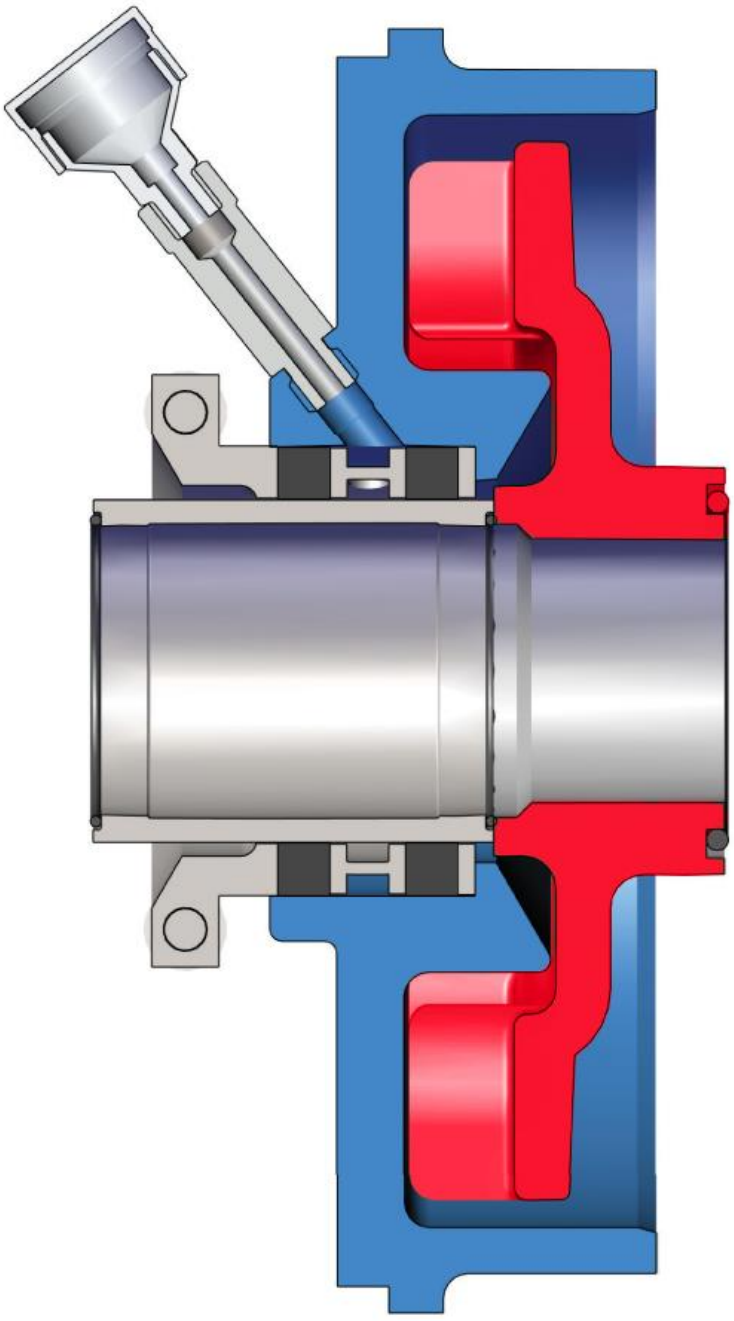

Figure 5. Expeller Ring Arrangement.

NOTE: If your expeller is water assist, then grease lubrication is not required.

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 throatbush.

On pumps fitted with an expeller, forward impeller adjustment increases seal area pressure. In other words expeller efficiency is sacrificed for pumping efficiency.

Thus on some applications it may be necessary to operate the pump with a slightly greater impeller clearance to ensure proper shaft sealing is achieved. Improved efficiency in all areas can be maintained by replacing worn parts.

8.4.1 Initial Adjustment

The following procedure describes a typical impeller clearance adjustment for a Flowrox pump that DOES NOT have a mechanical seal.

Loosen CLAMP BOLTS on Side 'B' only, as shown in Figure 6.

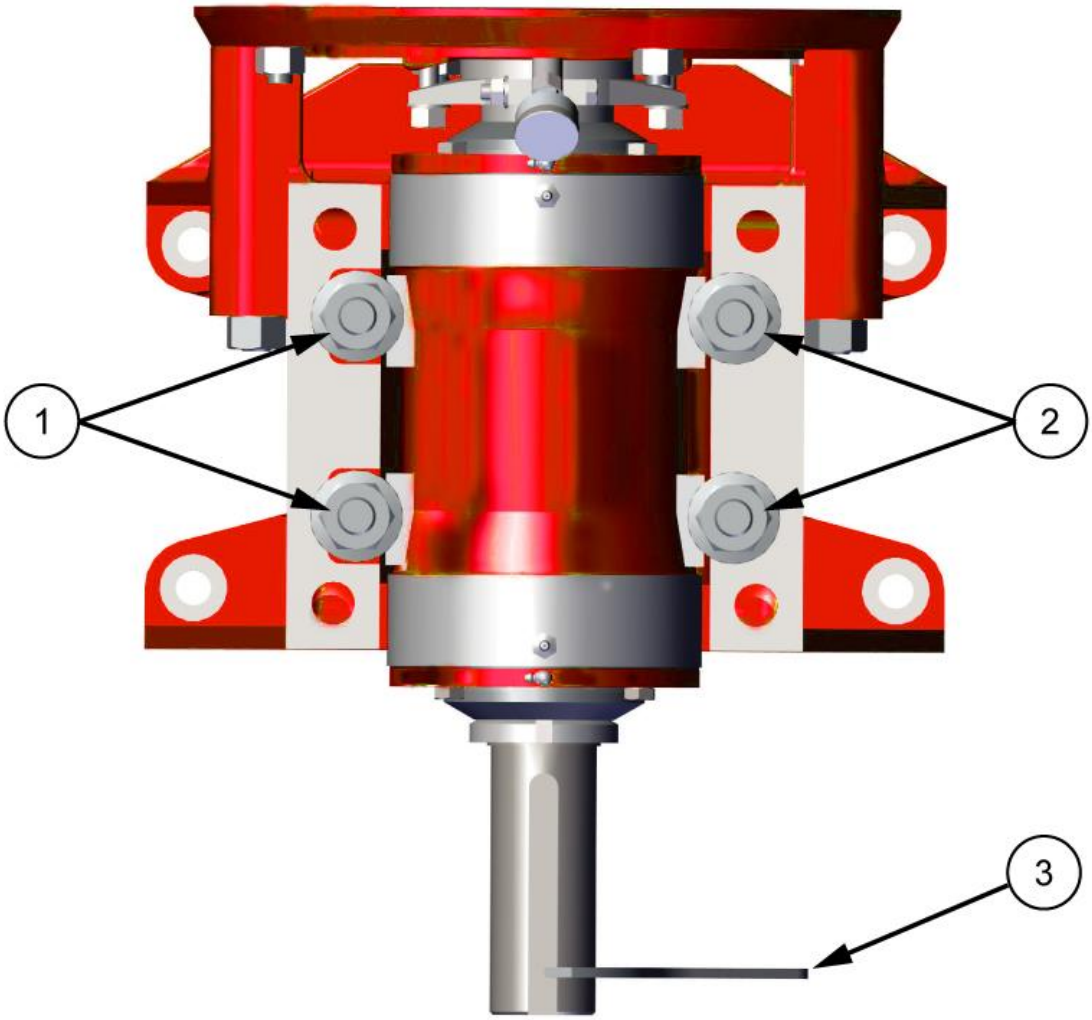

Figure 6. Bearing Assembly Clamp Bolts.

Part	Description	Part	Description
1	"B" Side Clamp Bolts (013)	3	Wrench
2	"A" Side Clamp Bolts (013)		

1. Rotate the shaft clockwise by hand and move the rotating assembly forward (toward suction) by tightening the rear nut on ADJUSTING BOLT (002) until the IMPELLER starts to rub on the suction side liner as shown in Figure 7.

2. Release the nut just tightened by 1/3 turn (2 flats), then move the BEARING ASSEMBLY back by means of the front nut until the housing lug is secure against the rear nut.
3. Tighten CLAMP BOLTS on side ‘B’ as shown in Figure 6. Adhere to the torques specified in Table 4. Bolts on side ‘A’ were tightened earlier.
4. Tighten both ADJUSTMENT BOLT nuts against BEARING HOUSING lug.
5. Rotate the shaft and, if rubbing occurs, adjust the IMPELLER towards drive end until the rubbing stops.

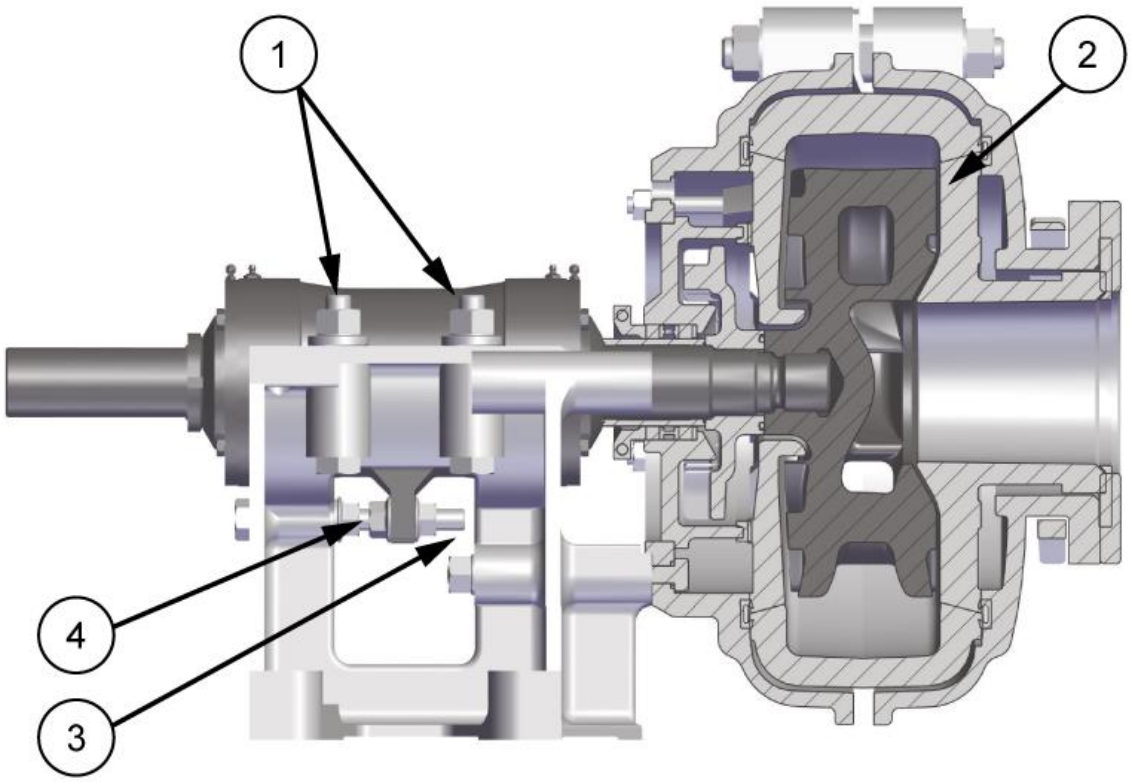

Figure 7. Impeller Clearance Adjustment.

Part	Description	Part	Description
1	Clamp Bolts	3	Adjustment Bolt (002)
2	Clearance	4	Rear Nut

NOTE: If the process fluid could cause expansion due to heat or swelling (possible with a rubber lined pump), provide for additional clearance in the adjustment procedure to allow for this expansion conditions.

⚠ CAUTION!

Make sure to check proper operating clearance of the pump before start up.

Severe damage to the pump may occur when it is operated with the impeller rubbing against the liner.

Table 4. Bearing Housing Clamp Bolt Torque Requirement.

Frame Size	Min. Torque (N-m)	Min. Torque (Ft-lb)
B	10	8
C,D,P,Q	45	35
E,F	185	140
G	325	240
R,S	185	140
T	525	390

8.4.2 Periodic Adjustment

Periodic adjustment of IMPELLER clearance over its operating life is an important factor in maximizing wear life of both IMPELLER and front Liner.

The recommended procedure for periodic Impeller adjustment is as follows:

1. At initial pump assembly, adjust IMPELLER to “just clear” the THROATBUSH or front Liner, as described in **Section 8.4.1**.
2. After 50 to 100 hours of pump operation, re-adjust IMPELLER front-end clearance.
3. Re-adjust Impeller front-end clearance a further two or three times at regular intervals over its wear life. This may coincide with regular pump maintenance intervals, typically 500 hours.

NOTE: After each Impeller adjustment is completed, the BEARING HOUSING CLAMP BOLTS must be tightened to torque values indicated in Table 4.

9 Bearing Assembly Instructions

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 a 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.

1. Use the grease quantities and type shown in this Section.
2. Always keep the cover on the grease can to prevent dirt from getting in.
3. 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.
4. 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). 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 is 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 outside the housing can cause misalignment between the bearing assembly and the pump casing. When in doubt, consult the factory or authorized dealer for proper fits, or replacement parts.

9.2 Bearing Frames B, C, D, E, F, & G

This section contains information for bearing assembly designs designated as B, C, D, E, F and G. This configuration consists of opposing tapered roller bearings (See Figure 8).

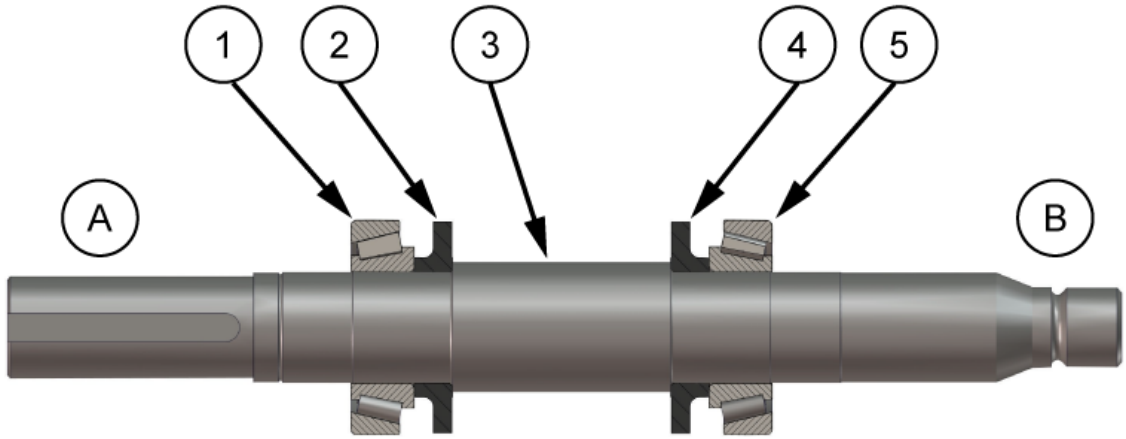

Figure 8. Fitting Grease Retainers and Bearing Cones.

Part	Description	Part	Description
1	Bearing	5	Bearing
2	Grease retainer	A	Drive end
3	Shaft	B	Impeller end
4	Grease retainer		

9.2.1 Fitting Bearings and Shaft into Bearing Housing

Flowrox recommends assembling the shaft and bearing assembly components in a vertical orientation, as opposed to horizontally, in order to obtain a more reliable rebuild. The following steps assume that vertically- oriented assembly procedures will be used.

9.2.1.1 Fitting Bearing Cones to Shaft

Reference Figure 8.

FRAMES B, C, D, E, F & G ONLY

1. Apply oil or light grease to the bearing lands on SHAFT (075), and, using an eye-bolt threaded into the impeller end, stand the shaft vertically with the impeller end up.
2. Slide on one GREASE RETAINER (049) with the flange against the shaft shoulder.

NOTE: PREHEATING BEARING CONES

Flowrox recommends the use of an induction heater for preheating bearing cones. Preheat should not exceed 100 °C (210 °F). Flame or torch heating the bearings is not recommended, and has the potential to warp cones.

3. The heated cone can be “dropped” on the vertically oriented shaft. Fit the cone of BEARING (005) to shaft with large diameter against retainer.
4. Allow the bearing to cool and set, pressing or tapping the cone down to the grease retainer. It is important to locate both grease retainers hard against shoulders, and locate bearings hard against the grease retainers. Fit should be checked again after components have cooled.
5. Rotate the shaft 180° and perform the same procedure on the opposite end.
6. Fit the other grease retainer and bearing cone as described above. Grease retainer should not rotate once the bearing is properly seated.

⚠ CAUTION!

Make sure not to damage locknut threads when seating drive end bearing cone against grease retainer.

7. Spray bearings with dewatering fluid to remove all moisture.
8. Once sufficiently cool, cover the shaft assembly with a clean plastic tarp or bag to protect it from contamination while the bearing housing is prepped in the following steps.

9.2.1.2 Fitting Wet end Bearing Cup to Housing

Reference Figure 9.

FRAMES B, C, D, E, F & G ONLY

1. Apply oil or light grease to bore at each end of BEARING HOUSING (008).
2. Press, or carefully tap with mallet, cup of BEARING (005) into one end of bearing housing until the cup is slightly below the end face of housing.
3. Bearing housing is symmetrical and bearing cup can be fitted to either end. The small diameter of the cup should face out. For single row taper roller bearings, cups and cones are not matched in sets, and may be interchanged. Assembly will be easier if you support the housing in a vertical position.
4. Place END COVER (028) with one SHIM (084) in housing and insert END COVER SCREWS (031). Use one thick shim only for sealing purposes, usually 0.45-0.50 mm (0.018” to 0.020”).
5. Tighten screws evenly. End cover will push bearing cup into correct position.

9.2.1.3 Fitting Shaft to Bearing Housing

For assemblies up to C size this procedure can be carried out with housing in horizontal position. For larger sizes, it is advisable to assemble in vertical position so that bearings will fit up concentrically. These instructions assume vertical assembly will be performed with the bearing housing resting on a block to allow the shaft assembly to seat through the housing without contacting the ground.

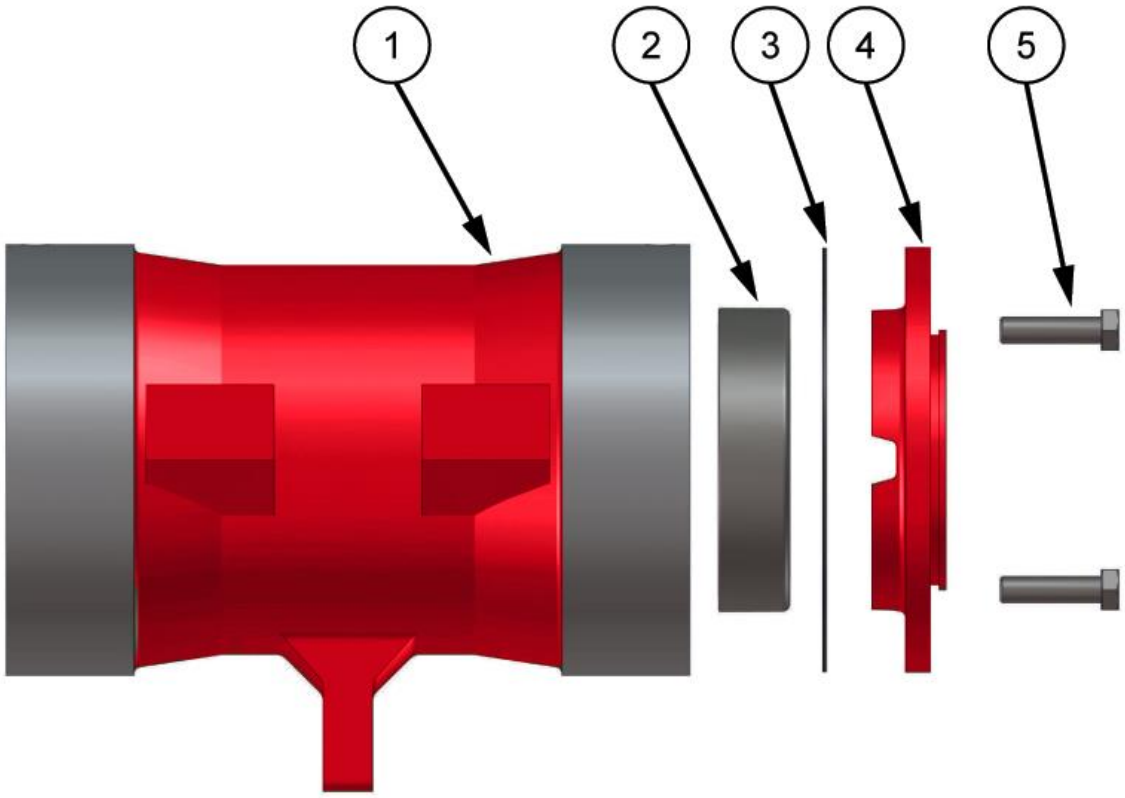

Figure 9. Fitting Wet Bearing Cup to Housing.

Part	Description	Part	Description
1	Bearing housing	4	End cover
2	Bearing	5	End cover bolt
3	Shim		

NOTICE

Do not over-tighten screws. Damage to the bearings may result.

1. Lift the shaft from the drive side using an eye bolt. Fit shaft with threaded (impeller) end down into housing.
2. Press or tap remaining bearing cup into housing over shaft.
3. Place END COVER (028) into housing and insert END COVER SCREWS (031). Do not use shims at this stage; they will be used later as shown in Figure 10.
4. While manually rotating shaft slowly, gradually tighten screws until bearing cup has been pushed right up to bearing cone. The shaft should barely rotate and bearings should have virtually no end play.

9.2.2 Determining and Setting End Play

9.2.2.1 Gap Measurement at Drive End

FRAMES B, C, D, E, F & G ONLY

1. Measure the gap between end cover flange and housing face with feeler gauges as shown in Figure 10. Providing screws have been tightened evenly, this measurement method is usually satisfactory.
2. Remove the End Cover.
3. Select SHIMS (084) of a total thickness equal to the gap measurement (obtained above) plus regular end play as shown in Table 7.
4. Fit shims, replace end cover, and insert end cover bolts. Temporarily install bolts to within approximately 3 mm (1/8”) of fully tightened position.

Table 5. Recommended Initial Quantity of Grease to be Used for Each Bearing (Frames B,C,D,E,F,G).

BEARING FRAME	GRAMS/BEARING (DRIVE END/WET END)	OUNCES/BEARING (DRIVE END/WET END)
B	30/30	1.5/1.5
C	50/50	1.75/1.75
D	100/100	3.5/3.5
E	200/200	7.0/7.0
F	500/500	17.5/17.5
G	1150/1150	40.0/40.0

Note: One shot from a standard grease gun is approx. one gram.

NOTE: Any other method of determining required thickness of shims may be used provided the final true end play between the bearings is obtained as shown in Table 7.

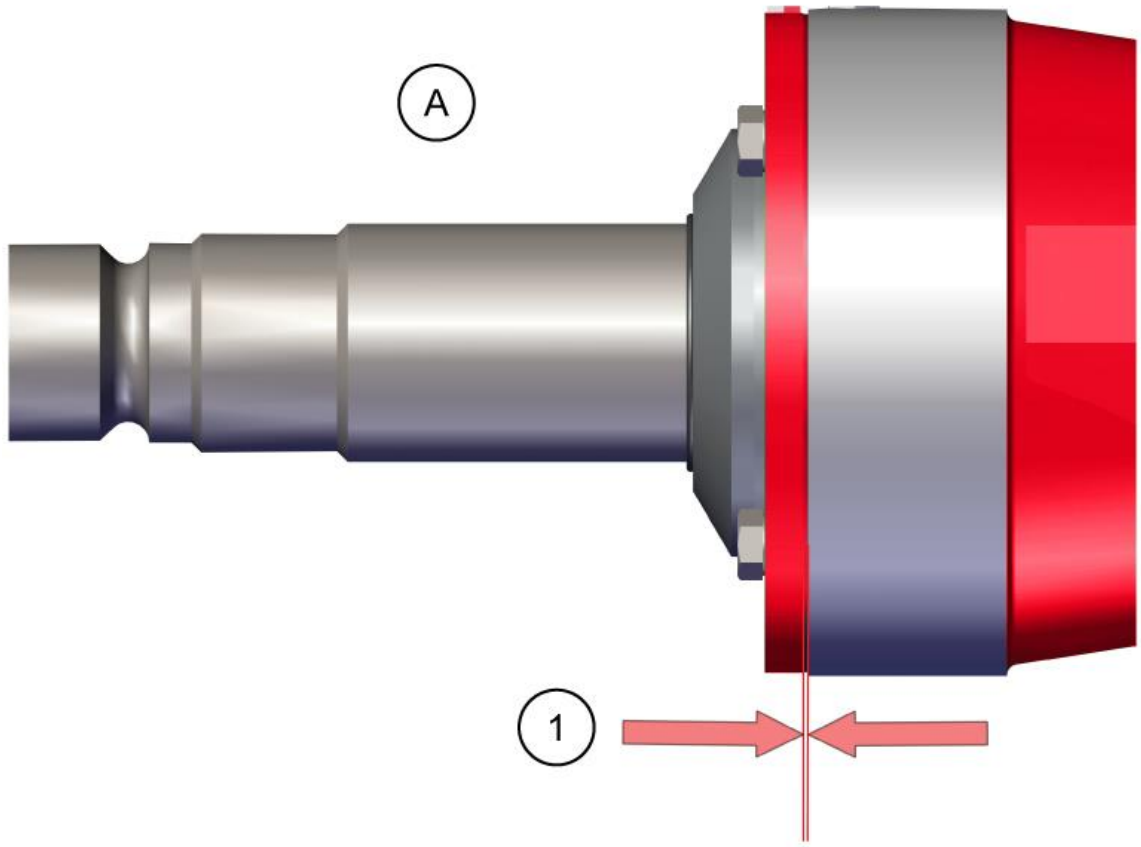

Figure 10. Gap Measurement.

Part	Description	Part	Description
A	Gap measurement	1	Regular end play

9.2.2.2 Adjustment of Bearing Cup

FRAMES B, C, D, E, F & G ONLY

1. With shims inserted, you must now move the drive end bearing cup back to the end cover to provide bearing end play.
2. Press or gently tap the shaft at threaded (impeller) end until bearing cup at opposite end has moved back to the loosely fitted end cover (see Figure 11). Be careful not to damage thread.
3. Tighten end cover bolts of loosely fitted end cover evenly to move the bearing cup into correct position. Both bearing cups should now be tight against their respective end covers and correct end play obtained.

Table 6. End Cover Shim Thickness.

SHIM COLOR	THICKNESS	
	MILLIMETERS (mm)	INCHES (in)
RED	0.05	.002
GREEN	0.08	.003
TAN	0.10	.004
BLUE	0.13	.005
TRANSPARENT	0.19	.008
BROWN	0.25	.010
PINK	0.38	.015
YELLOW	0.51	.020
WHITE	0.64	.025

Table 7. Table of Regular End Play (Cold).

FRAME	END PLAY (COLD)	
	MILLIMETERS (mm)	INCHES (in)
B	.10-.15	.004-.006
C	.10-.15	.004-.006
D	.13-.18	.005-.007
E	.18-.23	.007-.009
F	.25-.31	.010-.012
G	.36-.41	.014-.016

9.2.2.3 End Play Measurement

FRAMES B, C, D, E, F & G ONLY

Having moved the drive end bearing cup back to the end cover as shown in Figure 11 and fully tightened all screws, it is now necessary to measure the actual end play in the bearing assembly.

FRAME B & C ONLY

1. Set up bearing assembly in horizontal position with housing held firmly. Hold in bench vice if possible.
2. Attach a mounting bracket with a dial indicator micrometer securely to the housing by means of one screw (See Figure 12). Position dial actuating pin against end of shaft.

3. Manually rotate the shaft and push it hard backward and forward several times to establish a consistent dial reading. Note total movement.

FRAMES D, E, F & G

1. Set up bearing assembly in vertical position as shown in Figure 13, impeller end pointing down. Support the assembly as the lower end cover with the shaft free. The whole assembly must be located in a position where it can be reached by a hoist.

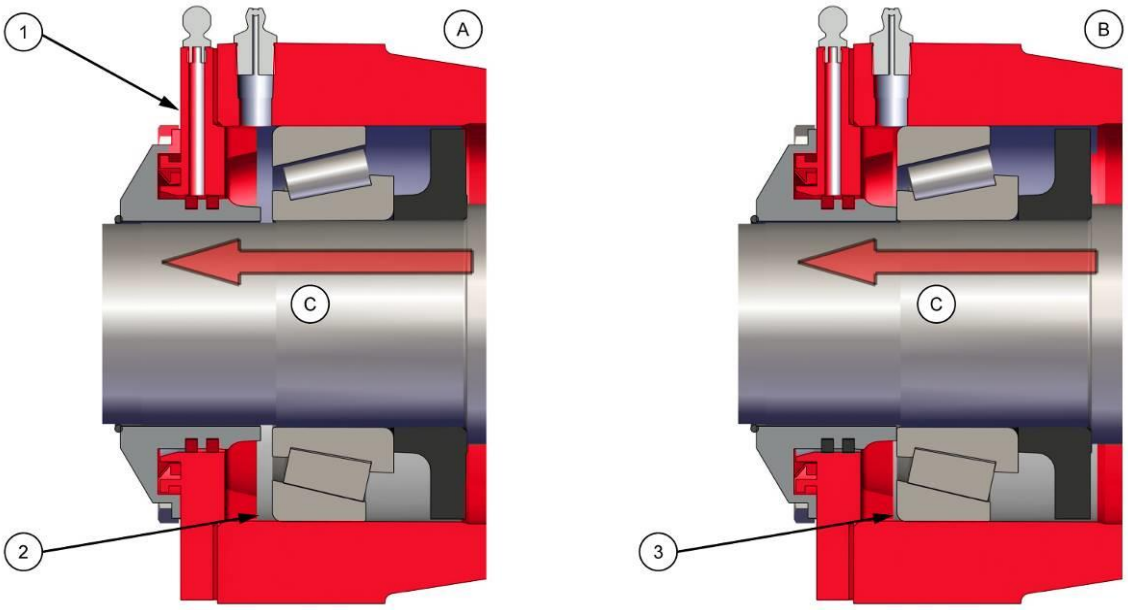

Figure 11. Adjustment of Bearing Cup.

Part	Description	*Phase*	Description
1	End cover	A	Note gap open
2	Note gap open	B	Note gap closes
3	Note gap closes when shaft is tapped		
C	Tap shaft in this direction		

Table 8. Torque Chart for Class 8 Metric Hex Head Cap Screws.

SIZE	N-m		FT-LB	
	ZINC PLATED	UNPLATED	ZINC PLATED	UNPLATED
M 6X1.00	10.4	9.5	7.8	7.1
M 7X1.00	17.0	15.5	12.8	11.6
M 8X1.25	25.0	23.0	18.8	17.3
M 10X1.50	51.0	46.0	38.3	34.5
M 12X1.75	87.0	79.0	65.3	59.3
M 14X2.00	140.0	125.0	105.0	93.8
M 16X2.00	215.0	195.0	161.3	146.3
M 18X2.50	300.0	280.0	225.0	210.0
M 20X2.50	430.0	390.0	322.5	292.5

2. Attach mounting bracket with dial indicator as described above (See Figure 12).
3. Temporarily attach a lifting eye to the threaded hole in drive end of shaft. Connect hoist or other lifting device to the lifting eye.
4. Move the shaft up and down by lifting the whole assembly off the support by means of the hoist and then lowering it back onto the support. Observe maximum and minimum readings on the dial indicator. Repeat several times until the readings become consistent. Note total movement.

ALL FRAMES

If the end play is outside the regular limits indicated in Table 7, shims must be added or removed as required (at drive end):

- If shims have to be removed, reposition end cover and tighten screws after removal of shims.
- If shims have to be added, follow procedure for fitting shims and moving bearing cup back to end cover as shown in Figure 11. After readjusting end play with shims, measure the actual play again with the dial indicator.

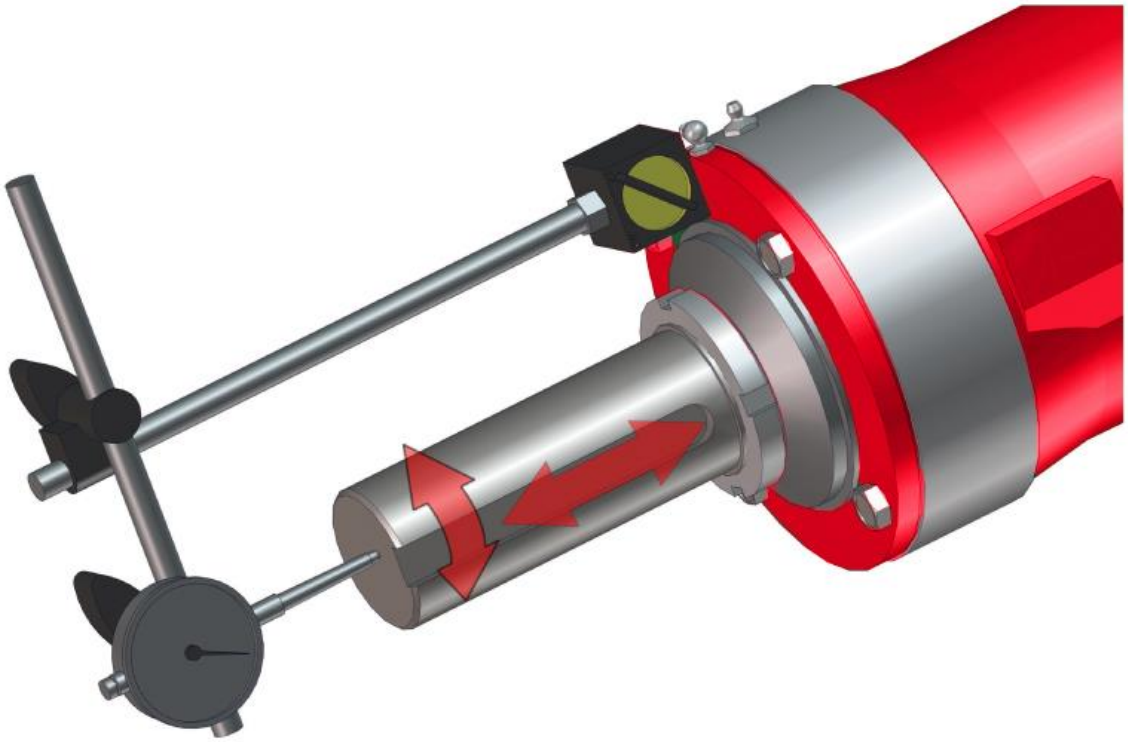

Figure 12. End Play Measurement.

9.2.3 Fitting Labyrinths, Piston Rings, and Locknut

1. Smear PISTON RINGS (072) with bearing grease and fit into the grooves of each LABYRINTH (064). Position ring grooves diametrically opposite.

NOTE: Some F and G frame pumps have a different style of Labyrinth at the two ends of the Bearing Assembly. Check Component Diagrams.

2. Refer to Figure 14 for correct placement of BEARING SEAL RING (009) in LABYRINTH (064) or END COVER (028), depending on site.
3. Slide labyrinths over shaft and push into end cover until piston ring prevents further entry.

NOTE: Position piston ring gaps away from main grease feed port in end cover.

4. Compress rings, then push labyrinths into end cover and against bearing cone.

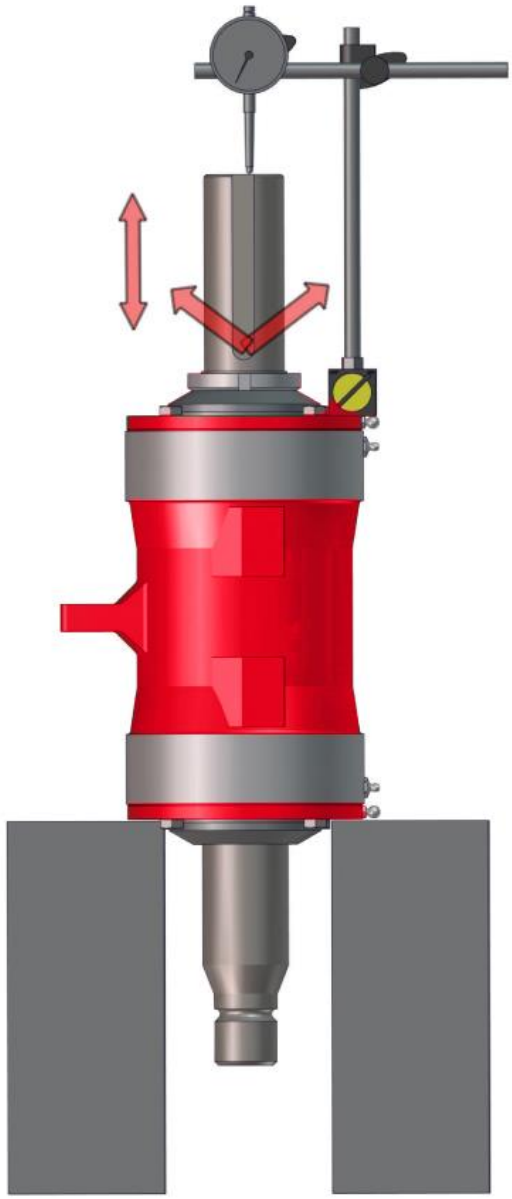

Figure 13. Checking End Play.

5. Fit LABYRINTH LOCKNUT (065) to drive end and tighten with C-SPANNER.

NOTE - Labyrinth locknut threads are left handed.

6. Fit SQUARE HEAD PIPE PLUGS or GREASE FITTINGS to bearing housing and GREASE FITTINGS to the end covers.
7. Review the recommended quantity of grease per bearing refer to Table 5. Refer to Section 8.3.1.2 for type of grease.
8. Work the grease into the bearing by injecting a quarter of the specified amount through the appropriate zerk fitting on the bearing housing, Rotate the shaft 360° five times to ensure the grease is properly lubricating all bearing surfaces. NOTE: One shot on a standard grease gun is equal to approximately one gram of grease. VERIFY THIS FOR YOUR PARTICULAR GREASING MECHANISM and modify your procedure as appropriate.

9. Repeat the previous step until the total recommended initial grease fill is reached in the bearing.
10. Repeat with other bearing.
11. Pump grease into each end cover zerk to purge labyrinth seals.
12. BEARING ASSEMBLY (006) should be ready for installation.

9.2.4 Bearing Assembly Testing

In some cases you may wish to test run the assembly before placing the unit into service. This can be carried out by mounting the completed assembly into a test rig or mounting per specifications on a pump BASE (004).

Ideally, the bearing assembly would be tested at the desired operating speed, which can be achieved through standard power transmission means: vee-belt drives, coupling to small motor.

Due to the bearing arrangement it will be necessary to induce pressure against the labyrinth as if the assembly were installed in a pump with an impeller locking a sleeve against it. This can be achieved using the following steps:

1. If no release collar is required for the given bearing assembly, proceed to Step 2. If the assembly calls for a release collar in the pump component diagram, join the three segments of the proper RELEASE COLLAR (073) with their socket head cap screws, and tighten securely. See Section 10 for release collar assembly instructions. Fit the assembled release collar against the labyrinth (flat face toward impeller thread).
2. Slip a piece of tube over the shaft, against the release collar if one is present. The tube should be of a length such that a nut on the impeller threads will hold the tube firmly in place against the release collar.

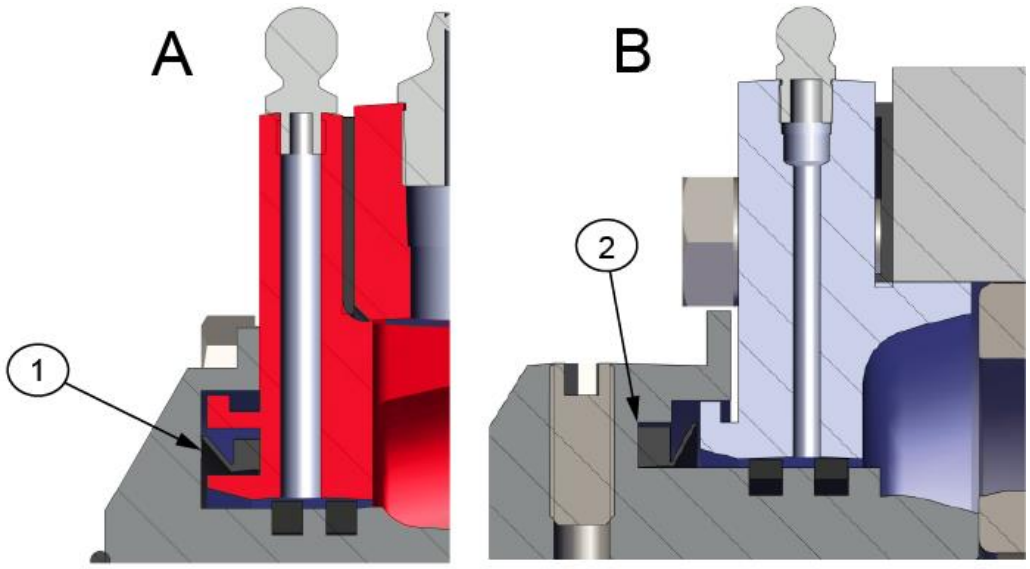

Figure 14. Bearing Seal Rings.

Part	Description	Phase	Description
1	Bearing seal ring	A	Frames C,D,E,F,G
2	Bearing seal ring	B	Frames B,R,S,T

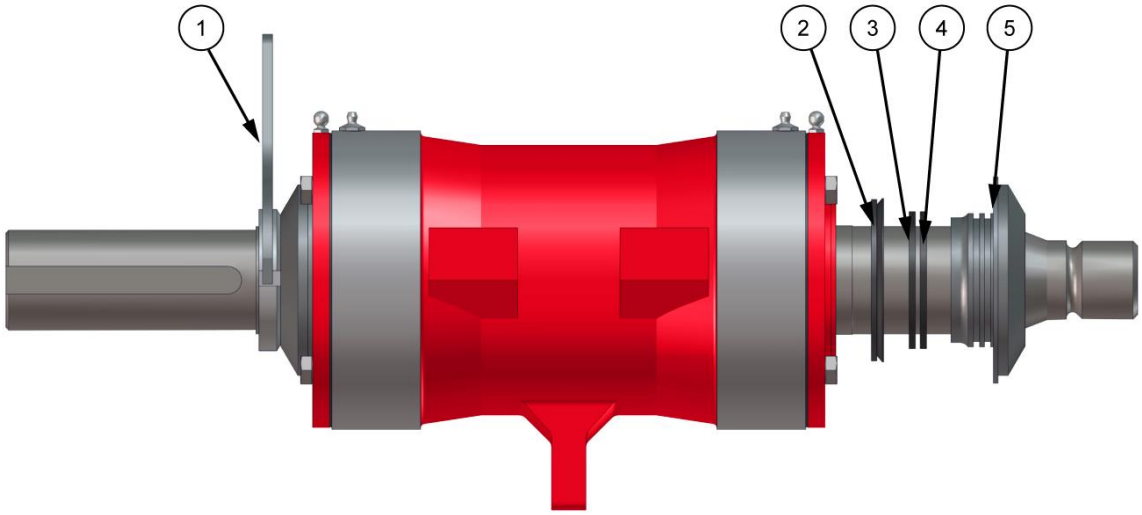

Figure 15. Fitting Labyrinths, Piston Rings and Locknuts

Part	Description	Part	Description
1	C-spanner	4	Piston ring (072)
2	Seal ring (009)	5	Labyrinth (064)
3	Piston ring (072)		

NOTE: The release collar must be fitted if one is required in the assembly. The angled bearing surface on the labyrinth may be damaged otherwise.

The above procedure will ensure that the wet end bearing remains in the correct position on the shaft and the end play, whatever it was set to, remains constant. Testing for one hour is adequate, and will result in either one of two outcomes:

1. If the end play and the grease quantities used are correct, and all components are in good working order, there should be little or no heating after this run-in period.
2. Alternatively, if one or both bearings heat quickly and excessively, proceed as follows:

    a. At or above 75°C (165°F) – continue to monitor
    b. Above 85°C (185°F) – stop testing and allow assembly to cool

Often a short heat-up time is caused by excessive grease in the bearings.

Allow the bearing assembly to cool and then restart the test adhering to the same protocols listed above. If excessive heat persists through several test cycles, stop, disassembly, and inspect all components. Watch for foreign material in the grease and other components.

9.3 Bearing Frames P, Q, R, S, T, CC, DD, EE, FF

The information provided in this section pertains to assembling bearing assembly designs Q, R, S, and T. See Figure 16 for bearing configuration.

9.3.1 Fitting of Drive End Inner Bearing and Wet End Bearing

1. Inspect the bearing journals of the shaft (075) for burrs, removing any with fine emery cloth before proceeding. Apply light oil of grease to bearing journals of SHAFT (075).
2. Fit inner ring of BEARING (007) to drive end of shaft against shoulder. For S bearing assembly fit two inner rings to drive end of shaft against shoulder.

It is advisable to preheat the bearing cone (NOTE: Preheat should not exceed 100 °C (210 °F)). It is suggested a propriety bearing induction heater is used following the manufacturers recommendations. The induction heating method is simple, quick, safe and economical.

With the shaft in vertical position, slip on the heated inner race or cones, and press or tap up to the shoulder.

3. Turn shaft end for end (impeller end up). Fit one cone of BEARING (005) with large diameter against shaft shoulder as shown in Figure 16.
4. Fit the cone spacer of BEARING (005) on the shaft against smaller end of cone as shown in Figure 16. For bearing assemblies using a one piece cup, check for the correct match number, if applicable, and fit the cup over the cone. With

those having a three piece cup, match the cup to the cone, if applicable, and place over the cone. Follow up with the cup spacer and the remaining cup.

5. Fit the second cone of BEARING (005) on the shaft with the smaller end of the bearing against the spacer. It is important that the cones and spacer are located hard against one another and against the shaft shoulder.

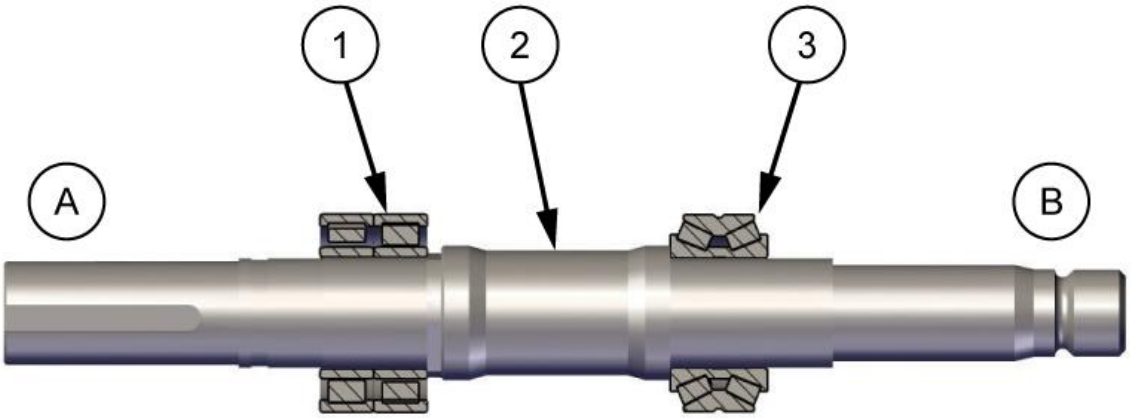

Figure 16. Fitting Drive End and Impeller End Bearing Assemblies.

Part	Description	Part	Description
1	Bearing (007)	A	Drive end
2	Shaft (075)	B	Impeller end
3	Bearing (005)		

NOTE: Bearings (005) are provided with spacers and, as such, are preset assemblies. The spacers are furnished to size for each bearing assembly to provide the correct fitted end play. Components are NOT interchangeable with similar assemblies. Each component bears an identifying serial number engraved on it. All parts with the same serial number must be kept together. The cup(s) and cones are further identified with a match number after the serial number (usually "-A" or "-B"). During installation the cones must be matched to the cup, or in the case of a three piece cup, the correct section. It is the fitment between the cones and cup(s) that determine the bearing inner spacer width, and in turn the final end play of the assembly. Thus, it is critical matching numbers are closely observed. Some small preset assemblies are not marked with serial numbers or match marked, but are still not interchangeable.

6. Spray the bearing with dewatering fluid to remove all moisture.
7. Manually work recommended grease into bearing from both sides until grease appears through holes in the cup. Refer to Table 9 for recommended quantities.

9.3.2 Fitting of Drive End Outer Bearing to Housing

1. Apply light grease or oil to drive end bore of BEARING HOUSING (008).
2. For T assembly, fit the BEARING SLEEVE into bearing housing and tap until it

rests against bearing cup.

3. Lightly grease inside surfaces of END COVER (028).
4. Stand housing with drive end up. Fit outer BEARING (007) and evenly tap it with a soft hammer against housing shoulder. For S assemblies, fit two outer rings of BEARINGS (005).
5. Place END COVER (028) with END COVER GASKET (084) into the housing. Insert END COVER SCREWS, and tighten evenly (See Figure 17).
6. Work recommended bearing grease into bearing(s) in housing, applying a liberal amount inside bearing(s). Leave the space between the grease retaining shoulder in housing and the bearing half empty. Refer to Table 9 for recommended quantities.

9.3.3 Fitting Shaft to Bearing Housing

1. Place bearing housing on two wooden blocks with fitted end cover down as shown in Figure 18. Clean and lightly grease bearing bore.
2. Screw SHAFT LIFTING NUT onto the impeller end of shaft, and by means of a hoist, lift shaft carefully into housing. Tap bearing until it rests against the bearing housing shoulder.
3. For T assembly, fit the BEARING SLEEVE (01T 010 Z0) into bearing housing and tap until it rests against bearing cup.
4. Lightly grease inside surfaces of END COVER (028).
5. Place END COVER with END COVER GASKET into the housing. Insert END COVER SCREWS, and tighten evenly.

Table 9. Recommended Initial Quantity of Grease to be used for Each Heavy Duty Bearing

Bearing Frame	Grams/ Bearing (Drive End/ Wet End)	Ounces/ Bearing (Drive End/ Wet End)
P,CC	80/100	2.8/3.5
Q,DD	160/250	5.5/8.8
R,EE	350/500	12/18
S,FF	550/800	19/28
T	800/2400	28/84

Note: One shot from a standard grease gun is approx. one gram.

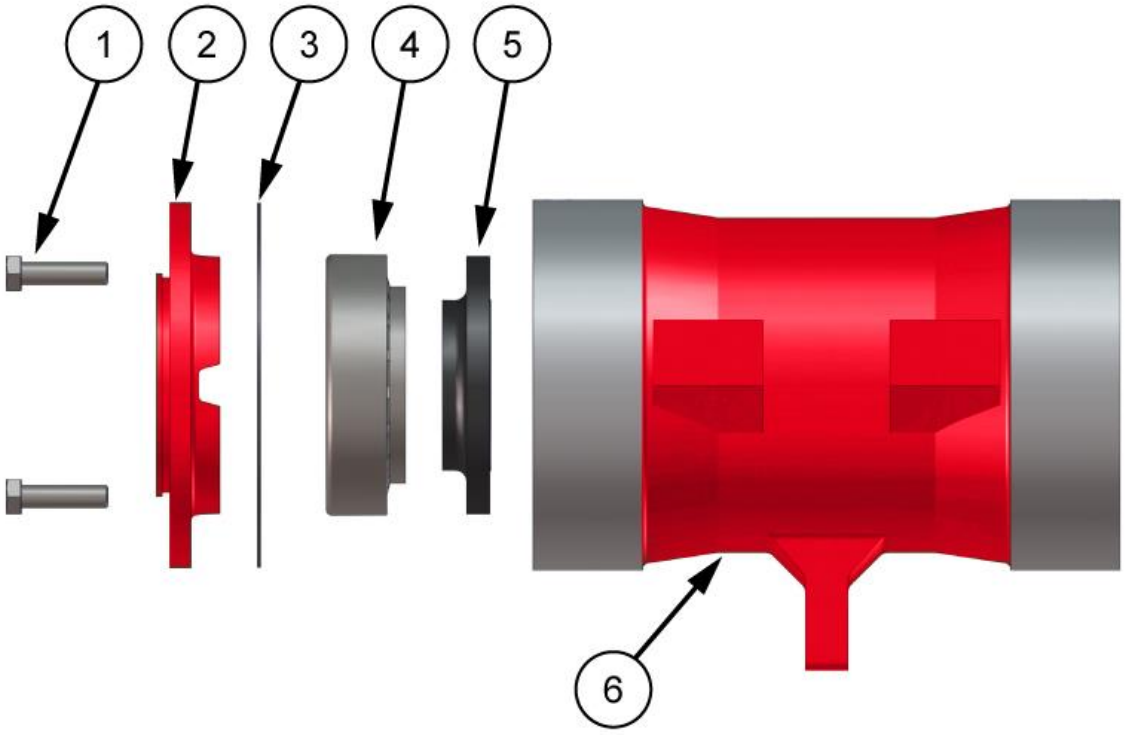

Figure 17. Fitting Drive End Outer Bearing to Housing.

Part	Description	Part	Description
1	End cover bolt	4	Bearing (007)
2	End cover (028)	5	Grease retainer (052)
3	Shim (086)	6	Bering housing (008)

9.3.4 Fitting Labyrinths, Piston Rings, and Locknut

1. Smear PISTON RINGS (072) with grease and fit two rings to the grooves of each LABYRINTH (064). Position piston ring hooks so they are not next to each other.

NOTE: Some F and G frame pumps have a different style Labyrinth at the two ends of the Bearing Assembly. Verify using relevant Component Diagrams.

2. Fit V-RING SEAL into groove in each labyrinth.
3. Slide labyrinths over shaft. Note the LABYRINTH (064) is fitted to the drive end.
4. Compress rings by hooking the ends together, then push labyrinths into end covers and against bearing cone. Note: Position Piston Ring hooked gaps away from main grease feed port in End Cover.
5. Fit LABYRINTH LOCKNUT (065) to drive end and tighten with C-SPANNER.

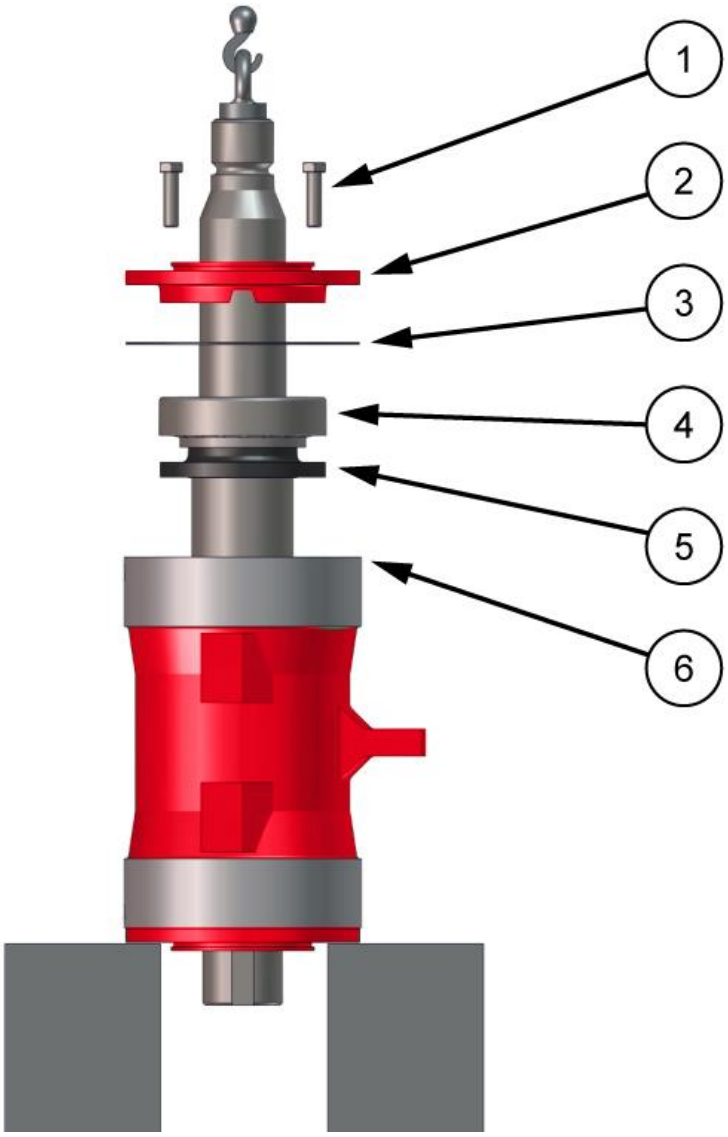

Figure 18. Fitting Shaft to Bearing Housing.

Part	Description	Part	Description
1	End cover bolts	4	Bearing (005)
2	End cover (028)	5	Grease retainer (052)
3	Shim (086)	6	Bearing housing (008)

6. Fit SQUARE HEAD PIPE PLUGS to bearing housing and GREASE FITTINGS to end covers.
7. Slowly rotate shaft and pump grease into each end cover to flush labyrinth.
8. The BEARING ASSEMBLY is complete and now take Generic Part Number (006). The BEARING ASSEMBLY (006) should be ready for installation.

9.3.5 Checked Bearing Fitted End Play

Although Frame Q, R, S, T and high-capacity bearing assemblies are fitted and require no adjustment, we suggest the fitted end play is checked against the values shown in Table 10.

Before measuring the fitted end play, it is necessary to have pressure against the impeller end labyrinth while testing. This ensures that the impeller end bearing cone remains in its correct position on the shaft, and the end play remains constant. Perform the following procedure, and refer to Figure 20:

Table 10. Heavy Duty Bearing Assembly Fitted End Play.

FRAME	END PLAY (COLD)	
	MILLIMETERS (mm)	INCHES (in)
P,CC	.07-.16	.003-.006
Q,DD	.10-.17	.004-.007
R,EE	.08-.15	.003-.006
S,FF	.06-.18	.002-.007
T	.17-.23	.007-.009

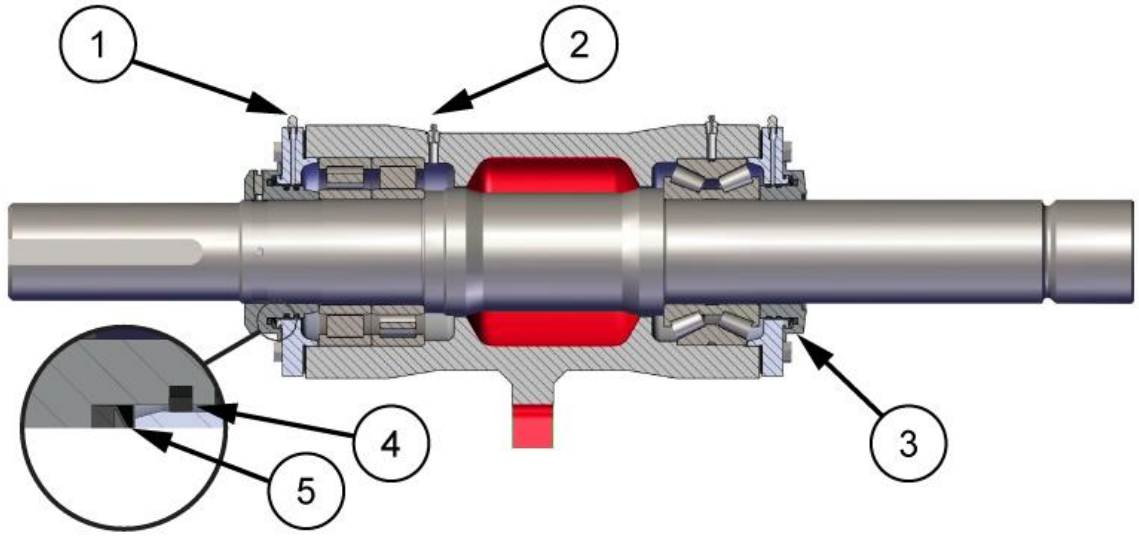

Figure 19. Fitting Labyrinths, V-Rings, Piston Rings on Heavy Duty Bearing Assemblies.

Part	Description	Part	Description
1	Grease fitting	4	Piston ring
2	Grease fitting	5	V ring (bearing seal ring)
3	Labyrinth		

1. Join the three segments of RELEASE COLLAR (073) with its socket head cap screws and tighten securely.

2. Fit the assembled release collar against the labyrinth, flat face out.

3. Slip a piece of tube over the shaft, against the release collar, and hold tightly by screwing a shaft lifting nut on the impeller thread. **NOTE**: The release collar must be fitted, otherwise the angled bearing surface on the labyrinth may be damaged. To measure the fitted end play of the bearing assembly, proceed as follows:

4. The whole assembly must be located in a position where it can be reached by a hoist. Stand assembly, impeller end up, on two wooden blocks as seen in Figure 20.

5. Attach a dial-indicator to the assembly so the relative axial movement between shaft and housing can be measured. It is suggested that a dial indicator with a magnetic base is used. The base can be clamped to the bearing end cover and the stem of the dial-indicator positioned on top of the shaft lifting nut.

6. Move the shaft up and down by lifting the whole assembly off the support by means of the hoist, then lowering it back onto the support. Observe maximum and minimum readings in the dial- indicator. Repeat several times until readings become consistent. Note total movement and check that it is within values given in Table 10. If the total movement is outside these limits review the assembly procedure.

IMPORTANT: Should the total end play be excessive, it can often be traced to gaps between bearing components or the shaft shoulder. Disassemble the unit, press bearings further on the shaft, and reassemble. If end play is less than the minimum, which is unlikely, ensure you are exerting sufficient force on the shaft. If there is no change the bearing spacers must be checked for proper match numbers. Replace the entire bearing set if end play remains under the minimum required.

Figure 20. Checking End Play on Heavy Duty Bearing Assemblies.

10 Release Collar

10.1 Release Collar Installation

The larger Flowrox Centrifugal slurry pumps employ a RELEASE COLLAR which is used to facilitate IMPELLER removal. The RELEASE COLLAR consists of 3 or 4 segments to form a ring fastened together with socket head cap screws. One face is squared and the other is tapered.

The RELEASE COLLAR is installed onto the shaft as an assembled part, and when the pump is disassembled, the segments of the RELEASE COLLAR are removed from the shaft and forces on the impeller threads are relieved, thus facilitating IMPELLER removal.

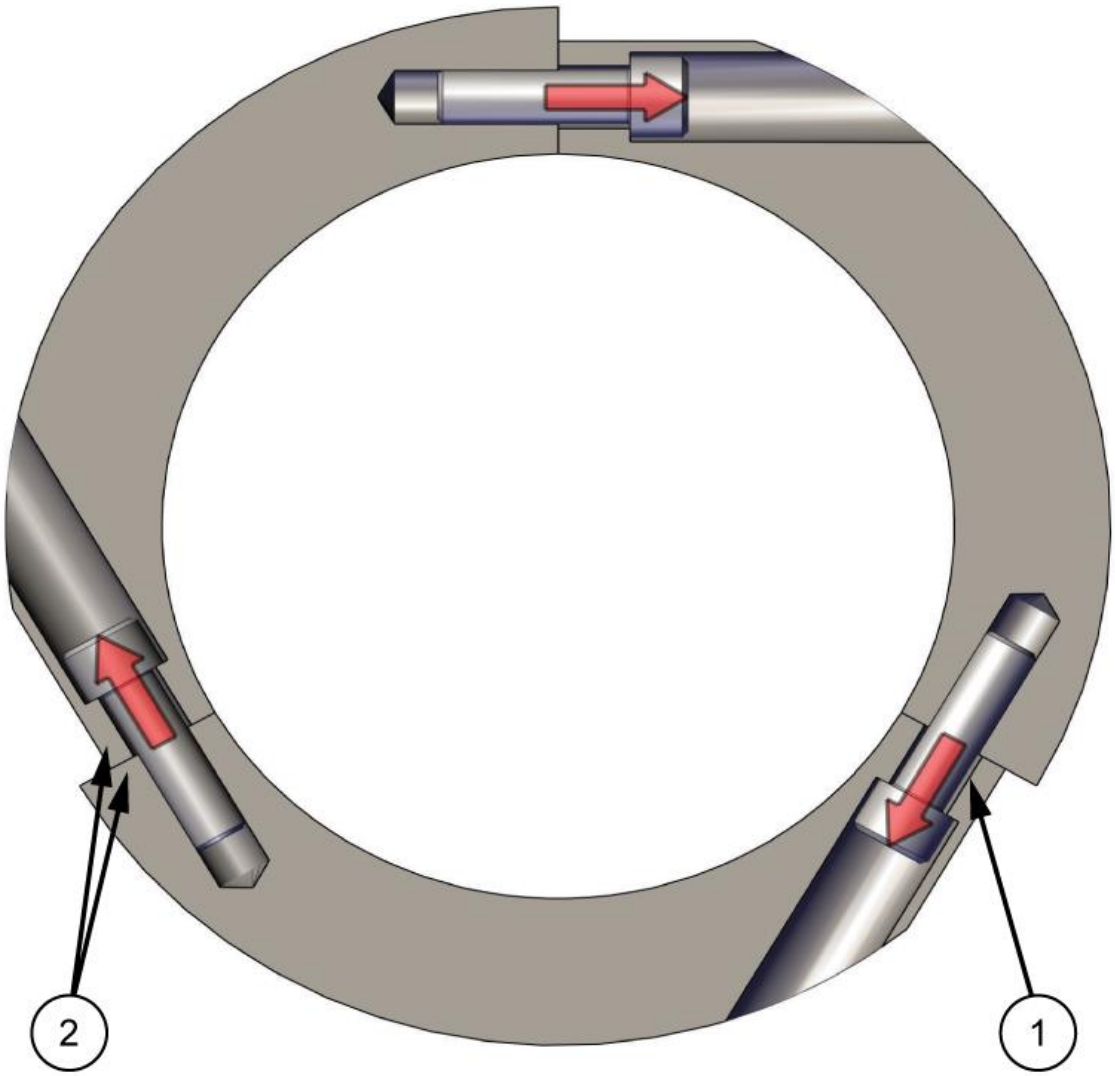

Figure 21. Assembled Release Collar.

Part	Description	Part	Description
1	Socket Head Cap Screw	2	Match Marks

RELEASE COLLAR INSTALLATION PROCEDURE

1. Thoroughly clean protective coating from RELEASE COLLAR.
2. Check to ensure that the RELEASE COLLAR O-RING has been installed on the shaft and slid up to the labyrinth. See Figure 22 and Figure 23.

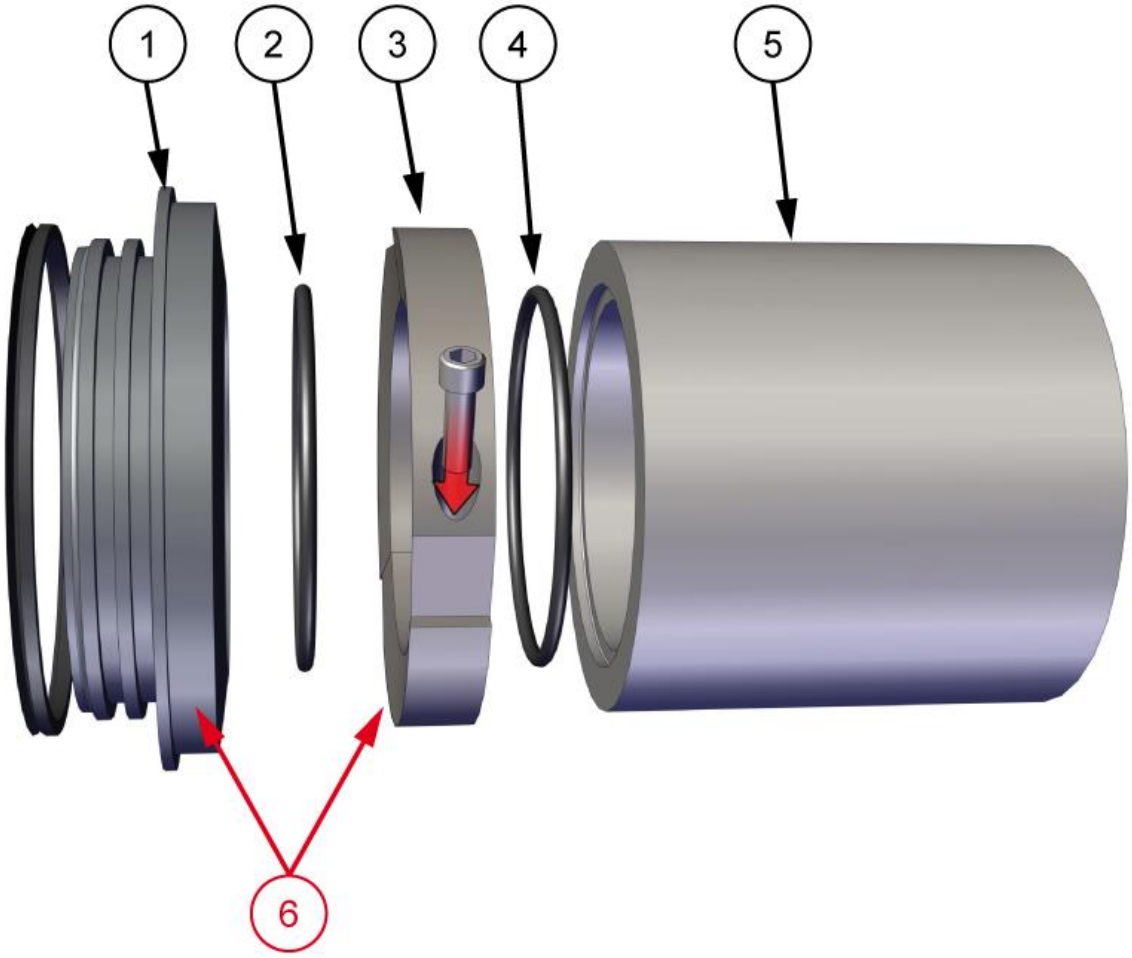

Figure 22. Impeller Release Collar, exploded view.

Part	Description	Part	Description
1	Labyrinth	4	O'ring
2	O'ring	5	Shaft sleeve
3	Impeller release collar	6	Important match tapered faces

3. Install the release collar with the tapered side toward the labyrinth and the flat side toward the shaft sleeve (see Figure 23).

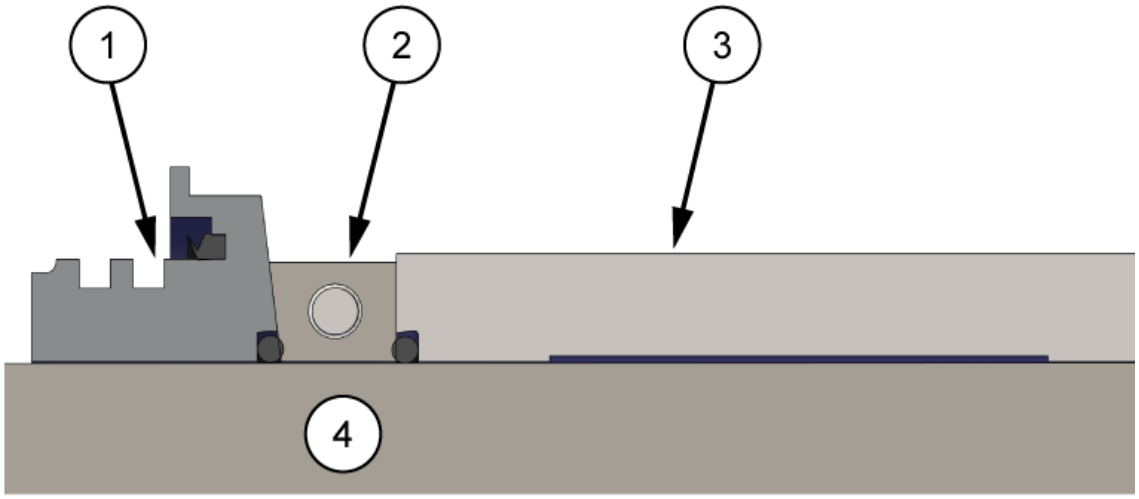

Figure 23. Impeller Release Collar Cross-Section.

Part	Description	Part	Description
1	Labyrinth (064)	3	Shaft sleeve (079)
2	Release collar (073)	4	O'rings (060)

4. It may be necessary to disassemble the three segments of the release collar to install it on the shaft.

NOTICE

Match mark all joint faces of the release collars if it is to be fully disassembled.

It is very important that the bolts holding the segments together be torqued properly. Socket head cap screws are supplied with the release collars and should be tightened per the recommendations given in Table 11.

Table 11. Release Collar Cap Screw Torque Recommendations.

Socket Head Cap Screw Size	316 SS (N-m [ft-lb])	Grade 5 (N-m [ft-lb])
3/8-16 UNC-2B	30 [20]	35 [25]
1/2-13 UNC2B	60 [45]	90 [65]
5/8-11 UNC-2B	100 [75]	180 [130]

5. Use Grade 5 socket head cap screws. Apply "Loctite 222 Screw-lock" or similar product to threads. Replace all used screws with new Grade 5 fasteners.
6. Fill the recess of the socket head cap screws and pusher holes with silicone or other suitable sealant to prevent moisture from contacting these

fasteners and fouling the threads.

NOTE - The flat faces of the shaft sleeve and release collar fit together. The seven degree taper on the labyrinth face and the seven degree taper on the release collar fit together.

NOTICE

Do not reuse the socket head cap screws after they have once been installed in a release collar.

Full fastener strength cannot be obtained from a used fastener. Obtain new, unused screws. If 316 SS fasteners are removed they should be replaced with Grade 5 of the same size.

⚠ WARNING!

Risk of loosening or failing of release collar fasteners

Inadequate torque of release collar fasteners might result in severe personal injury or equipment damage

Make sure release collar fasteners are properly torqued

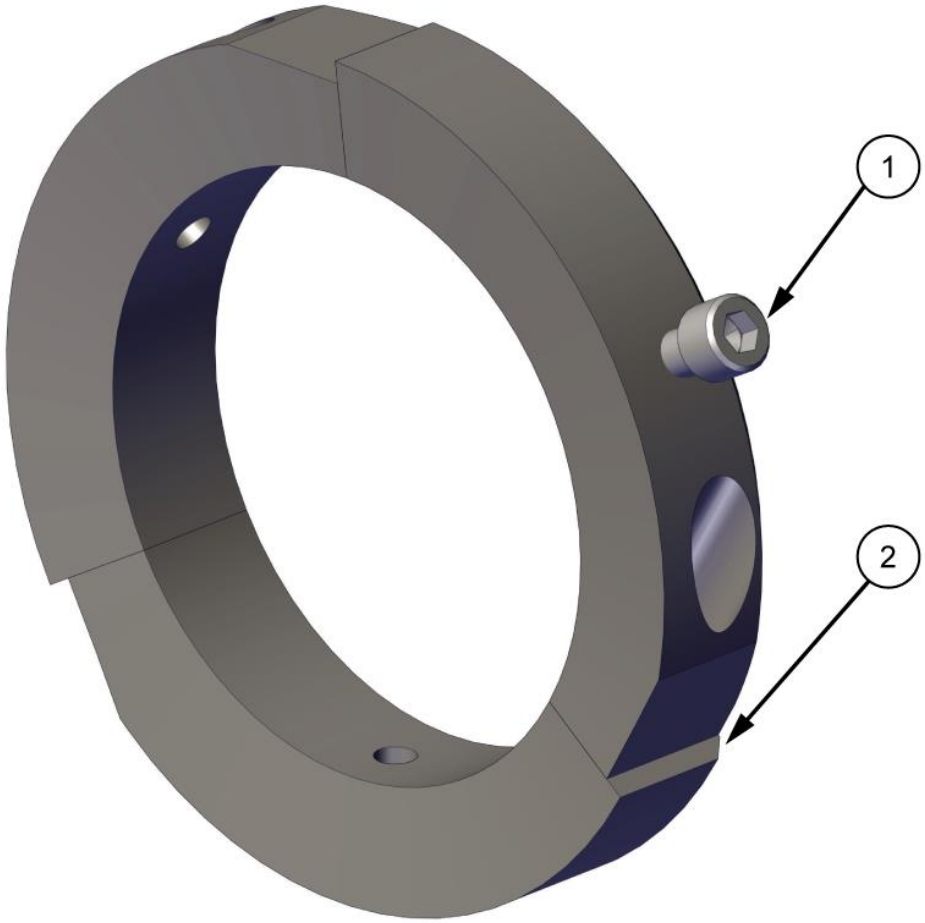

Figure 24. Segmented Release Collar.

Part	Description	Part	Description
1	Jacking bolt holes installed on some models are for release collar segment removal only Remove bolts prior to operating pump	2	Striking surface to assist in segment removal

10.2 Release Collar Removal

1. Remove sealant or other material in heads of socket head cap screws. Be certain to achieve full engagement of the Allen wrench into the socket head.
2. Remove the three bolts holding the release collar together and install Grade 5 or better bolts into the threaded pusher holes in each segment shown in Figure 24. Do not use the socket head cap screws which were just removed as pusher bolts if they are 316 SS, as their softer properties may result in damaging the threads during the subsequent removal procedure.
3. Tighten the jacking bolts against the shaft in an alternating sequence to force the segments out. A flattened “ledge” has been provided on the end of each segment to allow the positioning of a timber and mallet to aid in the removal.

NOTICE

Make sure not to apply heat to or attempt to cut the segments from the shaft.

Heat may damage either the bearing or the shaft.

11 Pump Assembly

Before you begin

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

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.

11.1 Frame Assembly

11.1.1 Fitting Bearing Assembly to Base

NOTICE

Apply an anti-seize lubricant to threads and nuts of all bolts or studs used in the following assembly procedures to facilitate later removal.

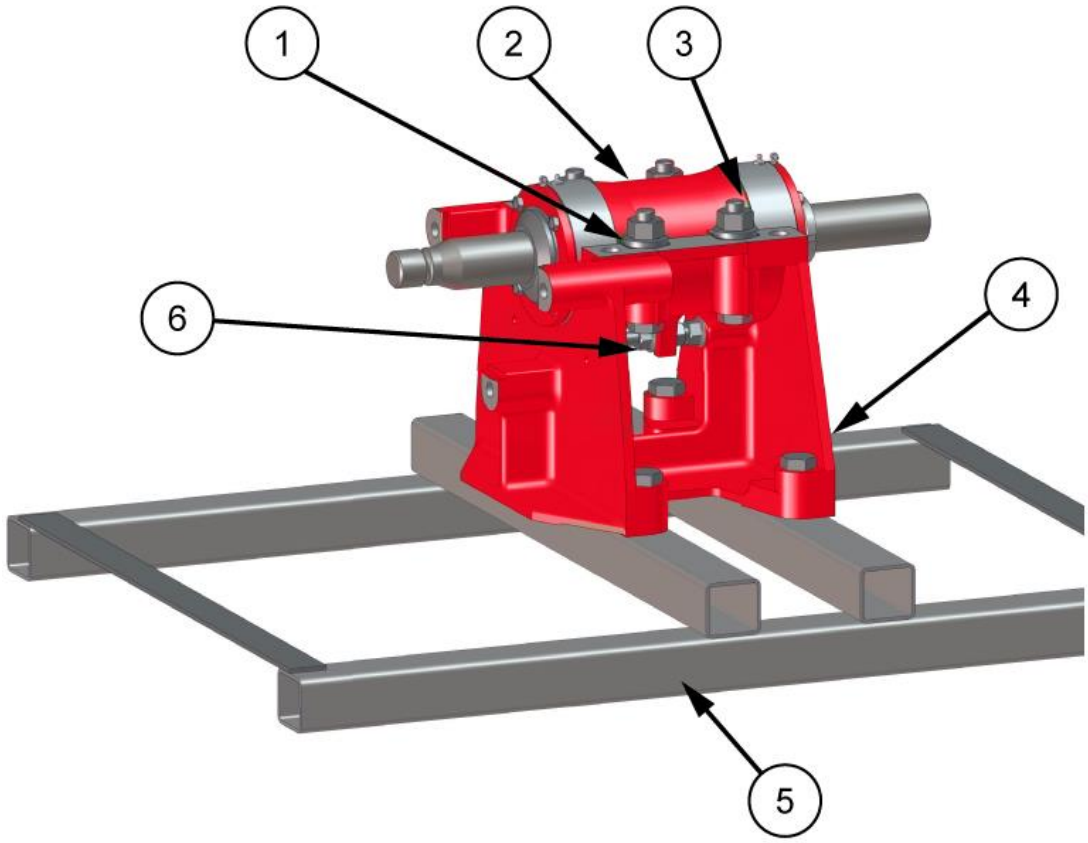

Figure 25. Fitting Bearing Assembly to Base.

Part	Description	Part	Description
1	Clamp washer (014)	4	Base (004)
2	Bearing assembly (006)	5	Shipping skid
3	Clamp bolt (013)	6	Adjusting bolt (002)

1. Insert ADJUSTING BOLT (002) in BASE (004) from outside, see Figure 25. Screw on one nut and fully tighten. Then screw on two additional nuts with two flat washers in between. These nuts are to be left loose and maximum distance apart.
2. Apply grease to the machined surfaces (bearing housing support cradle) in the base.
3. Lower the BEARING ASSEMBLY (006) onto the base. Line up machined surfaces of housing with surfaces in base. Check that the bearing housing lug fits over the adjusting bolt in base and is also between nuts and washers.
4. Fit CLAMP BOLTS (013) through base from underneath. Drop CLAMP WASHER (014) over each bolt (domed side up) and screw on nuts.
    - Fully tighten “A” side clamp bolts as shown in Figure 6.
    - The “B” side bolts should not be tightened yet. Leave these bolts finger tight only to maintain alignment and to allow axial movement.
5. Grease shaft protruding from labyrinth at impeller end. This application of grease will assist fitting and removal of shaft components and prevent moisture damage to the shaft.

6. Fit piece(s) of timber to the underside of the base or use an appropriate shipping frame as shown in Figure 25, to prevent the pump from tipping forward during assembly of the wet end.

NOTE: Check that the base is at sufficient height from the floor to allow assembly of wet end parts.

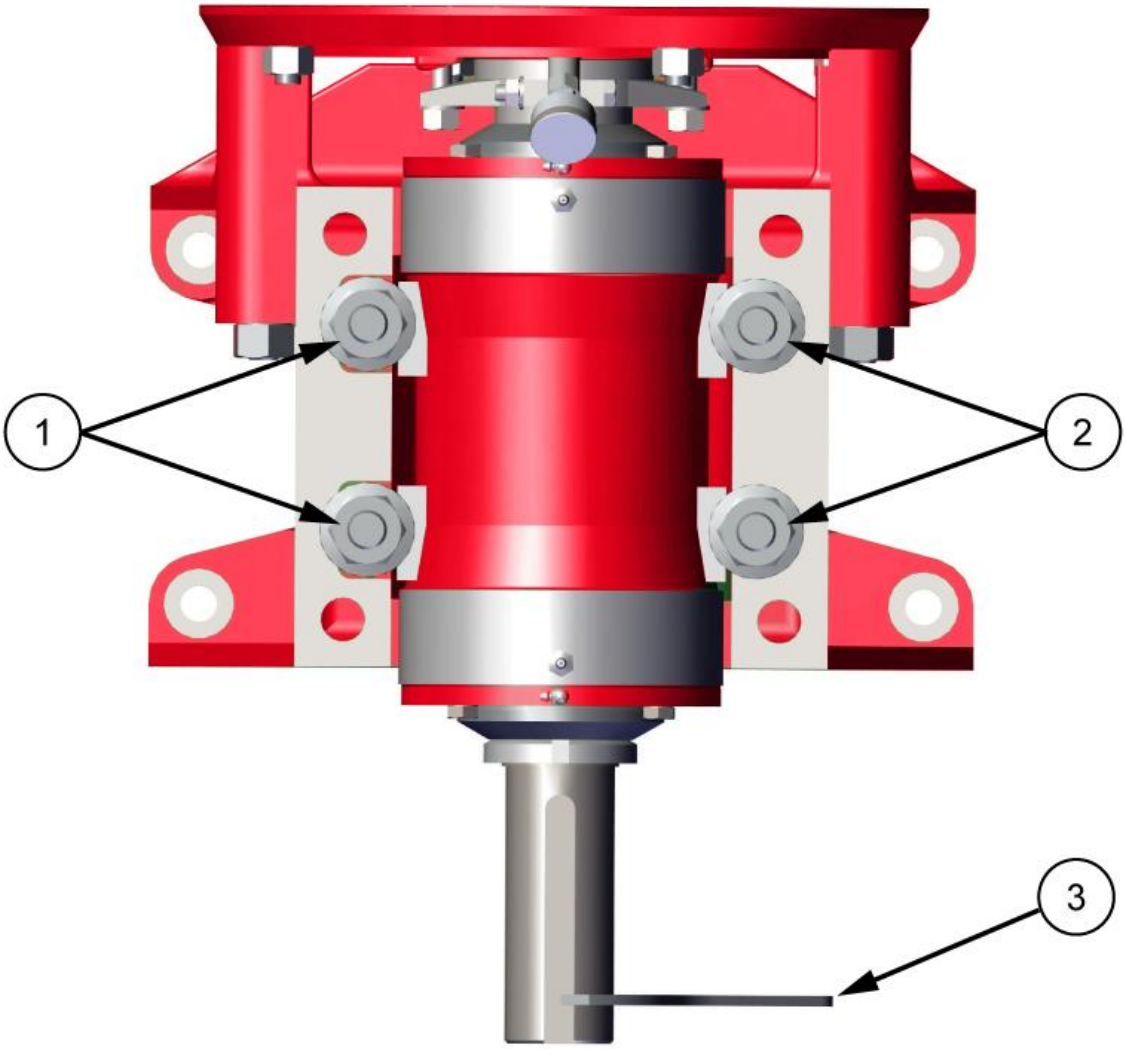

Figure 6. Bearing Assembly Clamp Bolts.

Part	Description	Part	Description
1	“B” Side Clamp Bolts (013)	3	Wrench
2	“A” Side Clamp Bolts (013)		

11.1.2 Fitting Frame Plate and Cover Plate Bolts

1. Fit FRAME PLATE (037) to base, making certain that the frame plate shoulder has engaged with the corresponding BASE RECESS. Except for a few smaller sizes, all pumps have provisions for locating the discharge at 45° increments from true vertical (refer to Figure 26).

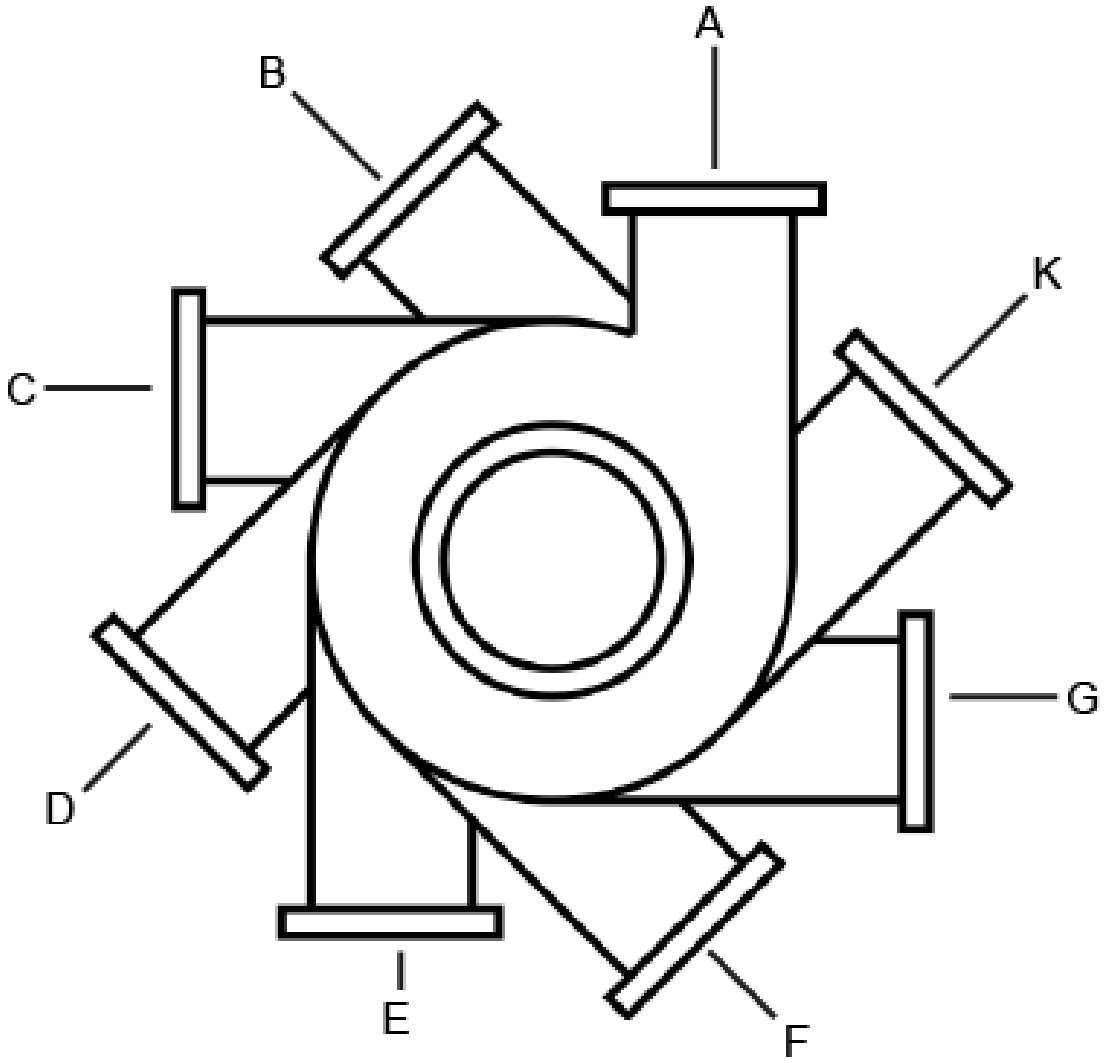

Figure 26. Discharge Orientation as Established by Frame Plate Assembly, facing suction side.

Part	Description	Part	Description
A	Standard	B	Not used with overhead motor

NOTE: With larger pumps, frame plates and cover plates are provided with radially tapped holes for eyebolts or cast lifting eyes to facilitate lifting.

NOTICE

Cast threaded inserts and lifting eyes are for single component lifting only.

2. Insert FRAME PLATE STUDS (043) or FRAME PLATE BOLTS (038), depending on the pump, being certain that the largest diameter end is closest to the frame plate. Refer to Figure 27. Fit nuts and tighten to recommended torque value indicated in Table 12.

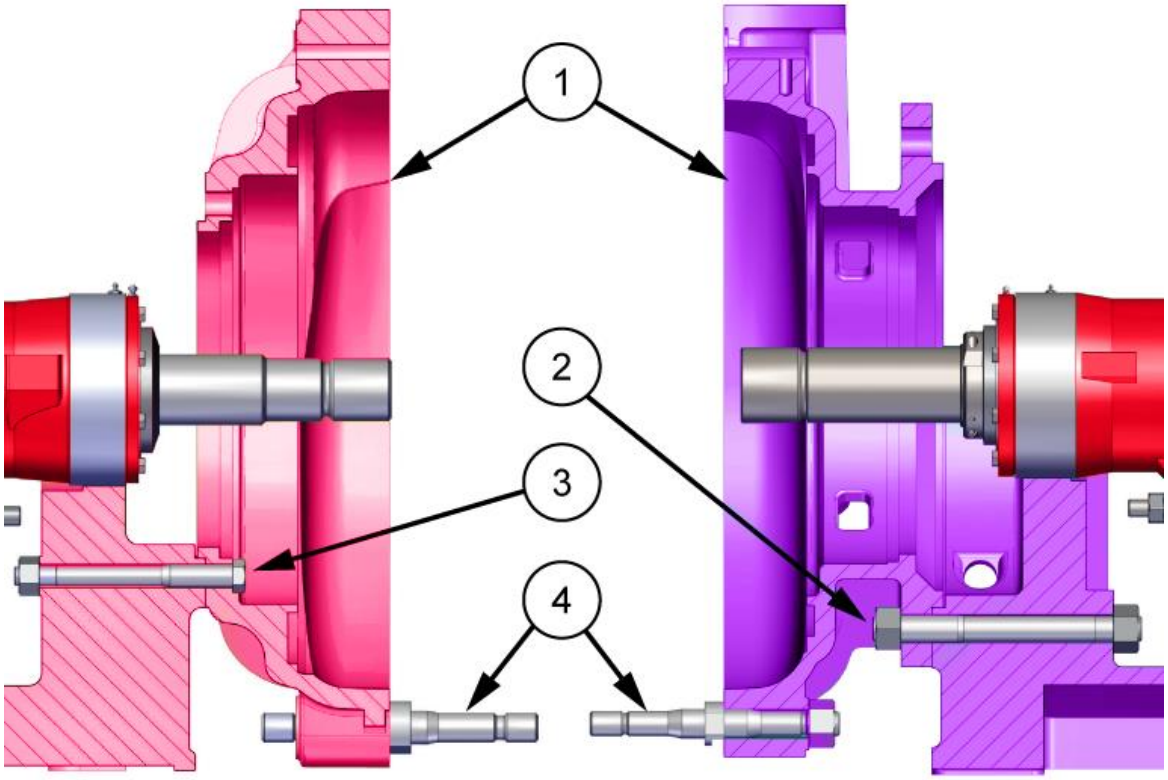

Figure 27. Fitting Frame Plate and Cover Plate Bolts.

Part	Description	Part	Description
1	Frame plate (037)	3	Frame plate bolt (038)
2	Frame plate stud (043)	4	Cover plate bolt (019)

3. On some pumps, the frame plate is bolted externally (studs are used). In other pumps, bolts are used and are inserted from inside the frame plate.

Table 12. Tightening Torque for Frame Plate Bolts (038, 043).

BOLT SIZE	RECOMMENDED TORQUE VALUE FOR FRAME PLATE BOLTS (N-m [ft-lb])
M12-1.75	55 [40]
M16-2.00	110 [80]
M20-2.50	180 [130]
M24-3.00	260 [190]
M30-3.50	520 [380]
M42-4.50	1020 [750]
M64-6.00	1360 [1000]

4. COVER PLATE BOLT (019) Installation:
5. For rubber lined pumps only: Fit COVER PLATE BOLTS (019) through Frame Plate lugs, screw on nuts, and torque all bolts evenly to values shown in Table 13, and in accordance with the tightening sequence indicated in APPENDIX B – Cover Plate Bolt Tightening Sequence.
6. For metal lined pumps: Fit through Frame Plate lugs, only those COVER PLATE BOLTS (019) that will NOT engage lugs on outside of metal VOLUTE LINER (104) (check Volute Liner for positions of lugs), attach nuts, and torque all bolts evenly, and in accordance with the tightening sequence indicated in APPENDIX B – Cover Plate Bolt Tightening Sequence, to values shown in Table 13.

NOTE: On some pumps, Cover Plate Bolts are fitted with KEEPER PLATES (063) that engage lugs on the outside of the Volute Liners. This applies to the 6 S 4 and 8 S 6 model pumps. These Cover Plate Bolts will be fitted later in the assembly.

Table 13. Tightening Torque for Cover Plate Bolts (019).

Pump Size/Series	Recommended Torque Value for Cover Plate Bolts (N-m [ft-lb])
1.5 S 1	50 [35]
2 S 1.5	50 [35]
3 S 2	50 [35]
4 S 3	110 [80]
6 S 4	220 [160]
8 S 6	220 [160]
10 S 8	570 [420]
12 S 10	570 [420]
14 S 12	950 [700]
16 S 14	1630 [1200]
20 S 18	3390 [2500]

11.2 Pump Shaft Seal Assembly

A variety of pump shaft seals are available for each Flowrox Centrifugal slurry pump:

- Gland Seal, stuffing box (wet gland)
- Centrifugal Seal, expeller ring (dry gland)
- Centrifugal Seal, metal expeller ring (wet gland)
- Mechanical Seal

NOTE: It is good practice to apply an anti-seize lubricant to threats and nuts of all bolts and studs used. Also apply a lubricant to the bare shaft before installing the shaft sleeve and/or spacer. A silicone based lubricant is best for this purpose as most other lubricants are petroleum based and incompatible with elastomer components like o-rings; otherwise, if using standard grease, avoid contact with elastomer components.

11.2.1 Gland Seal Assembly

The following are procedures for fitting stuffing box, lantern restrictor, packing gland, shaft sleeve, shaft spacer, and shaft sleeve o-rings for a gland sealed pump. Refer to your Component Diagram to determine the type of seal installed in your pump.

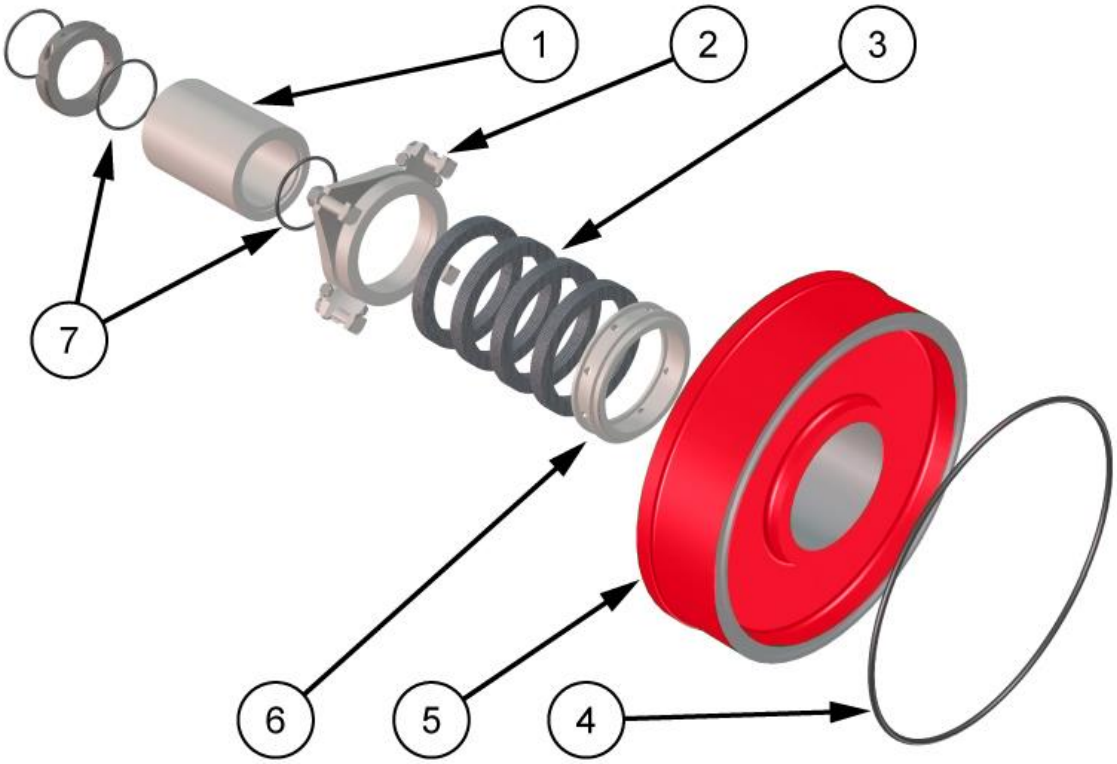

Figure 28. Gland Seal Assembly Exploded View.

Part	Description	Part	Description
1	Sleeve (075 or 111)	5	Stuffing box (089)
2	Gland (044)	6	Lantern restrictor (066)
3	Packing (071)	7	Shaft o-rings (060, 059)
4	Seal ring (074)		Shaft spacer (082) not shown

It is important that supply pressure and quality of Gland Sealing Water be provided in accordance with recommendations, as described in Section 6.1.3.1 Gland Seal Commissioning.

Minimum recommended flow rate of Gland Sealing Water to be provided for each pump size is shown in APPENDIX C Table C-1. Shaft Sleeve wear reduces velocity of the sealing water, and corresponding sealing effectiveness against entry of solid particles to the packing chamber.

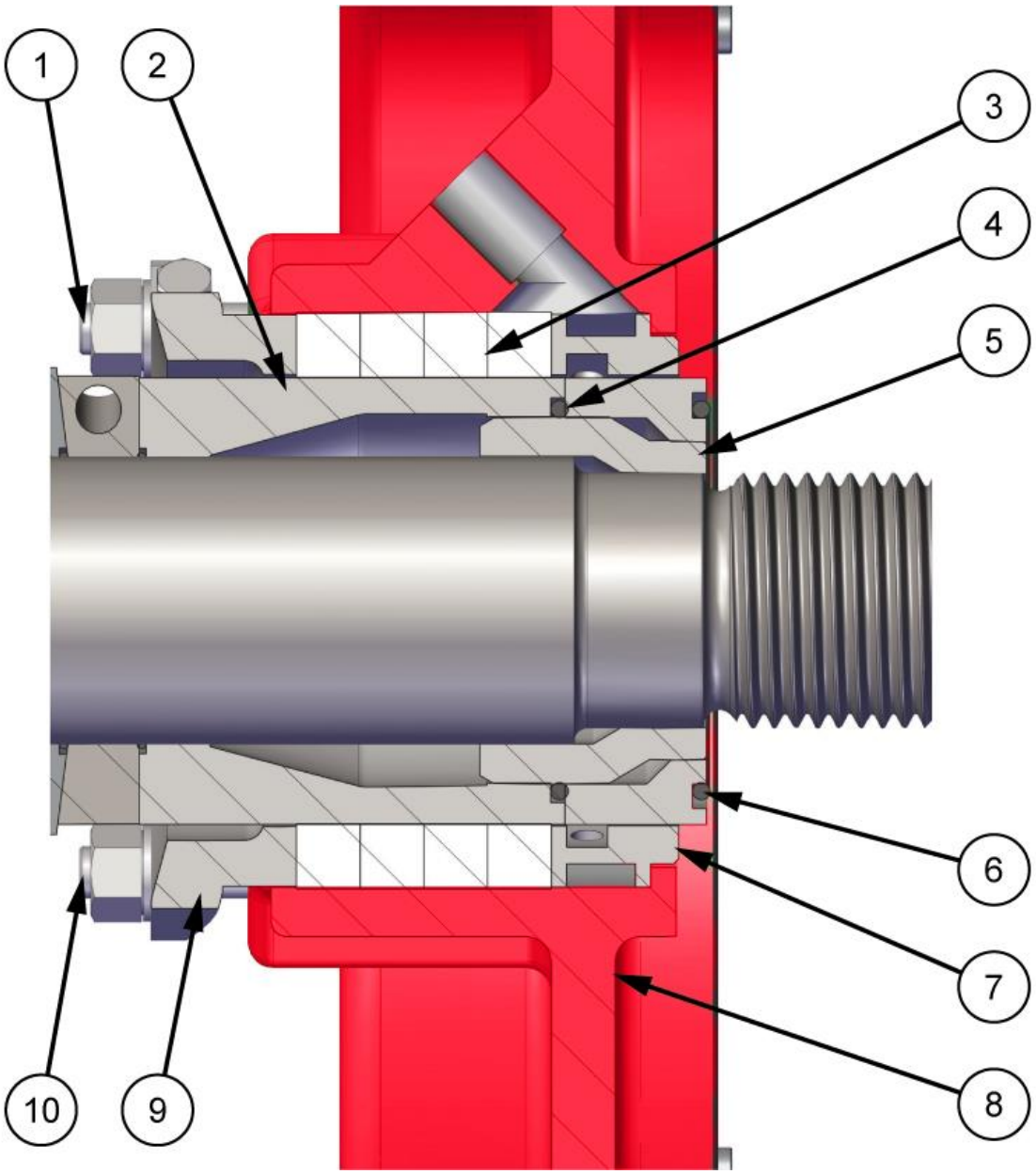

Figure 29. Gland Seal Cross Sectional View.

Part	Description	Part	Description
1	Gland clamp bolt	6	(059) shaft sleeve o-ring
2	(079) shaft sleeve	7	(066) lantern restrictor
3	(071) packing rings	8	(089) stuffing box
4	Shaft sleeve o-ring	9	(45) gland
5	(082) shaft spacer	10	(44) gland bolt

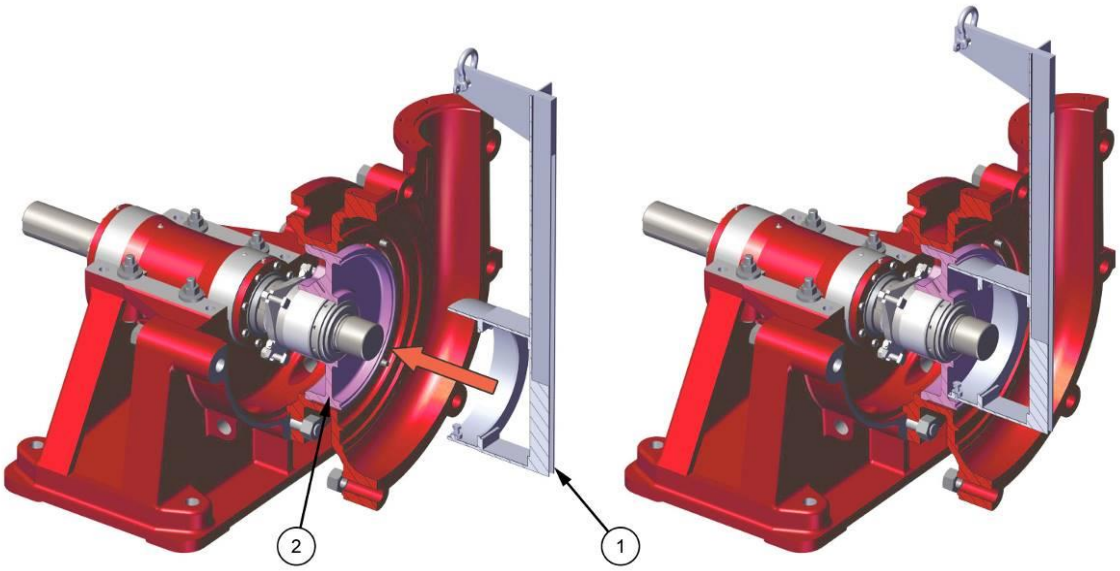

Figure 30. Lifting Beam and Stuffing Box.

Part	Description	Part	Description
1	Lifting beam (302)	2	Stuffing box (089)

NOTICE

Make sure to follow the appropriate instructions regarding each particular pump model and frame size.

Flowrox Centrifugal slurry pumps are all assembled similarly to one another.

11.2.1.1 Gland Seal Instructions for Group A Pumps

Group A Pumps:

S Series
1.5SB1
2SB1.5
3SC2
4SC3, 4SD3
6SD4, 6SE4
8SE6, 8SF6
12SG10
14SG12

1. Place the STUFFING BOX (089) flat on bench (gland side up).
2. Place the LANTERN RESTRICTOR (066) small diameter down so it rests on retaining lip in gland recess.

3. Stand the SHAFT SLEEVE (079) on end and place it through the lantern restrictor.
4. Fit PACKING RINGS (071). Make sure the packing rings are the correct length to fill annulus. The packing rings must be flattened separately, with joints staggered.
5. Assemble the GLAND (045) halves by inserting GLAND CLAMP BOLTS, fully tightening them. Place the gland into the stuffing box, pushing it down to compress packing rings. Insert GLAND BOLTS (045) and just snug nuts to hold shaft sleeve.
6. Fit the SHAFT SLEEVE O-RING (060) onto the bearing shaft and slide up to the labyrinth.
7. Insert assembled stuffing box into frame plate, tapping into position with a mallet. Locate the stuffing box with the water connection at top. The shaft sleeve will probably remain forward. It should be pushed back to the labyrinth and shaft sleeve o-ring.
8. Fit the second SHAFT SLEEVE O-RING (060) onto the bearing shaft and push it into the recess in the end face of the shaft sleeve.
9. Place SHAFT SPACER (082) onto the bearing shaft and press tight to the shaft sleeve.
10. Liberally coat the shaft thread with anti-seize lubricant.

11.2.1.2 Gland Seal Instructions for Group B Pumps

Group B Pumps:

S Series
10SF8, 10SG8
12SF10
14SF12

1. Place the STUFFING BOX (089) flat on a bench (gland side up).
2. Place the LANTERN RESTRICTOR (066) small diameter down so it rests on retaining lip in gland recess.
3. Stand the SHAFT SLEEVE (079) on end and place it through the lantern restrictor.
4. Fit PACKING RINGS (071). Make sure the packing rings are the correct length to fill annulus. The packing rings must be flattened separately with joints staggered.
5. Assemble the GLAND (045) halves by inserting GLAND CLAMP BOLTS, fully tightening them. Place the gland into the stuffing box, pushing it down to compress the packing rings. Insert GLAND BOLTS (044) just snugging the nuts enough to hold the shaft sleeve.
6. Fit a SHAFT SLEEVE O-RING (060) onto the bearing shaft and slide up to labyrinth.
7. Join the three segments of the RELEASE COLLAR (073) using its socket head

cap screws. Reference complete Release Collar installation and disassembly instructions in Section 10. Tighten up the socket head cap screws securely. Fit release collar (flat face out) onto the bearing shaft and slide up to the labyrinth.

8. Fit a second SHAFT SLEEVE O-RING (060) onto the shaft sleeve and slide it against the release collar.
9. Insert the assembled stuffing box into the frame plate, tapping into position with a mallet. Locate the stuffing box with the water connection at top. The shaft sleeve must be pushed up against the release collar.
10. Slide the SHAFT SPACER (07F 082) onto the shaft and under the SHAFT SLEEVE (079).
11. Place a second SHAFT SLEEVE O-RING (060) into the recess in the end face of the shaft sleeve.
12. Place a second SHAFT SPACER (01G 082) over the first and push up to the sleeve.
13. Liberally coat the shaft thread with anti-seize lubricant.

NOTE: All the o-rings, in their respective grooves, will be compressed and fully covered by these metallic parts when the impeller is screwed onto the shaft.

11.2.1.3 Gland Seal Instructions for Group C Pumps

Group C Pumps:

S Series
10SS8
12SS10
14SS12
16ST14

1. Place STUFFING BOX (089) flat on a bench with the gland side up.
2. Place LANTERN RESTRICTOR (066) with the small diameter down into the gland recess, resting it on retaining lip.
3. Stand shaft sleeve (111) (long) on end through lantern restrictor.
4. Fit PACKING RINGS (071). Make sure the packing rings are the correct length to fill annulus. The packing rings must be flattened separately, and joints must be staggered.
5. Assemble GLAND (045) halves, insert GLAND CLAMP BOLTS, and fully tighten. Place gland in stuffing box and push down to compress packing rings. Insert GLAND BOLTS (044) and just snug nuts sufficiently to hold shaft sleeve.
6. Fit the RELEASE COLLAR O-RING (060) on shaft and slide up to labyrinth.

7. Join the three segments of RELEASE COLLAR (073) with its socket head cap screws and tighten up securely. Complete Release Collar installation and disassembly instructions are covered in Section 10. Fit release collar (flat face out) on shaft up to labyrinth.
8. Fit SHAFT SLEEVE O-RING (060) in end of shaft sleeve.
9. Insert assembled stuffing box in frame plate and tap into position with a mallet. Locate stuffing box with water connection at top. The shaft sleeve must be pushed up against release collar.
10. Liberally coat shaft thread with anti-seize lubricant.

NOTE: All the o-rings, in their respective grooves, will be compressed and fully covered by these metallic parts when the impeller is screwed onto shaft

11.2.1.4 Gland Seal Instructions for Group D Pumps

Group D Pumps

S Series
10ST8
12ST10
14ST12
20ST18

1. Place STUFFING BOX (089) flat on bench (gland side up).
2. Place LANTERN RESTRICTOR (066) (small diameter down) in gland recess to rest on retaining lip.
3. Stand SHAFT SLEEVE (111) on end through lantern restrictor.
4. Fit PACKING RINGS (071). Packing rings must be of the correct length to fill annulus, flatten separately, and joints must be staggered.
5. Assemble GLAND (045) halves, insert GLAND CLAMP BOLTS, and fully tighten. Place gland in stuffing box and push down to compress packing rings. Insert GLAND BOLTS (044) and just snug nuts sufficiently to hold shaft sleeve.
6. Fit RELEASE COLLAR O-RING (060) on shaft and slide up to labyrinth.
7. Join the three (3) segments of RELEASE COLLAR (073) with its socket head cap screws and tighten up securely. Complete Release Collar installation and dis- assembly instructions are covered in Section 10. Fit release collar (flat face out) on shaft up to labyrinth.
8. Fit SHAFT SLEEVE SPACER O-RING (081) in end of SHAFT SLEEVE SPACER (083) and SHAFT SLEEVE (079).
9. Slide SHAFT SLEEVE SPACER (083) on shaft tight against locking collar.
10. Insert assembled stuffing box in frame plate and tap into position with a mallet. Use a lifting beam if necessary. Locate stuffing box with water connection at top. **NOTE**: The shaft sleeve must be pushed up against the shaft sleeve spacer.

11. Liberally coat shaft thread with anti-seize lubricant NOTE: All the o-rings, in their respective grooves, will be compressed and fully covered by these metallic parts when the impeller is screwed onto the shaft.

11.2.2 Centrifugal Seal Assembly, Metal Expeller Ring

Two styles of centrifugal seals using a metal expeller ring and packing are available. The first uses grease lubrication to provide a true “waterless” shaft seal. In some instances, the grease cup is removed and a minimal amount of water is injected into the packing for both lubrication and improved sealing ability. The second seal arrangement uses a restricted seal water flush through a close fitting, nonmetallic lantern restrictor.

FITTING EXPELLER RING, NECK AND LANTERN RINGS, PACKING, SHAFT SLEEVE, SHAFT SLEEVE (O-RING, AND EXPELLER). REFER TO FIGURE 31.

11.2.2.1 Grease Lubricated Centrifugal Seal

All grease lubricated centrifugal seals should use the grease recommended in Section 8.3.1.2.

Pump Models -

S Series
1.5SB1
2SB1.5
3SC2
4SC3, 4SD3
6SD4, 6SE4
8SE6, 8SF6
12SG10
14SG12

1. Place EXPELLER RING (033) flat on bench (gland seal up).
2. Drop NECK RING (070) into gland recess so it rests on the retaining lip.
3. Stand SHAFT SLEEVE (079) on end and place through neck ring.
4. Fit the following items, in turn:
   a. One PACKING RING (071) of correct length to fill annulus.
   b. Grease LANTERN RING (067) and press down to flatten first ring.
   c. Remaining packing rings (stagger packing joints and flatten each ring) to almost completely fill the annulus.

d. Assemble GLAND (045) halves, insert GLAND CLAMP BOLTS, and fully tighten. Place gland into expeller ring, pushing it down to compress the packing rings. Insert GLAND BOLTS (044) and snug nuts sufficiently to hold shaft sleeve.
e. Fit SHAFT SLEEVE O-RING (060) on shaft and slide up to labyrinth. Apply anti- seize lubricant to exposed shaft, including threads.

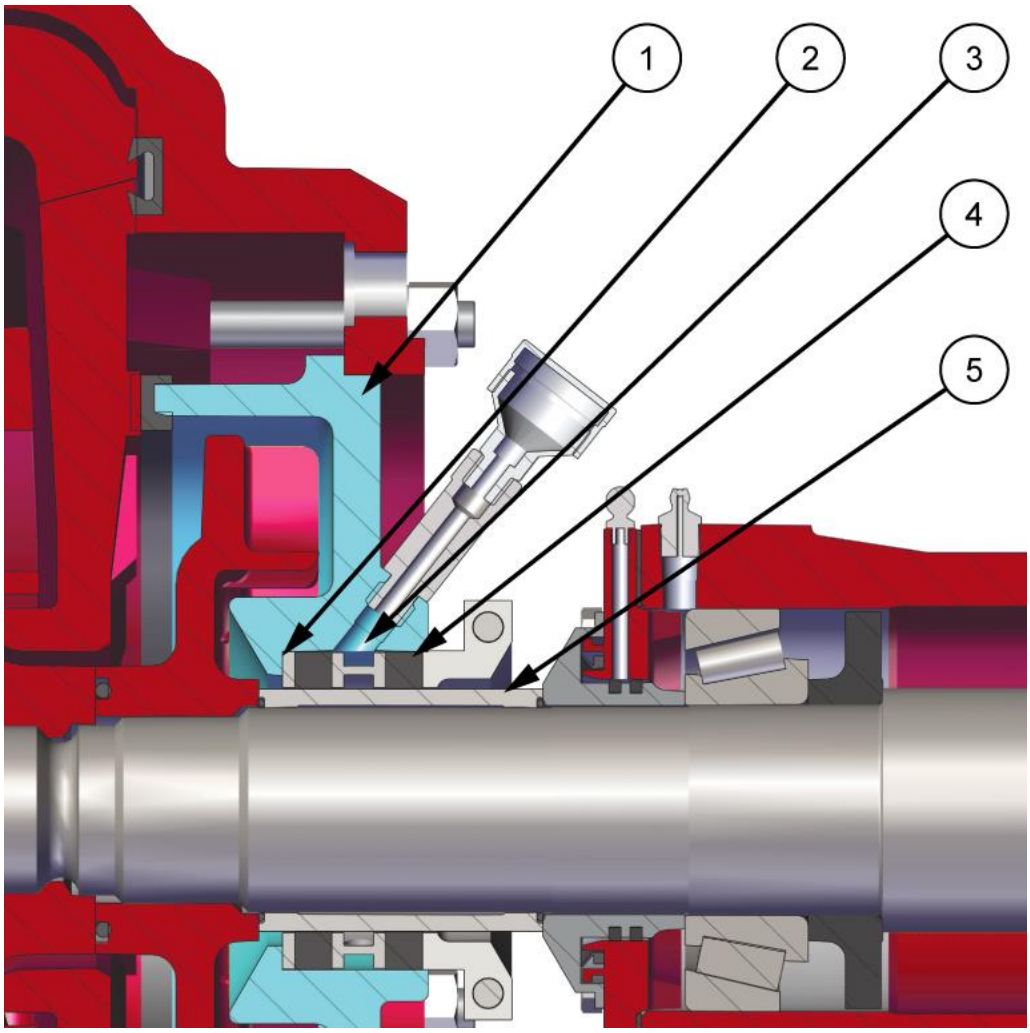

Figure 31. Centrifugal Seal Assembly.

Part	Description	Part	Description
1	Expeller ring	4	Packing
2	Neck ring	5	Shaft sleeve
3	Lantern ring		

5. Insert assembled expeller ring into frame plate, tapping into position with a mallet. Locate expeller ring with the grease inlet at top.
6. The shaft sleeve will probably remain forward. It should be pushed back to the labyrinth and o-ring.
7. Fit second SHAFT SLEEVE O-RING and push into recess in the end face of the shaft sleeve.

8. Place EXPELLER (032) onto the shaft and press up to the shaft sleeve.
9. Assembly of gland lubricating parts is done after all other parts of pump have been assembled.
10. Fit GREASE CUP ADAPTER (047) and GREASE CUP to expeller ring as shown in Figure 5. Fill cup with recommended grease and screw down the cap to charge lantern ring. Refill cup. (Refer to Section 8.3.1.2 for recommended grease)

Pump Models -

S Series
10SF8
12SF10
14SF12

1. Fit SHAFT SLEEVE O-RING (01G 060 Z0) onto the shaft and slide it up to the labyrinth face.
2. Join the three segments of RELEASE COLLAR (073) with its socket head cap screws and tighten securely. Complete Release Collar installation and disassembly are covered in Section 10 of this manual. Fit RELEASE COLLAR (flat face out) onto the shaft and slide it up to labyrinth.
3. Slide SHAFT SLEEVE O-RING (060) onto the shaft up to release collar. Apply anti-seize lubricant to exposed shaft, including threads.
4. Slide SHAFT SLEEVE (079) onto the shaft up to the release collar.
5. Slide SHAFT SPACER (082) onto the shaft and under shaft sleeve.
6. Fit LANTERN RING (067), followed by NECK RING (070), freely over sleeve, and push both against bearing housing.
7. Attach EXPELLER RING LIFTING BEAM to EXPELLER RING (033) on opposite side of lugs using three jacking screws provided, and insure that the grease inlet in the expeller ring is in line with the lifting beam.
8. Lift the expeller ring with lifting beam. Insert expeller ring in frame plate. Tap into position with a mallet. Locate with grease inlet on top. For safety purposes attach a bar across impeller face, using a bolt at both ends. Fit bolt through frame plate liner insert bolt hole. Remove bar after packing and gland are installed
9. After pump assembly has been completed. Install gland parts in the expeller ring in the following manner;
    a. Slide NECK RING (070) inside expeller ring against retaining lip.
    b. Fit one PACKING RING (071) of correct length to fill annulus and slide against neck ring.
    c. Slide grease filled LANTERN RING (067) into expeller ring and press to flatten first packing ring.
    d. Fit remaining packing rings to almost completely fill the annulus. Stagger packing joints and flatten each ring.
    e. Assemble GLAND (045) halves over outer sleeve, insert GLAND CLAMP BOLTS and fully tighten. Push expeller ring to compress

packing. Insert GLAND BOLTS (044) and tighten nuts snug.

f. Fit GREASE CUP ADAPTER (047) and GREASE CUP to expeller ring. Fill cup with recommended grease and screw down cap to charge lantern ring. Refill cup. (Refer to Section 8.3.1.2 for grease recommendations)

10. Fit second SHAFT SLEEVE O-RING (060) and push it into recess in end face of shaft sleeve.
11. Place EXPELLER (032) on shaft, slide over shaft spacer, and press up to shaft sleeve.

Pump Model – 16SG14

1. Fit SHAFT SLEEVE O-RING (01G 060 Z0) onto the shaft and slide it up to the labyrinth face.
2. Join the three (3) segments of RELEASE COLLAR (073) with its socket head cap screws and tighten securely. Complete Release Collar installation and disassembly are covered in Section 10 of this manual. Fit RELEASE COLLAR (flat face out) onto the shaft and slide it up to labyrinth.
3. Slide SHAFT SLEEVE O-RING (060) onto the shaft up to release collar. Apply anti-seize lubricant to exposed shaft, including threads.
4. Slide SHAFT SPACER (082) onto the shaft flange first
5. Slide SHAFT SLEEVE (079) and SHAFT SLEEVE O RING onto the shaft.

NOTE: All the o-rings when properly installed in their grooves, will be compressed and fully covered by the parts when the impeller is installed on the shaft.

6. Fit LANTERN RING (067), followed by NECK RING (070), freely over sleeve, and push both against bearing housing.
7. Attach EXPELLER RING LIFTING BEAM to EXPELLER RING (033) on opposite side of lugs using three jacking screws provided, and insure that the grease inlet in the expeller ring is in line with the lifting beam.
8. Lift the expeller ring with lifting beam. Insert expeller ring in frame plate. Tap into position with a mallet. Locate with grease inlet on top. For safety purposes attach a bar across impeller face, using a bolt at both ends. Fit bolt through frame plate liner insert bolt hole. Remove bar after packing and gland are installed
9. After pump assembly has been completed. Install gland parts in the expeller ring in the following manner;
    a. Slide NECK RING (070) inside expeller ring against retaining lip.
    b. Fit one PACKING RING (071) of correct length to fill annulus and slide against neck ring.
    c. Slide grease filled LANTERN RING (067) into expeller ring and press to flatten first packing ring.
    d. Fit remaining packing rings to almost completely fill the annulus. Stagger packing joints and flatten each ring.
    e. Assemble GLAND (045) halves over outer sleeve, insert GLAND

CLAMP BOLTS and fully tighten. Push expeller ring to compress packing. Insert GLAND BOLTS (044) and tighten nuts snug.

f. Fit GREASE CUP ADAPTER (047) and GREASE CUP to expeller ring. Fill cup with recommended grease and screw down cap to charge lantern ring. Refill cup.

10. Fit second SHAFT SLEEVE O-RING (060) and push it into recess in end face of shaft sleeve.
11. Place EXPELLER (032) on shaft, slide over shaft spacer, and press up to shaft sleeve.

Pump Models -

S Series
10SG8
16ST14
20ST18

1. Fit a SHAFT SLEEVE O-RING (060) into the labyrinth groove.
2. Join the SPLIT RELEASE COLLAR (73) with its socket head cap screws and tighten securely. Complete Release Collar installation and disassembly instructions are covered in Section 10 in this manual. Fit collar (flat face out) onto the shaft and slide up to labyrinth. Apply anti-seize lubricant to exposed shaft, including threads
3. Fit a second SHAFT SLEEVE O-RING (060) onto the shaft next to the collar.
4. Slide SHAFT SLEEVE (079) onto the shaft. Fit SHAFT SLEEVE O-RING (060) and push into recess in the face of the shaft sleeve.
5. Fit LANTERN RING (067), followed by NECK RING (070), freely over sleeve, and push both against bearing housing.
6. Attach EXPELLER RING LIFTING BEAM to EXPELLER RING (033) on opposite side of lugs using three jacking screws provided, and insure that the grease inlet in the expeller ring is in line with the lifting beam.
7. Lift the expeller ring with lifting beam. Insert expeller ring in frame plate. Tap into position with a mallet. Locate with grease inlet on top. For safety purposes attach a bar across expeller ring face, using a bolt at both ends. Fit bolt through frame plate liner insert bolt hole. Remove bar after packing and gland are installed
8. After pump assembly has been completed. Install gland parts in the expeller ring in the following manner;
    a. Slide NECK RING (070) inside expeller ring against retaining lip.
    b. Fit one PACKING RING (071) of correct length to fill annulus and slide against neck ring.
    c. Slide grease filled LANTERN RING (067) into expeller ring and press to flatten first packing ring.
    d. Fit remaining packing rings to almost completely fill the annulus. Stagger packing joints and flatten each ring.
    e. Assemble GLAND (045) halves over outer sleeve, insert GLAND

CLAMP BOLTS and fully tighten. Push expeller ring to compress packing. Insert GLAND BOLTS (044) and tighten nuts snug.

f. Fit GREASE CUP ADAPTER (047) and GREASE CUP to expeller ring. Fill cup with recommended grease and screw down cap to charge lantern ring. Refill cup.

9. Fit second SHAFT SLEEVE O-RING and push it into recess in end face of shaft sleeve.
10. Place EXPELLER (032) on shaft, slide over shaft spacer, and press up to shaft sleeve.

Pump Models -

S Series
10SS8
12SS10
14SS12

1. Fit a SHAFT SLEEVE O-RING (01S 060 Z0) into labyrinth groove.
2. Join the split RELEASE COLLAR (073) with its socket head cap screws and tighten securely. Complete Release Collar installation and disassembly are in this manual in Section 10. Fit collar (flat face out) onto the shaft and slide up to the labyrinth.
3. Fit a second SHAFT SLEEVE O-RING (060) next to collar.
4. Slide SHAFT SLEEVE (079) onto the shaft. Fit SHAFT SLEEVE O-RING (060) and push into recess in end face of shaft sleeve.
5. Fit LANTERN RING (067), followed by NECK RING (070), freely over sleeve, and push both against bearing housing.
6. Attach EXPELLER RING LIFTING BEAM to EXPELLER RING (033) onto the opposite side of lugs using three jacking screws provided, and insure that the grease inlet in the expeller ring is in line with the lifting beam.
7. Lift the expeller ring with lifting beam by means of a hoist, and insert the expeller ring into the frame plate. Tap into position with a mallet. Locate with grease inlet at top. For safety purposes it is desirable to attach a bar across the face of the expeller ring using a bolt at either end. Fit the bolt through one of the frame plate liner insert bolt holes. Remove the bar after the shaft packing and gland are installed.
8. After assembly of all other parts of the pump has been completed, carry out assembly of all gland parts in the expeller ring in the following manner:
    a. Slide neck ring (070) inside expeller ring against retaining lip.
    b. Fit PACKING RING (071) of correct length to fill annulus and slide against neck ring.
    c. Slide LANTERN RING (067) into expeller ring and press to flatten first packing ring.
    d. Fit the remaining packing rings to almost completely fill the annulus. Stagger packing joints and flatten each ring.
    e. Assemble GLAND (045) halves over shaft sleeve with gland neck

toward expeller ring, insert GLAND CLAMP BOLTS, and fully tighten. Push into the expeller ring to compress packing rings. Insert GLAND BOLTS (044) and tighten nuts until snug.

f. Fit GREASE CUP ADAPTER (047) and GREASE CUP to expeller ring. Fill cup with recommended grease and screw down cap to charge lantern ring. Refill cup.

9. Fit second SHAFT SLEEVE O-RING (060) and push it into recess in end face of shaft sleeve.
10. Place EXPELLER (033) on shaft, slide over shaft spacer, and press up to shaft sleeve.

11.2.2.2 Restricted Flow Centrifugal Seal

FITTING METAL EXPELLER RING, LANTERN RESTRICTOR, PACKING, SHAFT SLEEVE, SHAFT SLEEVE O-RING, AND EXPELLER. REFER TO FIGURE 31.

NOTE: Assembly of water connection will be done after all other parts of the pump have been assembled.

Both seal water flow and pressure should
be regulated to the values shown on the arrangement drawing for the pump. Excessive flow or pressure will necessitate over- compressing the packing, resulting in reduced packing and shaft sleeve wear life.

It may be necessary to modify the gland seal water port on field installed retrofits to this seal. This is done to allow sufficient flow to the lantern ring restrictor. Consult the factory for details.

The procedures for installing this seal are largely identical to those described in Section 11.2.2.1 with the exception of the EXPELLER RING (033), LANTERN RING (067), and PACKING RINGS (071).

A special expeller ring is required, suited for the use of a lantern ring restrictor. Consult the factory for the correct part number and identification of such a part. The expeller modified lantern ring restrictor is indicated in the part number with the digits “ZR” following “066” in the part.

1. Place the LANTERN RING RESTRICTOR (066 ZR) at the bottom of the expeller ring box over the shaft sleeve (079).
2. Place two PACKING RINGS (071) in the annulus behind the LANTERN RING RESTRICTOR (066 ZR).
3. Complete the assembly using the instructions indicated in the correct portion of Section 11.2.2.1.

NOTE: Ensure that the modified expeller ring will deliver unobstructed gland seal water to the lantern ring restrictor prior to final installation. Lack of seal water will cause excessive wear, heat and premature seal failure.

11.2.3 Centrifugal Seal Assembly, Rubber Expeller Ring

FITTING RUBBER EXPELLER RING, LIP SEALS, GLAND STUDS, GLAND SHAFT SLEEVE, SHAFT SLEEVE O-RINGS, AND EXPELLER. REFERENCE FIGURE 32.

Pump Models -

S Series
1.5SB1
2SB1.5
3SC2
4SC3, 4SD3
6SD4, 6SE4
8SE6, 8SF6

1. Place EXPELLER RING (034) flat on a bench with the gland side up as shown in Figure 28.

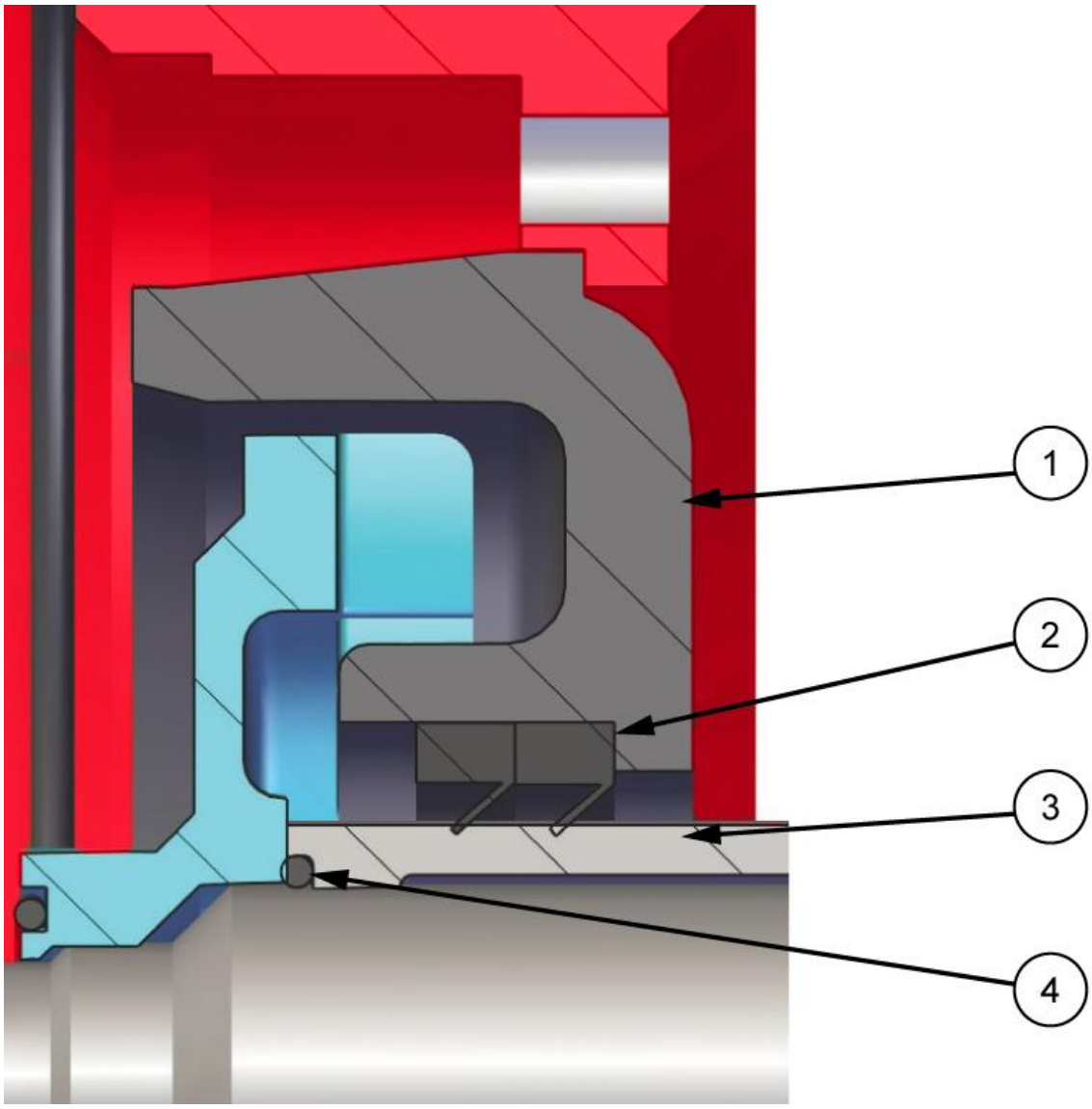

Figure 32. Assembly of Lip Seal Gland Components.

Part	Description	Part	Description
1	Expeller ring	3	Shaft sleeve
2	Lip seal	4	Shaft sleeve o-ring

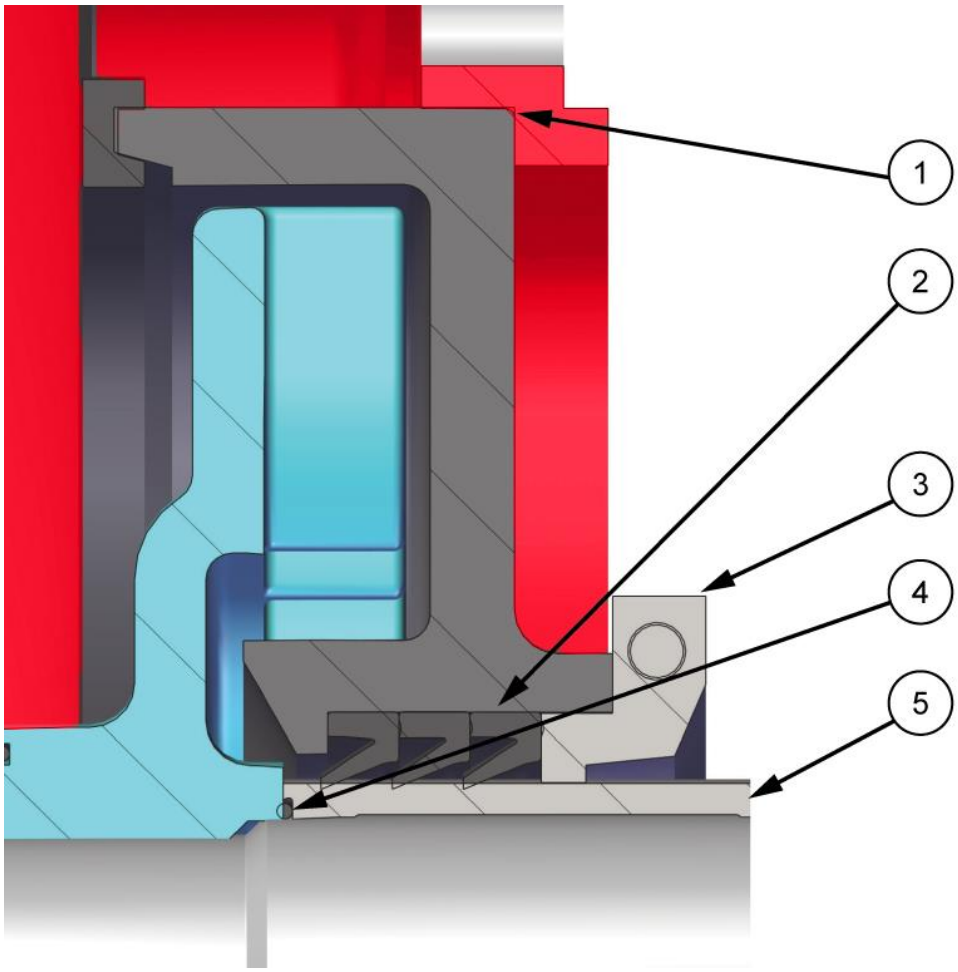

Figure 33. Fitting of Expeller Ring, Shaft Seals, Gland Studs, Gland, Shaft Sleeve, Shaft Sleeve O-Ring and Expeller.

Part	Description	Part	Description
1	Expeller ring	4	Shaft sleeve o-ring
2	Lip seal	5	Shaft sleeve
3	Lip seal gland		Expeller ring studs (not shown)

2. Fit two EXPELLER RING STUDS (035) into expeller ring tapped holes provided and tighten fully. (Where applicable; smaller pumps do not have studded expeller rings)
3. Insert two or three LIP SEALS (078) (lip toward wet-end) into gland recess and push against retaining lip. To ease fitting, smear the outside diameter of seals with liquid soap or rubber lubricant.
4. Place GLAND (045) into the expeller ring, fit nuts on studs, and tighten fully. (Gland adjustment is not required once set)
5. Fit SHAFT SLEEVE O-RING (060) onto the shaft and slide up to labyrinth as shown in Figure 33. Apply anti-seize lubricant to exposed shaft, including threads.
6. Slide SHAFT SLEEVE (079) on shaft.
7. Fit a second SHAFT SLEEVE O-RING (060) and push into recess in end face of shaft sleeve.

Pump Models -

S Series
10SF8, 10SS8
12SF10, 12SS10
14SF12, 14SS12
20ST18

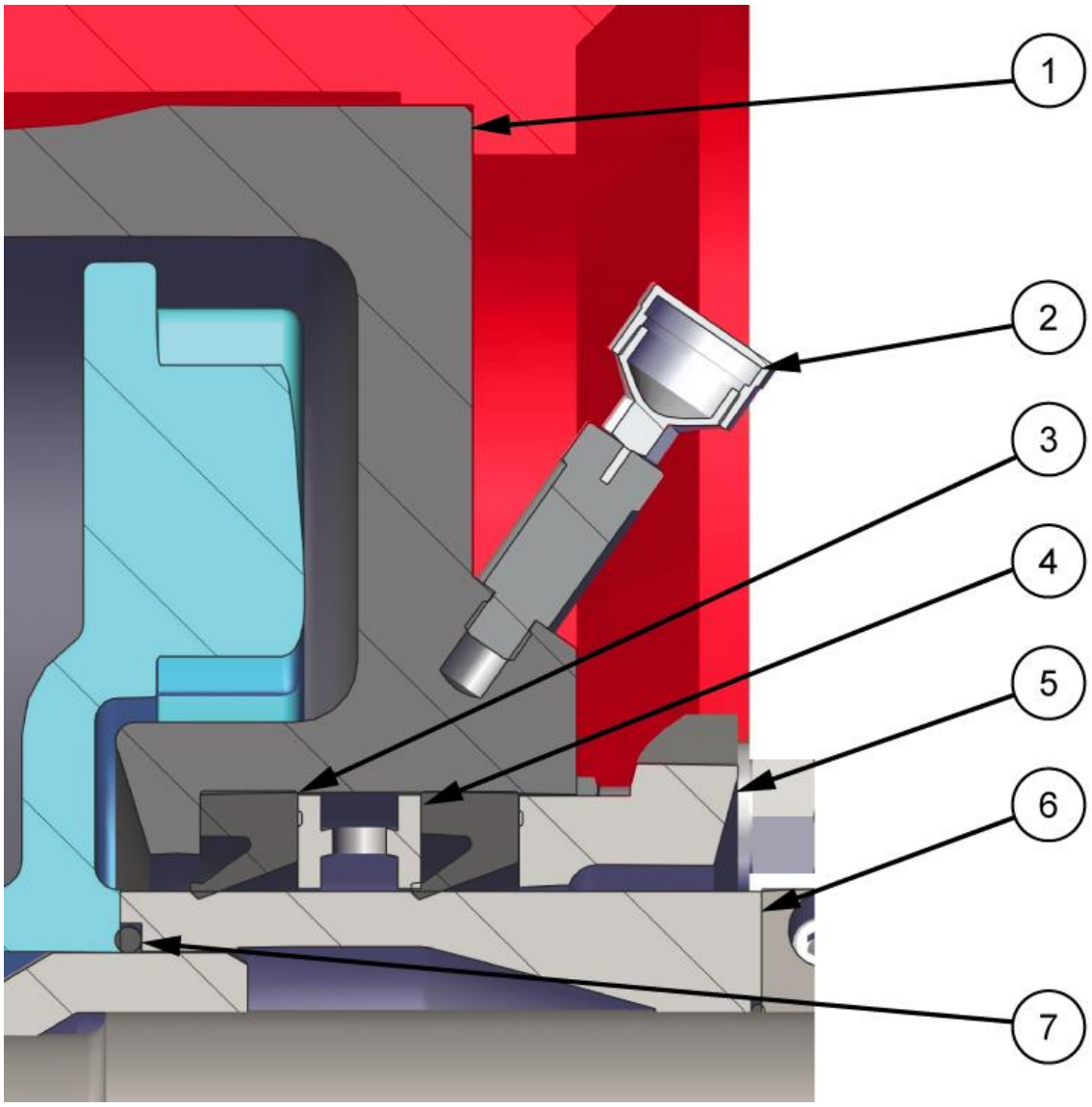

Figure 34. Fitting of Expeller Ring, Shaft Seals, Gland Studs, Gland, Shaft Sleeve, Shaft Sleeve O-Ring and Expeller.

Part	Description	Part	Description
1	Expeller ring	5	Lip seal gland
2	Grease cup	6	Shaft sleeve
3	Lip seal	7	Shaft sleeve o-ring
4	Lantern ring		Expeller ring studs (not shown)

These frames incorporate a LANTERN RING (063) or LANTERN RING (063)/NECK RING (067) to allow the introduction of grease lubrication to the lip seals. See Figure 34. Pre-grease the lantern ring before installing between lip seals. Only two lip seals are used with this arrangement.

ALL PUMP MODELS –

1. Insert assembled expeller ring over shaft sleeve into frame plate recess and tap into position with a mallet.
2. Place EXPELLER (032) on shaft and press up to shaft sleeve or spacer. Ensure vanes point toward expeller ring as shown in Figure 33.

11.2.4 Mechanical Seal

When a mechanical shaft seal is involved, review the seal manufacturer's instructions, along with the specific component diagrams for the pump and shaft seal prior to proceeding. Seal faces are most vulnerable when exposed while handling. Protect the faces until just prior to installing the seal or immediately after removal.

Seal face adjustment varies with the type and manufacturer. Correct adjustment is critical to successful operation and to avoid damage to the seal faces. Leave seal faces apart or drive collar/set screws disengaged from the shaft sleeve until impeller adjustment is completed. Read the manufacturer's instructions completely. If there are any questions, contact the seal manufacturer or Flowrox for guidance.

If a flush of any kind is required for your particular seal, that system (separate from the slurry pump) must be activated and operating correctly prior to starting the pump. Doing otherwise will likely damage the seal, and cause premature seal failure and/or heat buildup to occur.

When in doubt, consult the seal manufacturer's literature, or contact the seal manufacturer directly.

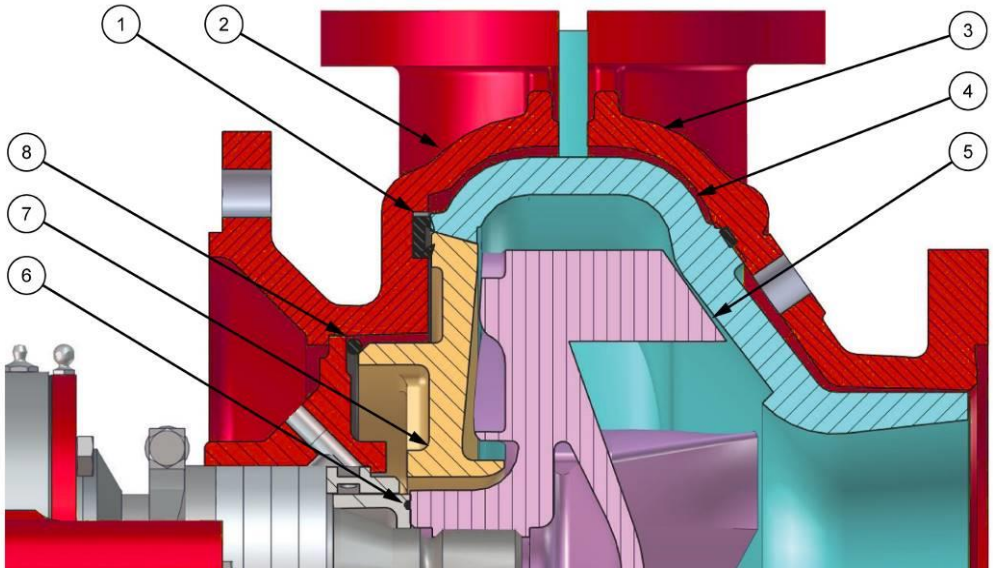

Figure 35. Two Part Metal. Fitting Seal Ring, Frame Plate Liner Insert, Volute Liner Seals, Impeller, Volute Liner and Cover Plate.

Part	Description	Part	Description
1	Volute liner seal (106)	6	Impeller o - ring
2	Frame plate (037)	7	Frame plate liner insert (040)
3	Cover plate (018)	8	Seal ring (074)
4	Volute liner (104)		Frame plate liner insert stud (042) (not shown)
5	Impeller		

11.3 Pump Liner Assembly Instructions

General Notes

Flowrox pumps are manufactured in several different liner configurations in order to facilitate as safe and easy assembly as possible in each given size.

Several material options are also available, and are specified based upon the application.

This manual contains the assembly instructions for all configurations offered by Flowrox. For lined pumps, locate your model number in Table 14, below, to determine the appropriate pump assembly section of the manual.

NOTICE

Use only silicone based lubricants or mild hand soap as a rubber lubricant.
Make sure not to use petroleum based lubricants on liner components.

Table 14. Pump Liner Configurations.

PUMP MODEL	NUMBER OF LINER PARTS	
	METAL	ELASTOMER
S SERIES		
1.5SB1	2	2
2SB1.5	2	2
3SC2	2	2
4SC3, 4SD3	2	2
6SD4, 6SE4	3	3
8SE6, 8SF6	3	3
10SF8, 10SG8, 10SS8	3	3
12SF10, 12SG10, 12SS10	3	3
14SF12, 14SG12, 14SS12	3	4
16SG14, 16ST14	3	4
20ST18	3	4

Refer to the following sections based upon your liner type and number of parts:

Metal, two parts	Section 11.3.1
Metal, three parts	Section 11.3.2
Elastomer, two parts	Section 11.3.3
Elastomer, three parts	Section 11.3.4
Elastomer, four parts	Section 11.3.5

After completing liner installation the impeller must be adjusted. Refer to Impeller Clearance Adjustment in Section 8.4.

All metal lined pumps (except unlined “U” series) incorporate MOLDED INTAKE JOINT RINGS (062) and DISCHARGE JOINT RINGS (025) between the pump liner projection and the adjacent piping flange. This is also true for all elastomer lined pumps except smaller sizes. Refer to your components diagram to see if they are not required.

NOTE: RUBBER LINED PIPING OR OTHER PIPING WITH INTEGRATED GASKET MATERIAL CANNOT REPLACE THE NEED FOR A FLOWROX INTAKE OR DISCHARGE JOINT RING WHERE SPECIFIED.

11.3.1 Metal Liners, Two Parts

(Refer to Figure 35)

Fitting seal ring, frame plate liner insert, volute liner seals, impeller, volute liner and cover plate.

For two piece metal lined pumps, the volute liner and throatbush are one piece. This applies for pump sizes 1.5SB1, 2SB1.5, 3SC2, 4SC3, 4SD3 pumps

1. Fit VOLUTE LINER SEAL (105)

    a. For models 1.5SB1, 2SB1.5, and 3SC2 this seal is an o-ring
    b. For models 4SC3, and 4SD3 this seal is a C-section gasket. Fit flat face into the Frame Plate groove. Use of rubber contact cement or RTV is acceptable

2. Fit SEAL RING (074)

    a. For 1.5SB1, 2SB1.5, 3SC2 models

    Fit C-section SEAL RING (074) onto rim of stuffing box or expeller ring. To aid in holding the seal in position during later assembly steps, it is recommended that the seal be cemented to the stuffing box/ expeller ring using a rubber cement (preferably the dry contact type), with sufficient drying time allowed before contacting the two parts. Only apply the cement on four to six locations at the bottom of the C-section in the seal, rather than all the way around the circumference. This ensures that the seal is not restrained during compression.

3. Fit FRAME PLATE LINER INSERT (040) and IMPELLER.

NOTE: Most of the sizes listed here do not employ studs for mounting the frame plate liner insert. It is instead held by a locating seat engaging with the frame plate or by the volute liner.

    a. For 1.5SB1, 2SB1.5, 3SC2, 4SC3 and 4SD3 models

        1. Obtain the correct impeller as specified by the component diagram or in consultation with the factory. Rest impeller, boss up, on a flat surface.

Apply sufficient anti-seize lubricant to the impeller threads. DO NOT ALLOW LUBRICANT OR OTHER FLUIDS TO COLLECT IN THE RECESSED CHAMBER IN THE IMPELLER BOSS.

2. Place FRAME PLATE LINER INSERT (040) over impeller boss, then screw impeller on shaft. Make certain that the various seals have not shifted, and that the locating seats on the back of the frame plate liner insert have engaged and located correctly on the frame plate.

3. Check CLAMP BOLTS (013) on side of base (See Figure 6) to ensure they are snug just enough to hold bearing assembly horizontal, but not locked in place. If the shaft is bare, fit SHAFT KEY (076) in keyway and bolt SHAFT WRENCH (301) onto the shaft. If the pump is installed, remove vee-belts or separate the coupling hubs. Lock the impeller to prevent it from rotating (a bar between vanes against the floor or alternate means), and turn the shaft with the wrench or vee-belt sheave to tight impeller onto shaft. DO NOT OVER TIGHTEN.

4. To hold the frame plate liner insert temporarily in its correct position, adjust the bearing assembly back by means of the front nut on the ADJUSTING BOLT (002).

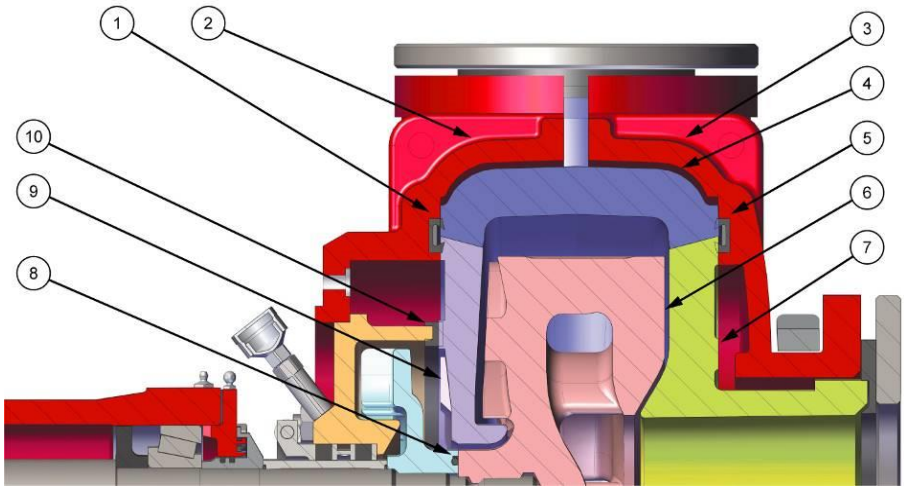

Figure 36. Three Part Metal. Fitting Frame Plate Liner Insert, Volute Liner, Seal Rings, Volute Liner Seals, Impeller O-Ring, Impeller and Cover Plate.

Part	Description	Part	Description
1	Volute liner seal (106)	7	Throatbush (093)
2	Frame plate (037)	8	Impeller o - ring
3	Cover plate (018)	9	Frame plate liner insert (040)
4	Volute liner (104)	10	Seal ring (074)
5	Volute liner seal (106)		Frame plate liner insert stud (042) (not shown)
6	Impeller		

5. Fit the VOLUTE LINER SEAL (106) over the rim of the frame plate liner insert and next to the frame plate.

4. Fit VOLUTE LINER (104) as follows:
   For two piece metal lined pumps, the volute liner and throatbush are one piece. Lift VOLUTE LINER (104) over impeller and push back into frame plate so that the taper of the frame plate liner insert engages with the corresponding taper in the volute liner as shown in Figure 39. Make certain the volute frame seal has not shifted. Hold the volute liner temporarily in this position with a C-clamp. Clamp the volute liner discharge nozzle to the half flange of the frame plate as shown in Figure 38.

5. Lift COVER PLATE (018) over volute liner and line up holes with COVER PLATE BOLTS (019) already fitted in the frame plate. Screw nuts on cover plate bolts. Do not tighten. Remove C-clamp from volute liner and tighten all cover plate bolts evenly to the torque given in Table 13.

6. Depending on the method used to assemble the gland components, complete the assembly of gland parts in the stuffing box or expeller ring by following the relevant instructions in the seal assembly section. For pumps fitted with Mechanical Seals, assembly of the remaining parts and header tank, etc. should now be completed.

7. The pump is now ready for fitting of joint rings and impeller adjustment. Refer to Section 8.4 for adjustment procedure.

11.3.2 Metal Liners, Three Parts

(Refer to Figure 36)

Fitting frame plate liner insert, volute liner, seal rings, volute liner seals, impeller o-ring, impeller, and cover plate.

1. Apply rubber cement in expeller or shaft spacer groove. Depending on pump type, fit either IMPELLER O-RING (059), or SHAFT SLEEVE O-RING (060) into the expeller as shown in Figure 33. Make sure that o-ring is held in position.

2. Fit SEAL RING (074). There are two different type seals.

   a. The C-section type fits on the rim of the stuffing box or the metal expeller ring. Use rubber cement to hold the seal in position, avoiding the possibility of the seal shifting when the frame plate liner is attached.

b. The o-ring type fits an o-ring in a groove on the stuffing box or expeller ring. Fit it in the groove in the rim of the stuffing box or the metal expeller ring. Use rubber cement to hold seal in position if needed.

3. Fit VOLUTE LINER SEAL (106). The seal is of C-section and it is actuated by internal pressure. Fit it (flat face in) into the frame plate groove. Use rubber cement to hold the seal in position, avoiding the possibility of the seal shifting when the frame plate liner is attached.

4. Fit FRAME PLATE LINER INSERT (040) and IMPELLER.

The frame plate liner insert has provisions to accommodate studs for mounting insert into frame plates. Proceed as follows:

1. Screw and tighten LINER STUD (042) into tapped holes provided in the frame plate liner inserts.
2. Suspend LIFTING TUBE (306) from a hoist. Stand the frame plate liner insert on edge and push the lifting tube into insert hole.
3. Lift tube along with the insert and slide the tube over shaft thread. Line up studs, or bolts, with holes and push liner insert against frame plate.

    a. Make sure that the various seals have not shifted. Screw on nuts, but do not tighten, then remove lifting tube.

4. Check CLAMP BOLTS (013) on side of base (see Figure 6) to ensure they are just tight enough to hold the bearing assembly horizontal, but not to lock it. Assuming the shaft is bare, fit SHAFT KEY (076) in keyway and bolt SHAFT WRENCH (301) onto the shaft. If the pump is installed, remove vee-belts or separate coupling hubs.
5. Hold the shaft and screw LOCATING NUT (307) on the shaft. The conical face will locate the frame plate liner insert in its correct position. Tighten up all studs on the insert, then remove locating nut. NOTE: If not using a locating nut to fix the frame plate liner insert position, leave studs snug, not tight, to frame plate, and fully tighten after installing cover plate.
6. Obtain correct type of IMPELLER as specified for particular pump application. Elastomer impellers require use of a BOSS CAP (308). To keep in position during assembly tape it to the impeller hub. Rest impeller (boss up) on flat surface. Apply anti-seize lubricant to thread.
7. Lift impeller with hoist using a sling, cable or hook. Use a bar between vanes to hold impeller while turning shaft and tighten snugly. Do not over tighten.

    a. Make sure that the various o-rings on the shaft are not damaged during assembly and that they are fully covered by the corresponding sleeves, etc.

⚠ CAUTION!

A leak will almost certainly occur if seals are damaged.

This requires a tear down to correct.

8. Fit VOLUTE LINER (104) and THROATBUSH (093).

    a. Use LIFTING BEAM (305) and a hoist to lift VOLUTE LINER (104) off the floor. Use a C-clamp on the lower end of the lifting beam to ensure volute does not rotate during handling.
    b. In large pumps, lugs are provided around the periphery of the liner. These lugs are positioned so three of the cover plate bolts line up with them. KEEPER PLATES (063) are used to hold the volute in place as shown in Figure 37.

⚠ CAUTION!

Risk of personal injury or equipment damage

Make sure to hold the volute liner firmly in place during the final stages of assembly

It is recommended that a C-clamp be placed on the discharge as shown in Figure 38 to ensure the volute remains in place during the remainder of the assembly.

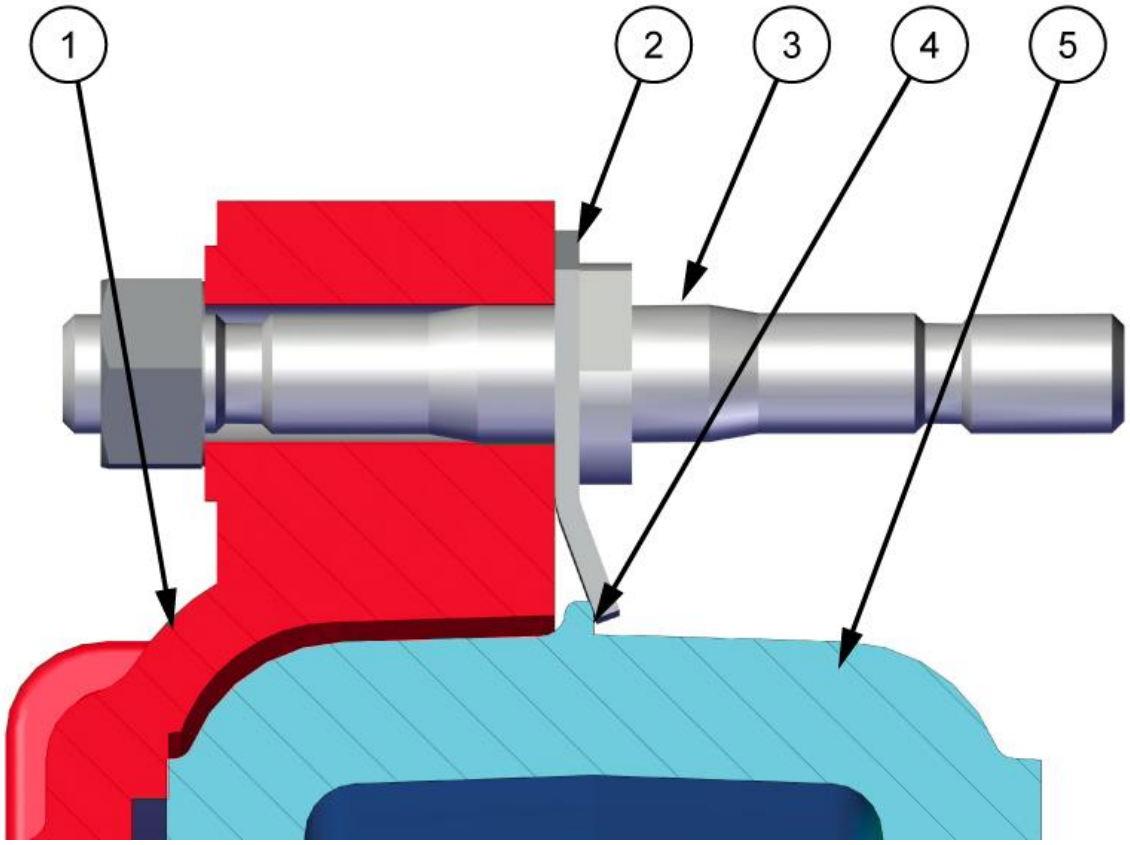

Figure 37. Using Keeper Plate to Retain Volute.

Part	Description	Part	Description
1	Frame plate (037)	4	Lug
2	Keeper plate (063)	5	Volute liner (104)
3	Cover plate bolt (019)		

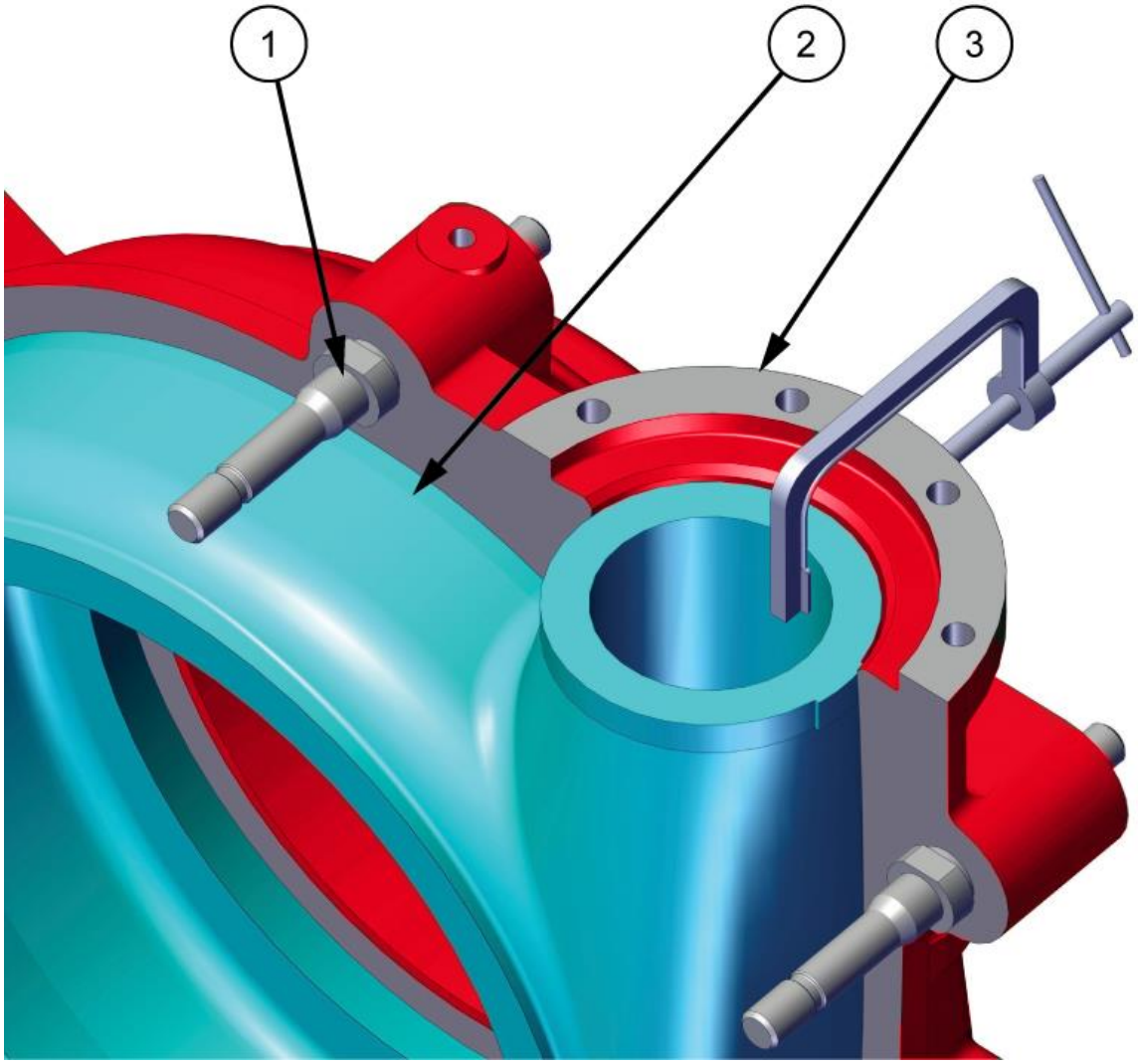

Figure 38. Fitting Frame Plate and Impeller.

Part	Description	Part	Description
1	Cover plate bolts (019)	3	Frame plate (037)
2	Volute liner (104)		

This is particularly true for smaller sizes which do not have retaining lugs on the volute.

c. Rest COVER PLATE (018) (intake flange down) on suitable supports so as to keep flange approximately one inch above floor.
d. Fit VOLUTE LINER SEAL (106) with flange down into the groove in the cover plate.
e. Lower THROATBUSH (093) into cover plate.
f. Insert wedge-shaped COTTERS (017) through slots in the neck of the cover plate. Tap them carefully and evenly until throatbush is held firmly in cover plate.

NOTE: Large pumps may utilize four (4) studs instead of cotters to hold throatbush in position. Mark stud locations and matching holes in cover plate before lowering in place.

9. Fit COVER PLATE (018).

    a. Lift cover plate, complete with throatbush, where applicable, over volute liner and line up holes with COVER PLATE BOLTS (019) already in frame plate.

Large cover plates are provided with radially tapped holes for eye bolts to facilitate lifting.

Screw nuts on cover plate bolts. Do not tighten. Remove throatbush cotters and C-clamp from volute liner, then tighten all cover plate bolts evenly according to the tightening sequence indicated in APPENDIX B and the torque listed in Torque Table 13.

Check all liner insert bolts for tightness and reinstall throatbush cotters.

11.4 Lifting and Handling Large Metal Volute Liners

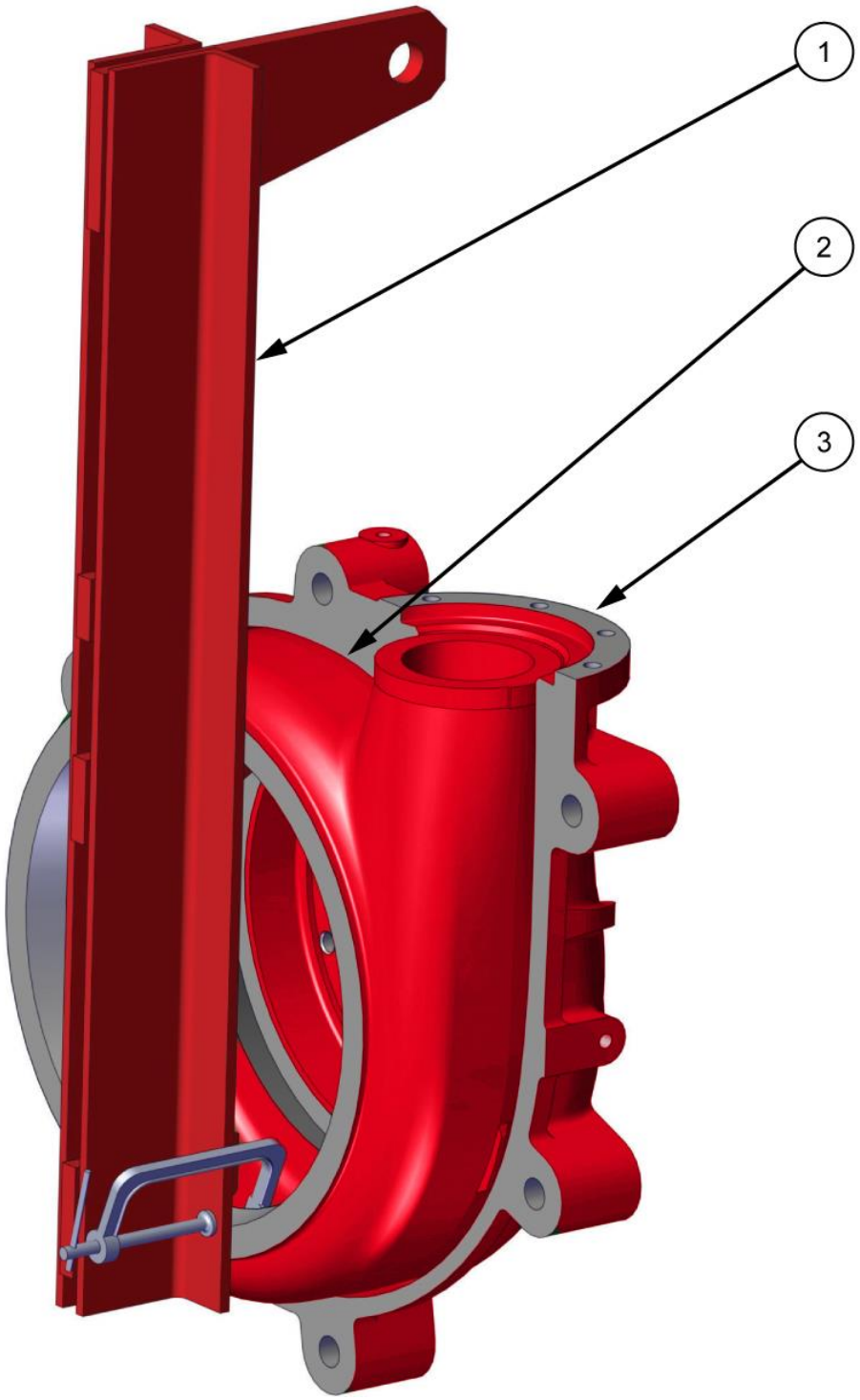

Figure 39. Volute Lifting Beam Installation.

Part	Description	Part	Description
1	Lifting beam	3	Frame plate (037)
2	Volute liner (104)		

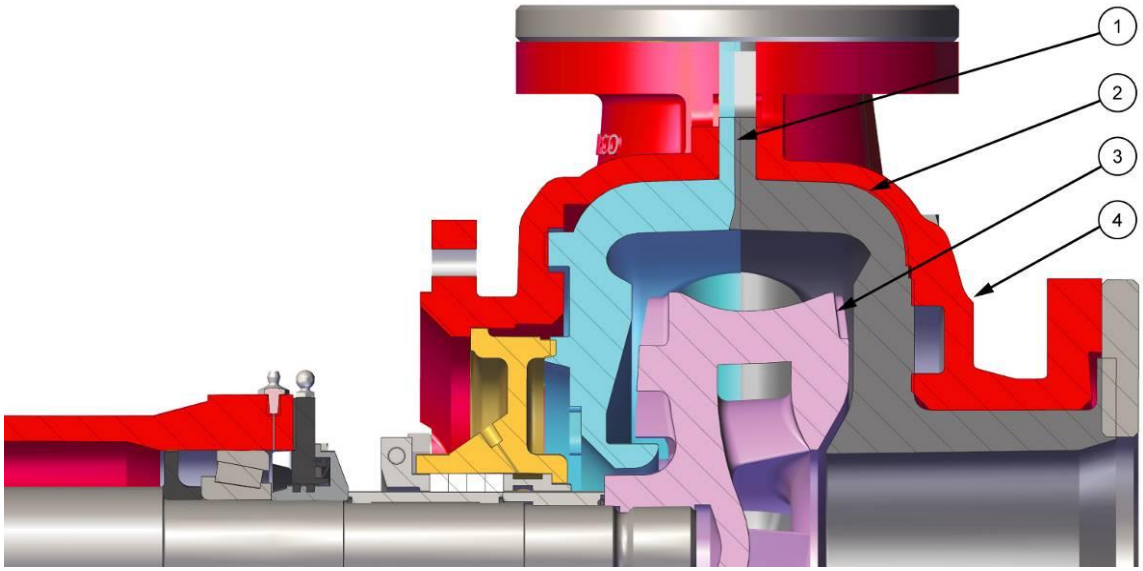

Figure 40. Two Part Rubber. Fitting Frame Plate Liner, Cover Plate Liner, Impeller and Cover Plate.

Part	Description	Part	Description
1	Frame plate liner	3	Impeller
2	Cover plate liner	4	Cover plate

It is recommended that large volutes be handled horizontally until installation. If the volute is attached to a sturdy skid, use the skid for transporting it. Otherwise we recommend three heavy slings be placed through the volute at equal spacing with some padding placed between the sling and volute. This serves to protect the sling and prevent it from sliding around the volute while handling. The volute should be kept relatively close to the ground while transporting it.

Installation of large volutes is best handled with the aid of a lifting beam. Refer to Figure 39. The lifting beam allows the volute to be picked up from the horizontal position and balanced vertically while being installed in the frame plate. Rig with an auxiliary sling or chain attached to a heavy “C” clamp at the discharge neck. This prevents any rotation of the volute from occurring while being handled regardless of orientation. The beam is installed in the horizontal position and then lifted to a vertical position. Do not remove the beam until the volute is securely attached to the pump frame plate.

11.4.1 Elastomer Liners, Two Parts

(Refer to Figure 40)

FITTING FRAME PLATE LINER, COVER PLATE LINER, IMPELLER AND COVER PLATE

1. Apply some rubber cement in the expeller groove or haft spacer groove, and fit either IMPELLER O-RING (059) or, depending on the pump, SHAFT SLEEVE O-RING (060) into it. (See appropriate components diagram.) Make sure that the o-ring is held in position.

2. Fit FRAME PLATE LINER (039)

    a. Screw and tighten LINER STUDS (042) in tapped bosses provided in the frame plate liner.
    b. Lift liner into position, line up studs with holes, and push liner into frame plate. Fit nuts onto studs.

3. Fitting IMPELLER.

    a. Obtain correct type of impeller as specified for particular pump application. Rest the impeller (boss up) on a flat surface. **NOTE**: Elastomer impellers on pump sizes 4SC3 and larger can be fitted with the impeller boss cap (308). To keep it in position during assembly tape it to the impeller hub.
    b. Check CLAMP BOLTS (013) on side of base (See Figure 6) to ensure they are snug just enough to hold the bearing assembly horizontal, but not locked in place. Assuming shaft is bare, fit SHAFT KEY (076) in keyway and bolt SHAFT WRENCH (301) onto the shaft. If the pump is installed, remove vee-belts or separate coupling hubs. While holding impeller with a bar between the vanes, turn shaft with wrench or v-belt pulley and tighten impeller on shaft. Do not over tighten. Make sure the various o-rings on the shaft are not damaged during assembly.

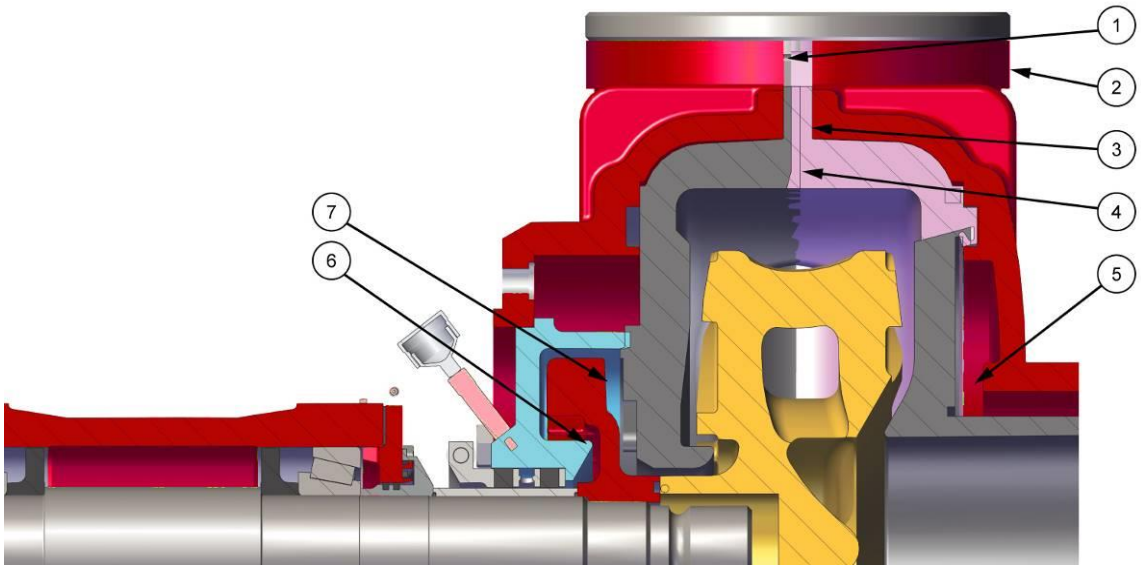

Figure 41. Three Part Integral Rubber. Fitting Frame Plate Liner, Cover Plate Liner, Throatbush, Impeller and Cover Plate.

Part	Description	Part	Description
1	Frame Plate	5	Throat Bush
2	Cover Plate	6	Expeller Ring
3	Cover Plate Liner	7	Expeller
4	Back Liner		

4. Fit COVER PLATE LINER (020) and COVER PLATE (018).

   a. Screw and tighten LINER STUDS (042) into tapped bosses, when provided, on COVER PLATE LINER (020).
   b. Place cover plate liner on floor (suction flange up). Apply a liberal amount of liquid soap or rubber lubricant on suction flange and inside suction neck of COVER PLATE (018).
   c. Place cover plate over liner, lining up studs with holes. Press cover plate down until liner is hard against cover plate. Insert a small tire iron between suction neck and liner and lift flange out. Fit nuts onto studs.
   d. Lift cover plate complete with liner and line up holes with COVER PLATE BOLTS (019) already in frame plate. Screw nuts on the cover plate bolts and tighten evenly to torque values given in Table 13.

Pump Sizes 1.5SB1 AND 2SB1.5 (Rubber Lined Only)

Place a rod which is the diameter of the discharge into the pump discharge during final casing assembly to ensure proper discharge diameter. This rod should be lubricated with a soap of non-petroleum origin and re- moved after the cover plate bolts have been properly tightened.

After completing assembly the impeller must be adjusted. Refer to Section 8.4.

11.4.2 Elastomer Liners (Integral Volute Liner Seals), Three Parts

FITTING FRAME PLATE LINER, COVER PLATE LINER, THROATBUSH, IMPELLER AND COVER PLATE

1. Apply some rubber cement in the expeller or shaft spacer groove and fit either IMPELLER O-RING (059) or, depending on pump, SHAFT SLEEVE O-RING (060) into it. (Refer to appropriate components diagram.) Make sure that the o-ring is held in position.

2. Fit FRAME PLATE LINER (039).

    a. Screw and tighten LINER STUDS (042) into tapped bosses provided in frame plate liner.
    b. Lift liner into position, line up studs with holes, and push into frame plate. Fit nuts onto studs.

3. Fit IMPELLER.

    a. Check CLAMP BOLTS (013) on side of base (See Figure 6) to ensure they are just tight enough to hold the bearing assembly horizontal, but not to lock it. Assuming the shaft is bare, fit SHAFT KEY (076) in keyway and bolt SHAFT WRENCH (301) onto the shaft. If the pump is installed, remove vee-belts or separate coupling hubs.
    b. Obtain correct type of impeller as specified for particular pump application. **Note**: Elastomer impellers can be fitted with the impeller BOSS CAP (308). To keep it in position during assembly tape it to the impeller hub. Apply anti-seize lubricant to the thread. Lift the impeller with a rope hoist, and screw it onto shaft. Use a bar between vanes and hold while turning shaft to tighten impeller. Be careful not to damage various o-rings on the shaft during assembly.

4. Fit COVER PLATE LINER (023), THROATBUSH (093), and COTTERS (017) or STUD (042) as shown in Figure 41.

If STUDS (042) are used on the throatbush or cover plate liner they must be installed before assembling to the cover plate.

Natural rubber (R) compounds are more flexible than materials such as polyurethane (U) or neoprene (E). Follow Steps “e - h” for materials other than natural rubber. Continue on with Step “j”. for all materials.

a. Place COVER PLATE (018) on floor resting on suction flange. If required install COVER PLATE LINER STUDS (042) in COVER PLATE LINER (023). Position liner in cover plate and tighten nuts on liner studs just until snug.
b. For throatbushes having studs, mark the relative location of one mating hole in the cover plate on the over plate liner, and also on the back of the throatbush. Install studs in the throatbush and place two blocks of lumber in the suction opening of the cover plate. Lower throatbush onto supporting blocks and remove rigging. Align studs with holes in cover plate. Lift cover plate and remove blocking.
c. For throatbushes without studs, use of supporting blocks will allow easy removal of rigging used for lifting. In this case alignment is not required.
d. Apply a liberal amount of liquid soap or rubber lubricant on tapered edge of throatbush and lip seal of liner. Avoid solvent based soap solutions as a lubricant, because they can affect overall life and durability of the liner material. Mild hand soap or silicone base lubricants are best.
e. Using a tire iron or flat pry bar between liner and throatbush, pry up tapered edge of liner and force throatbush down against lip seal. Assist this action by stepping down on the area being worked while tapping the edge with a small mallet.
f. For elastomer liners other than natural rubber, place COVER PLATE LINER (023) (outer flange down) on floor with a block in the center of sufficient height to finish flush or slightly above liner. Rest the THROATBUSH (093) (suction flange up) on the block.
g. Apply a liberal amount of liquid soap or rubber lubricant on the tapered edge of the throatbush and on the lip seal of liner.
h. If throatbush has studs, mark location of one with respect to mating hole in cover plate on throatbush and liner. Align throatbush studs with cover plate. Lift and tilt liner to engage lip seal over one-third of the throatbush diameter. Run a small tire iron with rounded edges between throatbush and liner, and lift lip seal to engage over the back of throatbush. Insure that the lip is properly set.

Make sure not to damage or tear lip seal during this operation.

i. Lift COVER PLATE (018) (suction flange up) and fit over throatbush and liner.

j. Insert COTTERS (017) through slots in neck of cover plate. Tap them carefully and evenly until throatbush is held firmly in cover plate. If studs are used on the throatbush install nuts and tighten until snug.

5. Fitting COVER PLATE (018).

Lifting cover plate, complete with throatbush and liner, and line up holes with COVER PLATE BOLTS (019) already in frame plate.

NOTE: Large cover plates are provided with radially tapped holes for eye bolts to facilitate lifting. Screw nuts on cover plate bolts and tighten evenly to torque values given in Table 13.

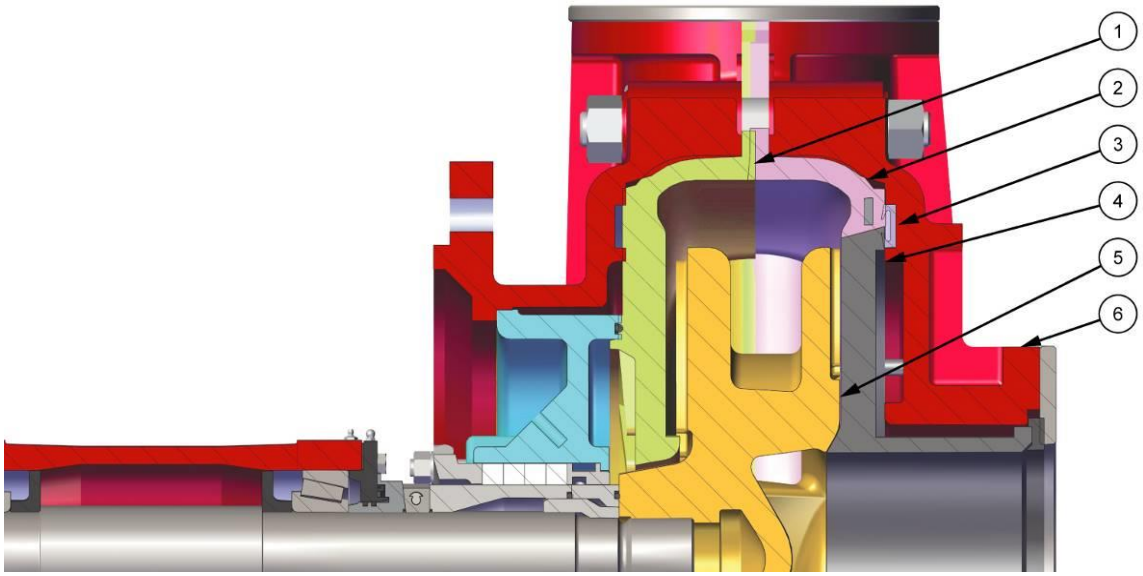

Figure 42. Three Part Separate Rubber. Fitting Frame Plate Liner, Cover Plate Liner, Throatbush, Volute Liner Seal, Impeller and Cover Plate.

Part	Description	Part	Description
1	Frame plate liner	4	Throatbush
2	Cover plate liner	5	Impeller
3	Volute liner seal	6	Cover plate

After completing assembly the impeller must be adjusted. Refer to Section 8.4.

11.4.3 Elastomer Liners (Separate Volute Liner Seals), Three Parts

(Refer to Figure 42)

FITTING FRAME PLATE LINER, COVER PLATE LINER, THROATBUSH, VOLUTE LINER SEAL, IMPELLER AND COVER PLATE.

1. Apply some rubber cement in expeller or shaft spacer groove. Fit either IMPELLER O-RING (59) or, depending on pump, SHAFT SLEEVE O-RING (060) into it. See appropriate components diagram. Make sure that o-ring is held in position.

2. Fit FRAME PLATE LINER (039).

    a. Screw and tighten STUDS (042) in tapped bosses provided in frame plate liner.
    b. Lift liner carefully into position, line up studs with holes, and push into frame plate. Fit nuts onto studs. Do not over tighten. Limit torque to 14 N-m (10 ft-lbs) for studs 12 mm (.500”) or less and 20 N-m (15 ft- lbs) for those larger.

3. Fit impeller.

    a. Check CLAMP BOLTS (013) on side of base (See Figure 6) to ensure they are just tight enough to hold the bearing assembly horizontal, but not to lock it. Assuming the shaft is bare, fit SHAFT KEY (076) in keyway and bolt SHAFT WRENCH (301) onto the shaft. If the pump is installed, remove vee-belt or separate coupling hubs.
    b. Obtain correct type of impeller as specified for particular application. **Note**: Elastomer impellers can be fitted with a BOSS CAP (308). To keep it in position during assembly tape it to the impeller hub. Apply anti-seize lubricant to the thread. Lift impeller with a rope hoist and use a bar between vanes to hold impeller while turning the shaft. Be careful not to damage the various o-rings on the shaft during the assembly and ensure that the impeller boss cap remains in place.

4. Fit VOLUTE LINER SEAL (106).

Fit seal (106) into recess, flat side first, in cover plate. Rubber contact cement may be used to secure the seal into the recess during assembly.

5. Fit THROATBUSH (093).

    a. Screw and tighten STUDS (042) into tapped bosses provided in throatbush (093).
    b. Place COVER PLATE (018) on floor resting on suction flange. Lift throatbush carefully into position, line up studs with holes, and push into cover plate. Fit nuts onto studs. Ensure volute liner seal remains in place.

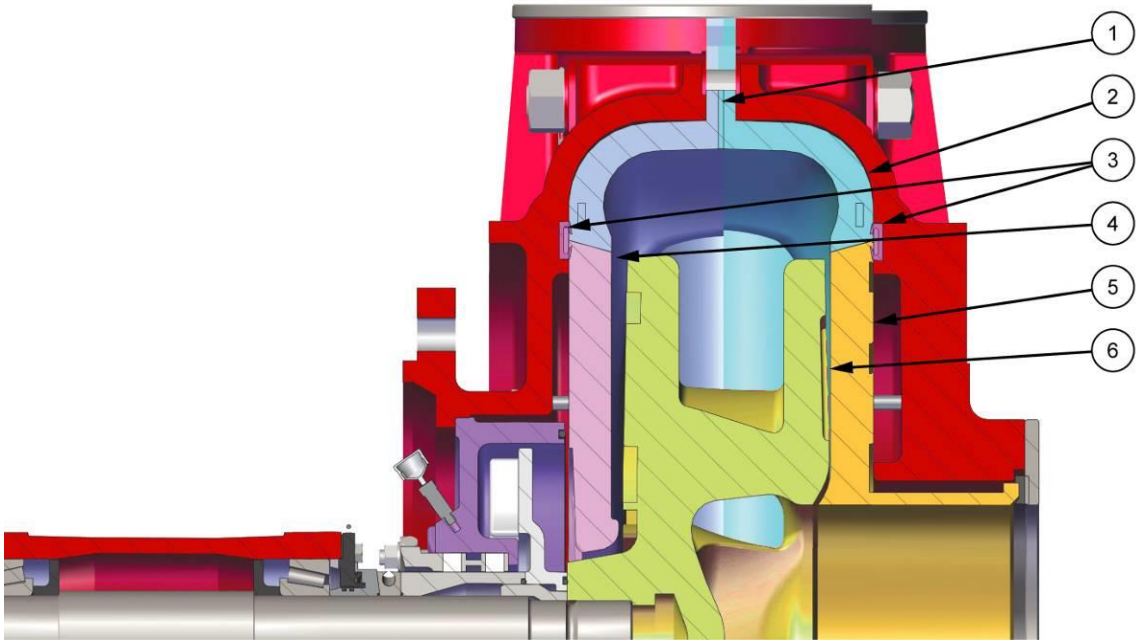

Figure 43. Four Part Separate Rubber. Fitting Frame Plate Liner, Cover Plate Liner, Frame Plate Liner Insert, Throatbush, Volute Liner Seals and Impeller.

Part	Description	Part	Description
1	Frame plate liner	4	Frame plate liner insert
2	Cover plate liner	5	Throatbush
3	Volute liner seals	6	Impleller

6. Fit COVER PLATE LINER (023).

    a. Screw and tighten LINER STUDS (021) in tapped bosses provided in cover plate liner.
    b. Apply a liberal amount of liquid soap or rubber lubricant on tapered edge of throatbush and cover plate liner.
    c. Lift cover plate liner carefully into position, line up studs with holes and push into cover plate. Fit nuts onto studs.

7. Fit COVER PLATE (018). Lift cover plate, complete with throatbush and liner, and line up holes with COVER PLATE BOLTS (019) already in frame plate.

   Screw nuts on cover plate bolts and tighten evenly. Refer to Table 13 for torque values. After completing assembly impeller must be adjusted. Refer to Section 8.4.

11.4.4 Elastomer Liners (Separate Volute Liner Seals), Four Parts

(Refer to Figure 43)

FITTING FRAME PLATE LINER, COVER PLATE LINER, FRAME PLATE LINER INSERT, THROATBUSH, VOLUTE LINER SEALS AND IMPELLER.

1. Apply some heavy grease in expeller or shaft spacer groove. Fit IMPELLER O-RING(059) or, depending on pump, SHAFT SLEEVE O-RING (60)into it. (See appropriate components diagram.) Make sure that o-ring is held in position.

2. Fit volute liner seals (106) into recess in frame plate and cover plate. Contact cement may be used to secure the seals into the recess during assembly.

3. Fit FRAME PLATE LINER INSERT (040)

   a. Screw and tighten STUDS (042) in tapped bosses provided in frame plate liner insert.
   b. Lift FRAME PLATE LINER INSERT carefully into position, line up studs with holes, and push into frame plate. Fit nuts onto studs. Do not over tighten. Limit torque to 14 N-m (10 ft-lbs) for studs 12 mm (.500”) or less and 20 N-m (15 ft-lbs) for those larger. Ensure volute liner seal remains in place.

4. Fit FRAME PLATE LINER (039).

   a. Screw and tighten STUDS (021) in tapped bosses provided in frame plate liner.
   b. Apply a liberal amount of liquid soap or rubber lubricant on the 45° taper edge of the frame plate liner and frame plate liner.
   c. Lift liner and insert carefully in position, line up studs with holes, and push into frame plate. Fit nuts onto studs.

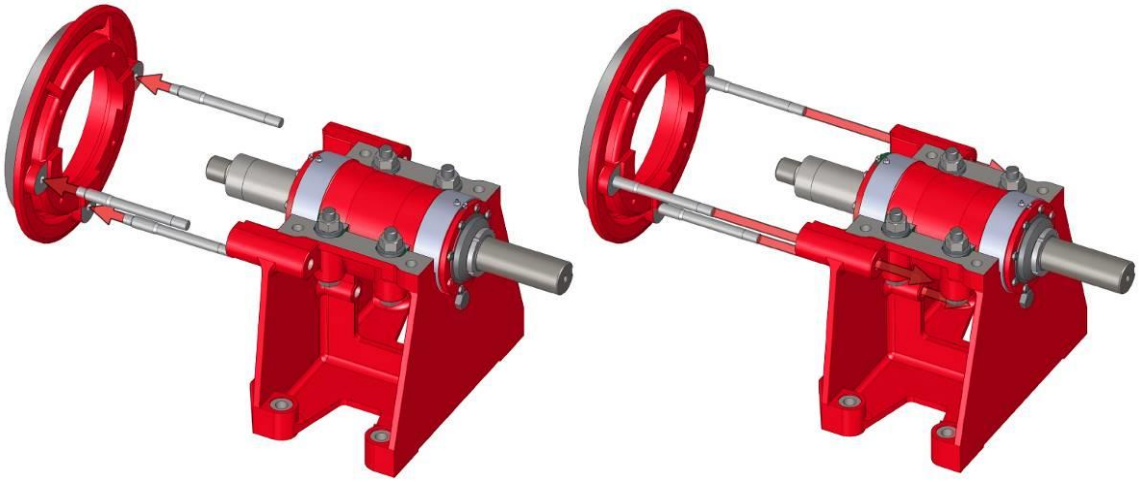

Figure 44. Fitting Adapter Plate to Base.

5. Fit IMPELLER.

    a. Check CLAMP BOLTS (013) on side of base (see Figure 6) to ensure they are just tight enough to hold the bearing assembly horizontal, but not to lock it. Assuming the shaft is bare, fit SHAFT KEY (076) in keyway and bolt SHAFT WRENCH (301) onto the shaft. If the pump is installed, remove vee-belts or separate coupling hubs.
    b. Obtain correct type of IMPELLER as specified for particular application. **Note**: Elastomer impellers can be fitted with a BOSS CAP (308). To keep it in position during assembly tape it to the impeller hub. Apply anti-seize lubricant to the thread. Lift the impeller with a rope hoist, and screw it onto shaft. Use a bar between vanes and turn shaft to tighten impeller. Be careful not to damage the various o-rings on the shaft during assembly.

6. Fit THROATBUSH (093).

    a. Screw and tighten studs (042) in tapped bosses provided in THROATBUSH.
    b. Lift THROATBUSH carefully into position, line up studs with holes in COVER PLATE (018) and push into cover plate. Fit nuts onto studs. Ensure volute liner seal installed above remains in place.

7. Fit COVER PLATE LINER (023).

    a. Screw and tighten studs (021) in tapped bosses provided in cover plate liner.
    b. Apply a liberal amount of liquid soap or rubber lubricant on tapered edge of throatbush and cover plate liner.
    c. Lift cover plate liner carefully into position, line up studs with holes and push into cover plate. Fit nuts onto studs.

8. Fit COVER PLATE (018).

   a. Lift cover plate, complete with throatbush and liner, and line up holes with COVER PLATE BOLTS (019) already in frame plate.

NOTICE

Large cover plates are provided with radically tapped holes for eye bolts to facilitate lifting.

   b. Screw nuts on cover plate bolts and tighten evenly. Refer to Table 13 for torque values.
   c. After completing assembly the impeller must be adjusted. Refer to Section 8.4.

11.5 Pump Dismantling

⚠ WARNING!

Explosion hazard

Risk of personal injury or death

Make sure not to use heat to expand or cut an impeller from the shaft

Dismantling the pump is the reverse of the instructions given for assembly purposes, with the exception of removing the impeller on the larger pumps. It is recommended that assembly procedures be reviewed prior to beginning work.

To allow the impeller to be unscrewed easily, the RELEASE COLLAR (073) must be removed before the impeller is unscrewed. Release collars are only available on certain pump models. Consult your component diagram to confirm the presence or absence of a release collar in your pump assembly.

The procedure for release collar installation removal is included in Section 10 of this manual.

APPENDIX A – Fault Detection Chart

FAULTS		SYMPTOMS										
= *Probable Faults*		Discharge failure	Reduced discharge delivery	Insufficient pressure	Pump loses prime	Excessive horsepower	Leakage from stuffing box	Packing has short life	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 to small.		■						■			
	Foot valve partially clogged.		■						■			
	Intake pipe insufficiently submerged.	■	■		■				■			■
	Blocked intake.	■	■		■							■
	Intake pipe diameter too small or length of intake pipe to 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.	■	■	■	■				■			■
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.						■	■				
	Packing improperly installed.					■	■	■				
	Incorrect type of packing or operating conditions.					■	■					
	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.								■	■		
	Expeller worn or blocked.						■	■				
	Excessive clearance at bottom of stuffing box, forcing packing into pump.						■	■				

APPENDIX B – Cover Plate Bolt Tightening Sequence

When fully-tightening the cover plate bolts, it is recommended to adhere to the sequence indicated in Figure B-1 to obtain equal torque across the face of the cover plate. Refer to your particular cover plate and the bolt patterns given below. It may be useful to mark with permanent marker on the face of the bolt the appropriate sequence number. See Table 13 for cover plate bolt torque requirements.

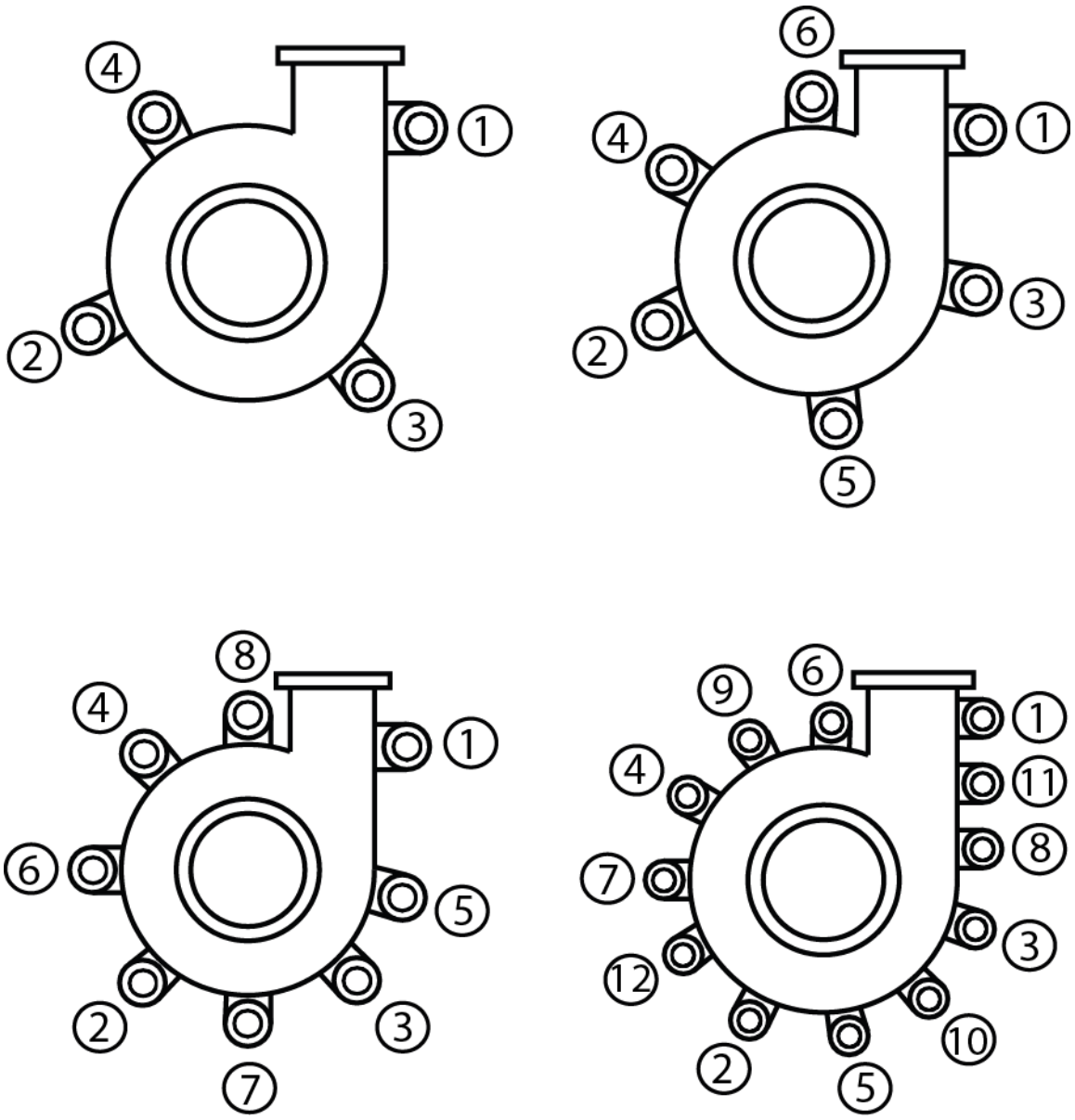

Figure B-1. Cover Plate Bolt Tightening Sequence.

APPENDIX C - Gland Seal Water Flowrates

Table C-1. Minimum Gland Seal Water Flowrates in l/min (US GPM)

Pump Model	Minimum Flow rates by Pump Model and Frame l/min (US GPM)			
	Gland Light Slurry	Gland Heavy Slurry	Gland Low Flow	Expeller Water Assist
1.5SB1	7.6 (2)	13.2 (3.5)	5.7 (1.5)	1.9-3.8 (.5-1)
2SB1.5	7.6 (2)	15.1 (4)	5.7 (1.5)	1.9-3.8 (.5-1)
3SC2	7.6 (2)	15.1 (4)	7.6 (2)	1.9-3.8 (.5-1)
4SC3	11.4 (3)	18.9 (5)	7.6 (2)	1.9-3.8 (.5-1)
4SD3	15.1 (4)	30.3 (8)	9.5 (2.5)	1.9-3.8 (.5-1)
6SD4	15.1 (4)	30.3 (8)	9.5 (2.5)	2.8-5.7 (.75-1.5)
6SE4	18.9 (5)	37.9 (10)	13.2 (3.5)	2.8-5.7 (.75-1.5)
8SE6	18.9 (5)	37.9 (10)	13.2 (3.5)	2.8-5.7 (.75-1.5)
8SF6	34.1 (9)	68.1 (18)	17.0 (4.5)	3.8-11.4 (1-3)
10SF8	45.4 (12)	90.8 (24)	24.6 (6.5)	3.8-11.4 (1-3)
10SS8	45.4 (12)	90.8 (24)	24.6 (6.5)	3.8-11.4 (1-3)
12SF10	45.4 (12)	90.8 (24)	24.6 (6.5)	3.8-11.4 (1-3)
12SS10	45.4 (12)	90.8 (24)	24.6 (6.5)	3.8-11.4 (1-3)
14SF12	45.4 (12)	90.8 (24)	24.6 (6.5)	3.8-11.4 (1-3)
14SS12	45.4 (12)	90.8 (24)	24.6 (6.5)	3.8-11.4 (1-3)
16ST14	56.8 (15)	132.5 (35)	37.9 (10)	7.6-15.1 (2-4)
20ST18	56.8 (15)	132.5 (35)	37.9 (10)	7.6-15.1 (2-4)

APPENDIX D – 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)”

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

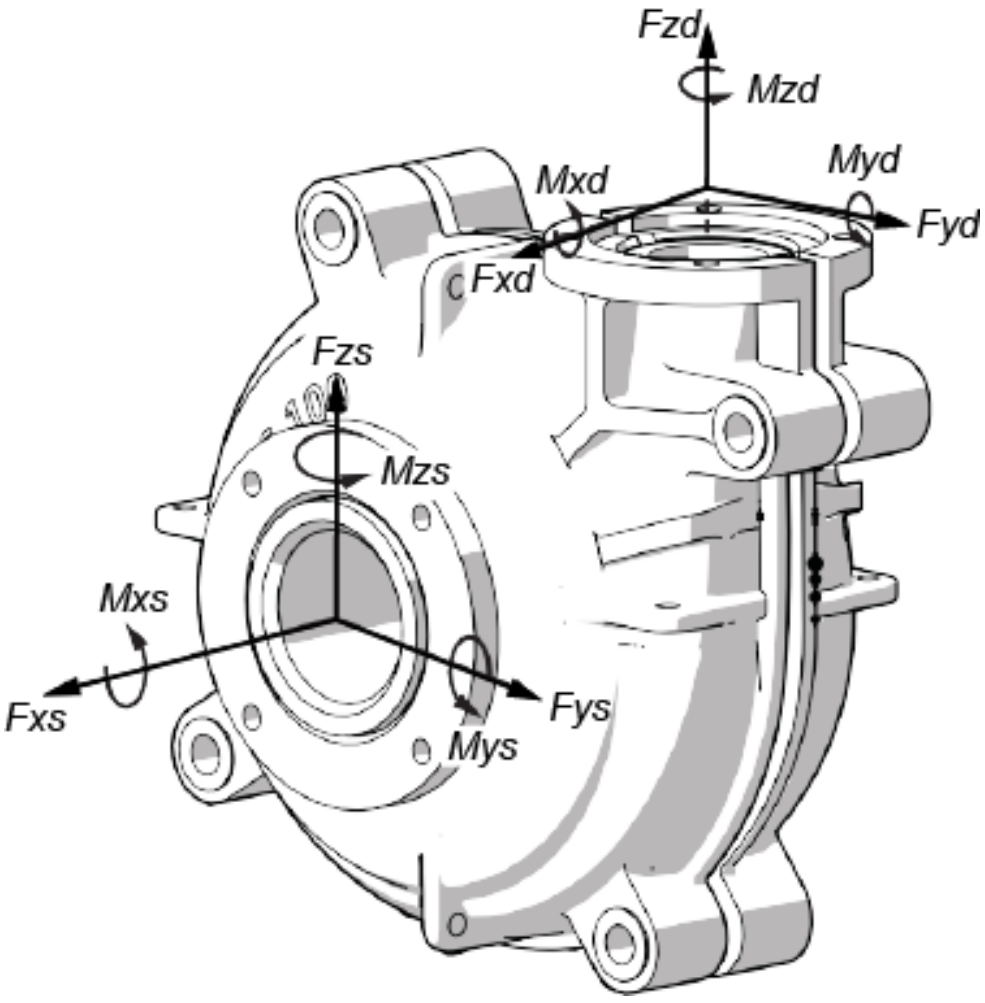

Figure D-1. Direction of forces and moments being applied to suction and discharge nozzles.

Table D-1. Allowable combined nozzle loads for Flowrox Slurry pumps – Metric Units and US Units. NOTE: Coordinate system per Figure D-1.

Branch Size	Discharge						Suction					
	Fxd	*Fyd*	*Fzd*	*Mxd*	*Myd*	*Mzd*	*Fxs*	*Fys*	*Fzs*	*Mxs*	*Mys*	*Mzs*
	kg (lb)	kg (lb)	kg (lb)	N*m (ft*lb)	N*m (ft*lb)	N*m (ft*lb)	N*m (ft*lb)	N*m (ft*lb)	N*m (ft*lb)	N*m (ft*lb)	N*m (ft*lb)	N*m (ft*lb)
2	726 (1,600)	581 (1,280)	1474 (3,250)	3579 (2,640)	3579 (2,640)	5423 (4,000)						
3	798 (1,760)	640 (1,410)	1547 (3,410)	3932 (2,900)	3932 (2,900)	5952 (4,390)	4623 (3,410)	2386 (1,760)	1912 (1,410)	5952 (4,390)	3932 (2,900)	3932 (2,900)
4	875 (1,930)	703 (1,550)	1624 (3,580)	4284 (3,160)	4284 (3,160)	6494 (4,790)	4854 (3,580)	2617 (1,930)	2102 (1,550)	6494 (4,790)	4284 (3,160)	4284 (3,160)
6	1030 (2,270)	826 (1,820)	1778 (3,920)	4989 (3,680)	4989 (3,680)	7565 (5,580)	5315 (3,920)	3078 (2,270)	2468 (1,820)	7565 (5,580)	4989 (3,680)	4989 (3,680)
8	1193 (2,630)	953 (2,100)	1941 (4,280)	5694 (4,200)	5694 (4,200)	8623 (6,360)	5803 (4,280)	3566 (2,630)	2725 (2,010)	8623 (6,360)	5694 (4,200)	5694 (4,200)
10	1365 (3,010)	1093 (2,410)	2114 (4,660)	6372 (4,700)	6372 (4,700)	9667 (7,130)	6318 (4,660)	4081 (3,010)	3268 (2,410)	9667 (7,130)	6372 (4,700)	6372 (4,700)
12	1551 (3,420)	1243 (2,740)	2300 (5,070)	7064 (5,210)	7064 (5,210)	10711 (7,900)	6874 (5,070)	4637 (3,420)	3715 (2,740)	10711 (7,900)	7064 (5,210)	7064 (5,210)
14	1764 (3,890)	1411 (3,110)	2513 (5,540)	7742 (5,710)	7742 (5,710)	11728 (8,650)	7511 (5,540)	5274 (3,890)	4217 (3,110)	11728 (8,650)	7742 (5,710)	7742 (5,710)
16	2014 (4,440)	1610 (3,550)	2762 (6,090)	8406 (6,200)	8406 (6,200)	12257 (9,040)	8257 (6,090)	6020 (4,440)	4813 (3,550)	12745 (9,400)	8406 (6,200)	8406 (6,200)
18	2318 (5,110)	1855 (4,090)	3066 (6,760)	9070 (6,690)	9070 (6,690)	13748 (10,140)	9165 (6,760)	6928 (5,110)	5545 (4,090)	13748 (10,140)	9070 (6,690)	9070 (6,690)
20	2676 (5,900)	2141 (4,720)	3252 (7,170)	9721 (7,170)	9721 (7,170)	14738 (10,870)	10236 (7,550)	7999 (5,900)	6399 (4,720)	14738 (10,870)	9721 (7,170)	9721 (7,170)
22	3030 (6,680)	2427 (5,350)	3778 (8,330)	10372 (7,650)	10372 (7,650)	15727 (11,600)	11294 (8,330)	9057 (6,680)	7254 (5,350)	15727 (11,600)	10372 (7,650)	10372 (7,650)
24	3334 (7,350)	2672 (5,890)	4082 (9,000)	11009 (8,120)	11009 (8,120)	16690 (12,310)	12202 (9,000)	9965 (7,350)	7986 (5,890)	16690 (12,310)	11009 (8,120)	11009 (8,120)
26	3583 (7,900)	2871 (6,330)	4332 (9,550)	11646 (8,590)	11646 (8,590)	17653 (13,020)	12948 (9,550)	10711 (7,900)	8582 (6,330)	17653 (13,020)	11646 (8,590)	11646 (8,590)
28	3960 (8,730)	3039 (6,700)	4545 (1,0020)	12270 (9,050)	12270 (9,050)	18602 (13,720)	13585 (1,0020)	11348 (8,370)	9084 (6,700)	18602 (13,720)	12270 (9,050)	12270 (9,050)
30	3983 (8,780)	3189 (7,030)	4731 (10,430)	12894 (9,510)	12894 (9,510)	19537 (14,410)	14141 (10,430)	11904 (8,780)	9531 (7,030)	19537 (14,410)	12894 (9,510)	12894 (9,510)
32	4155 (9,160)	3329 (7,340)	4903 (10,810)	13504 (9,960)	13504 (9,960)	20473 (15,100)	14656 (10,810)	12419 (9,160)	9952 (7,340)	20473 (15,100)	13504 (9,960)	13504 (9,960)
34	4318 (9,520)	3456 (7,620)	5067 (11,170)	14114 (10,410)	14114 (10,410)	21381 (15,770)	15144 (11,170)	12907 (9,520)	10331 (7,620)	21381 (15,770)	14114 (10,410)	14114 (10,410)
36	4472 (9,860)	3579 (7,890)	5221 (11,510)	14711 (10,850)	14711 (10,850)	22290 (16,440)	15605 (11,510)	13368 (9,860)	10697 (7,890)	22290 (16,440)	14711 (10,850)	14711 (10,850)

APPENDIX E - Standard Conditions of Sale 12/2015

1. GENERAL. These standard conditions of sale apply to all equipment and services (jointly "**Products**") manufactured or provided by Flowrox Oy, a Finnish limited liability company with business identity code 0162133-5 and registered address at Marssitie 1, FI-53100 Lappeenranta, Finland (including its affiliates "**Flowrox**"), to its customer ("**Customer**"). Any quotation or proposal ("**Proposal**") submitted by Flowrox to Customer (jointly "**Parties**") for the sale of Products shall be governed by these standard conditions of sale.

2. PROPOSAL; CONCLUSION OF CONTRACT. Unless otherwise indicated in the Proposal, the Proposal shall be valid for a period of 30 days from the date stated therein. Flowrox may revoke or amend the Proposal at any time by issuing a written notice thereof until Customer has accepted the Proposal in writing. The Proposal shall become binding between the Parties, and constitutes a contract ("**Contract**"), only when accepted by Customer in writing (e.g. by issuing a purchase order) and confirmed by Flowrox in writing (e.g. by issuing an order acknowl- edgement). The documents accompanying and constituting the Contract are to be applied as mutually supplementary to each other, but in case of ambiguities or discrepancies, the Contract shall prevail over these standard conditions of sale. Any changes to the Contract, including the price and time effect of the same, shall be defined in writing and be subject to prior written approval of Flowrox in order to be binding.

3. DOCUMENTATION. The weight, dimensions, size, performance and other specifications of the Products provided in the technical or commercial documentation of Flowrox ("**Documentation**") are of indicative nature only and are not contractually binding unless expressly indicated in writing by Flowrox. Any Documentation provided to Customer remains the exclusive property of Flowrox. Customer may only use the Documentation for the purpose of the Contract. No Documentation may be disclosed to third parties without the prior written consent of Flowrox before or after the Contract.

4. PRICES. The prices for the Products are agreed in the Contract. Unless otherwise agreed in the Contract, all prices are quoted in Euros (EUR), which shall be the invoicing and payment currency. Time and material prices, or prices for on-going services (if any) are subject to change by Flowrox upon 12 months' prior written notice. All prices are exclusive of Value Added Tax and all other taxes, customs, duties, levies and public charges which shall be paid by Customer in accordance with the applicable regulations in force from time to time.

5. PAYMENT TERM. Unless no other payment term has been agreed in the Contract, payment term is 14 days net, and the Products are invoiced in accordance with the following: (i) 30 % of the price of the Products shall be payable in advance upon conclusion of the Contract against an invoice issued by Flowrox, and (ii) 70 % of the price of the Products shall be paid after the Products are delivered against an invoice issued by Flowrox. No payment shall be deemed to have been received until Flowrox has received cleared funds to its disposal.

6. LATE PAYMENT. In the event Customer fails to make any payment on the due date, Flowrox may, without prejudice to any other right of Flowrox, (a) postpone the fulfillment of its own obligations under the Contract until full payment of the amounts due to Flowrox; (b) charge Customer penalty interest on the amount due for the payment at the annual rate of 12 % accruing on a daily basis until the payment is made; and/or (c) terminate the Contract with a written notice to Customer if the amounts due remain unpaid for a period of 14 days or longer.

7. DELIVERY. The delivery time set out in the Proposal (if any) is intended to be an estimate and shall be specified in the Contract. If no delivery time is specified, the delivery shall take place within a reasonable period of time. Should the delivery of Products be postponed at Customer's request or for any rea- son attributable to Customer, Flowrox shall be entitled to store the Products at Customer's risk and expense including without limitation to the costs of storage and insurance, the date of stor- age being the date of delivery. Flowrox reserves the right to make partial deliveries.

8. DELAY. If the delivery is delayed over 2 weeks due to a rea- son attributable to Flowrox, then Customer is entitled to liquidated damages amounting to 0.5 % of the value of the delayed part of the delivery for each full week of delay. Under no cir- cumstance shall the amount of liquidated damages exceed 7.5 % of the value of the delayed delivery. If the maximum amount of liquidated damages has been reached, then Customer may demand in writing a final reasonable delivery time which shall not be less than 2 weeks. If said final delivery time is not met due to a reason attributable to Flowrox,

then Customer is enti- tled to terminate the Contract on the delayed part and demand full

The liquidated damages and termination of the Contract on the delayed part constitutes Customer's sole and exclusive remedy for late delivery.

9. RETENTION OF TITLE; OWNERSHIP. The Equipment shall remain property of Flowrox until paid in full. Customer shall not annex the Equipment or any part thereof to real prop- erty of its own or a third party in such a way that the Equipment or any part thereof becomes a fixture until the Equipment has been paid in full. Flowrox reserves all rights of repossession and removal if the Equipment is not paid in full or the Contract is terminated. In case of repossession and removal, Customer shall at its own cost and risk provide Flowrox an access to the Equipment and allow Flowrox to remove the Equipment without any liability towards Customer or third parties.

10. DELIVERY TERM; TRANSFER OF RISK. The risk of loss or damage to the Equipment is transferred in accordance with the agreed delivery term. If no delivery term has been specified in the Contract, the delivery shall take place "EXW Flowrox factory, Lappeenranta, Finland" (INCOTERMS 2010).

11. WARRANTY. Subject to Customer complying with all its obligations under the Contract, Flowrox warrants that the Equipment purchased is free from defects in material and work- manship under normal use and service for a period of 12 months, such period to commence on the date of delivery provided however that the warranty period shall not exceed 18 months from the date of shipment of the Equipment. Customer shall notify Flowrox of any defects in the Equipment within 7 days after the detection of defects by issuing a reasonably detailed notice of non-compliance.

Customer shall retain the Equipment claimed defective within its or third party's premises, unless Flowrox requests Customer to return the Equipment to Flowrox. If the defect is subject to warranty, Flowrox shall, at its sole discretion, either replace or repair the Equipment. The replacement or repair of the Equipment shall be free of charge to Customer, excluding any repair work performed elsewhere than Flowrox's premises. The transportation and insurance costs for the Equipment returned to Flowrox shall be at Customer's charge, whereas the same for replaced or repaired Equipment shall be at Flowrox's charge. The Equipment replaced or repaired under warranty is deliv- ered under same terms as the original Equipment, however the originally agreed warranty period will continue to apply. After the refund of the price of the Products paid by Customer to Flowrox so far. warranty period, the liabilities of Flowrox for Products are strictly limited to separately agreed after sales services (if any).

The warranty of Flowrox excludes defects arising from (i) Customer's failure to operate or maintain the Equipment in accordance with Flowrox's instructions or manuals and generally with standard practices of equipment operation; (ii) ordinary wear and tear or deterioration; (iii) defective installation, operation, maintenance or storage; (iv) alterations or repair carried out by Customer or a third party without Flowrox's written consent; (v) combination or installation of the Equipment with equipment, materials, products, or systems not furnished, not approved, or not specifically recommended by Flowrox; (vi) defective protection of Equipment against exterior influence or similar circumstances for which Flowrox is not responsible; or (vii) insufficient or incorrect information from Customer. FLOWROX DISCLAIMS ANY AND ALL OTHER WARRANTIES, WHETHER EXPRESS, IMPLIED OR STATUTORY, SUCH AS WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PURPOSE.

12. LIMITATION OF LIABILITY. FLOWROX SHALL NOT BE LIABLE FOR (I) ANY CONSEQUENTIAL, SPECIAL OR INDIRECT DAMAGE OR LOSS, INCLUDING BUT NOT LIMITED TO LOSS OF PROFITS, PRODUCTION, OR CONTRACTS, PLANT DOWN-TIME, LIABILITIES TOWARDS THIRD PARTIES, OR DAMAGE RELATING TO THE PROCUREMENT OF SUBSTITUTE EQUIPMENT OR SERVICES DUE TO ANY CAUSE; (II) ANY LOSS OR DAMAGE ARISING FROM THE SOLE OR CONTRIBUTORY NEGLIGENCE OF CUSTOMER OR THIRD PARTIES; (III) ANY SPECIAL OR PUNITIVE DAM- AGE OF ANY NATURE; OR (IV) ANY DAMAGE OR LOSS CAUSED TO PROPERTY OR PERSONS BY THE PRODUCT AFTER DELIVERY AND WHILE IN THE POSSESSION OR OPERATION OF CUSTOMER OR THIRD PARTIES; EVEN IF FLOWROX HAS BEEN ADVISED OF THE POSSIBILITY OF DAMAGES MEANT ABOVE (I-IV). THE TOTAL AGGREGATE LIABILITY OF FLOWROX HEREUNDER, INCLUDING ALL LIQUIDATED DAMAGES, PRICE REDUCTIONS, WARRANTY REPAIRS OR REPLACEMENTS, OR CONSEQUENCES OF TERMINATION (IF ANY), IS LIMITED TO THE PAYMENT OF DIRECT DAMAGES AND SHALL UNDER NO CIRCUMSTANCE EXCEED THE PRICE OF PRODUCTS IN QUESTION. Customer shall defend, indemnify and hold Flowrox harmless from and against any claim based on the damage, loss or cost exceeding Flowrox's liability.

13. INTELLECTUAL PROPERTY; SOFTWARE. All intellectual property rights (including but not limited to patents, copy-rights, trademarks, designs, trade secrets, know-how or applications thereof; jointly "**Intellectual Property Rights**" or "**IPR**") to the Products, the Documentation and related materials shall remain property of Flowrox or third parties. No right, title, license, or interest is transferred to Customer by the Contract in any such IPR. Customer shall not make any use of IPR than for the purpose of the Contract, such as the installation or operation of the Products. No markings or trademarks affixed to the Products or the Documentation may be removed. If a Product sold to Customer becomes, or in Flowrox's opinion may be-come, subject of any claim, suit or proceedings for infringement of third party IPR, Flowrox has the right, at its own expense, either (i) obtain for Customer a right to use the Product; (ii) re-place or modify the Product; (iii) or remove the Product and refund price of Products in question. Any computer programs and the accompanying documentation ("**Software**") supplied or embedded into the Products are provided strictly under the appli- cable license or other terms applying to such Software.

14. CONFIDENTIALITY; USE OF DATA. The Party receiving confidential information either in oral or written form from the other Party shall not use or disclose such confidential infor-mation than for the purpose of the Contract. Said obligations do not apply to information that (i) is or becomes generally available through no confidentiality violation of the receiving Party, (ii) was lawfully available to the receiving Party prior to its disclosure, (iii) becomes available to the receiving Party from a third party on a non-confidentiality basis, (iv) is developed in-dependently by the receiving Party having no access to such confidential information, or (v) is required to be disclosed by a competent authority. Notwithstanding the above, Flowrox shall have the right to utilize, amend and transfer to third parties all data acquired or collected by Flowrox from Customer and its use of the Products for analyzing, reporting or similar purposes in anonymized format and provided that no confidential information of Customer is thereby disclosed.

15. FORCE MAJEURE. Neither Party shall be liable for any failure or delay to perform any of its obligations if the failure or delay is due to an impediment, which is beyond the reasonable control of the affected Party and which the affected Party cannot circumvent without unreasonable work or costs, such as fire, war, general mobilization or military mobilizations to a similar extent, general strikes or lockouts, requisition, seizure, currency restrictions, insurrection and civil commotion, restrictions or delays in the supply of power or materials from subcontractors as well as natural catastrophes and other equivalent events ("**Force Majeure**"). The Party seeking suspension due to event of Force Majeure shall immediately notify and keep the other Party updated thereof. Both Parties are entitled to terminate the Contract for convenience without liability insofar as the performance is suspended for a period of 60 days or more.

16. APPLICABLE LAW; DISPUTES. The Contract shall be governed by the laws of Finland excluding its choice of law provisions. The applicability of the United Nations Convention on Contracts for the International Sales of Goods (1980) shall be expressly excluded. Any dispute, controversy or claim arising out of or relating to the Contract, or the breach, termination or validity thereof shall be first subject to negotiation between the top management of the Parties. If the dispute is not settled within 60 days after a Party has requested for such negotiations, either Party may bring to dispute to be finally settled by arbitration in accordance with the Arbitration Rules of the Finland Chamber of Commerce. The Arbitration proceedings shall be conducted in Helsinki, Finland and the language of the proceeding shall be English. The arbitration proceedings including their existence are confidential. Notwithstanding the above, Flowrox may claim any unpaid invoices before the District Court of Helsinki, Finland.

17. MISCELLANEOUS.

Compliance with Laws. Both Parties shall comply with all applicable laws and regulations including but not limited to export control and anti-bribery legislation.

Waiver. No delay or omission by either Party to exercise any right hereunder shall impair any such right or be construed to be a waiver thereof.

Severability. If any provision of the Contract is found invalid or unenforceable, the same shall not invalidate or render unenforceable any other part of the Contract.

Entire Agreement. The Contract together its accompanying documents constitute the entire agreement regarding its subject matter between the Parties and replace any previous agreements, proposals, representation, inducement or notifications regarding the same.

APPENDIX F – Claim form

The purchaser must file a claim for all compensation related to the hose and pump guarantee within 30 days after the fault has been detected.

The following information must be included. Fill in the form using block letters, or provide the manufacturer with the same information in another manner. In any instance, the claim must be made in writing.

PUMP SERIAL NUMBER:	
DATE WHEN THE FAULT WAS DETECTED (dd.mm.yyyy):	
OPERATING CONDITIONS IN WHICH THE FAULT WAS DETECTED:	
DESCRIPTION OF THE FLOWING MEDIUM:	
AN EXACT DESCRIPTION OF THE FAULT:	

If all of the above information is not sent to the manufacturer in writing, the purchaser loses the right of guarantee.