

Installation, Operation, and Maintenance Manual
For Lineshaft Turbine Pumps



Table of Contents

Introduction2

Warranty3

Safety3

General Layout and Description4

Receiving5

Storage5

 Short-Term (< 2 Months)5

 Long-Term (2-12 Months)5

 Uncontrolled Storage5

Handling6

Well Design6

Sump Design6

Suction Barrels7

Installation7

 New Baseplate8

 Existing Baseplate8

 Assembled Pump Installation9

 Unassembled Pump Installation9

 Column10

 Open Lineshaft10

 Enclosed Lineshaft11

 Discharge Head13

 Stuffing Box / Stretch Assembly14

 Open Line Shaft – Stuffing Box14

 Enclosed Line Shaft – Stretch Assembly15

 Driver and Coupling16

 Vertical Hollow Shaft16

 Vertical Solid Shaft17

 Lubrication19

 Oil-Lubricated19

 Water-Lubricated19

Start-Up19

 Start-Up Checklist19

 Initial Start-Up20

Routine Maintenance 20

 Replacing the Packing 20

Troubleshooting 22

Typical Pump Assembly Layout – *Open Lineshaft* 25

Typical Pump Assembly Layout – *Enclosed Lineshaft* ... 26

Typical Bowl Assembly Layout – *Open Lineshaft* 27

Typical Bowl Assembly Layout – *Enclosed Lineshaft* 28

Introduction

Thank you for purchasing a FloWise product. Our pumps are designed for safe operation, long life, and ease of service. This manual is intended to provide instructions to install, operate, and maintain FloWise open and enclosed lineshaft vertical turbine pumps. The procedures shown in this manual cover all our vertical turbine pump models with a few exceptions. Those exceptions will be noted as required within the manual.

It is necessary that you read and understand this manual in its entirety before installation or maintenance of the FloWise vertical turbine pump. Following the instructions and service procedures as noted herein will help extend the life of the pump and ensure trouble-free operation.

Note: FloWise shall not be liable for physical injury, death, damage, or delays caused by a failure to observe the instructions for installation, operation, and maintenance contained in this manual.

Specific Pump Information

Pump Model: _____

Pump Serial: _____

Motor Model: _____

Motor Serial: _____

Contact Name: _____

Contact Phone: _____

Purchase Date: _____

Install Date: _____

Warranty

FloWise pumps are warranted to be free from defects in material and workmanship for a period of one year from the date of shipment. This warranty does not include wear parts or consumables such as seals, gaskets, elastomers, coatings, bearings, etc. Warranty void on items damaged due to misuse or improper handling by others.

Safety

This product is a rotating piece of machinery typically coupled to an electric motor. It is important that you follow all safety instructions within this manual and on the pump in order to avoid serious or fatal personal injury. While safety must always be observed while working with this product, we have noted specific situations throughout this manual which require additional attention. These situations will be denoted as follows:



WARNING

Hazards marked by this symbol are severe and may cause serious personal injury, death, or result in major property damage.



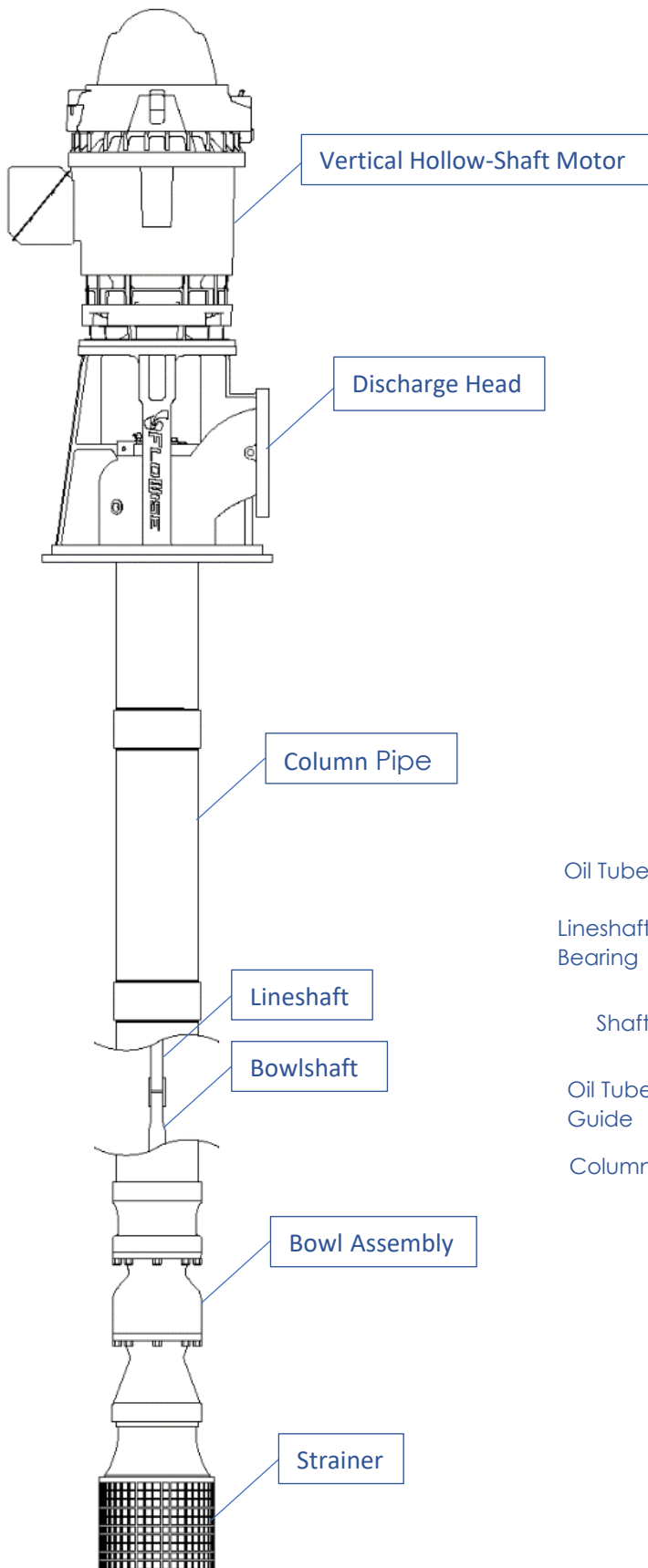
CAUTION

Hazards marked by this symbol may cause personal injury or result in major property damage.

Safety Considerations:

- **DO NOT REMOVE** any safety decals found on the equipment.
- **DO NOT** allow fluid to freeze inside the pump.
- **DO NOT** allow the pump to run dry or start without proper submergence.
- **DO NOT** allow the pump to run backwards. Proper motor rotation must be checked before starting the pump.
- **DO NOT** operate the pump outside of its recommended flow range. Consult the pump curves and/or your FloWise factory representative to determine proper pump design points.
- **DO NOT** operate the pump if noise or vibration is observed. Shutdown the pump immediately.
- **DO NOT** operate the pump without the coupling guard and any other safety devices properly installed.
- **DO NOT** apply heat during pump disassembly or impeller removal. Heat applied to components may cause entrapped liquid to vaporize, causing an explosion.
- Always make sure that proper lockout-tagout safety procedures have been performed and power is disconnected prior to starting maintenance on the pump.
- Use extreme caution if the pumped liquid is hazardous. Follow necessary precautions to avoid contact and prevent spills during installation, removal, and maintenance.
- Ensure adequate flow is available to the pump suction and that no valves are closed on the suction or discharge.

Figure 1 – General Pump Layout



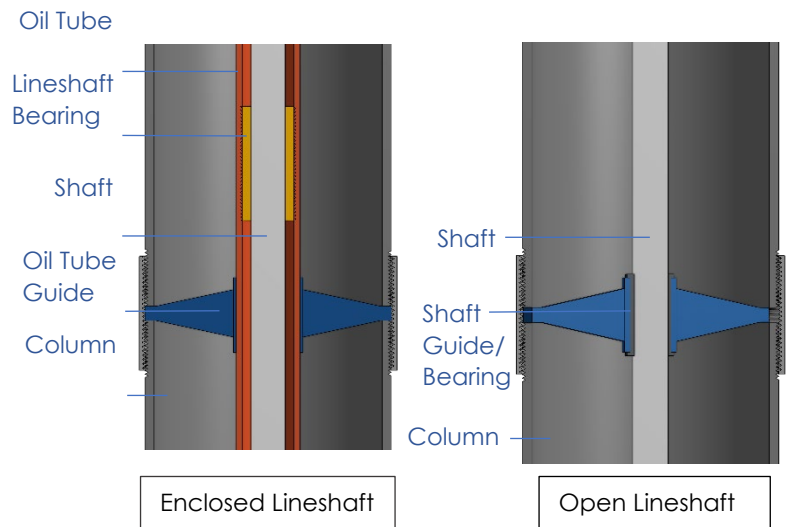
General Layout and Description

The FloWise *open* lineshaft vertical turbine pump has the typical configuration shown in Figure 1. A vertical hollow-shaft motor or right-angle gear drive rests upon the discharge head. This motor is connected to the lineshaft, which runs to the bowl assembly. At the bowl assembly, the lineshaft is connected to the bowlshaft, driving the impellers. The impellers are either semi-open or enclosed. The impellers channel the flow from each bowl to the next, up the column pipe, and out through the discharge head. The column is either threaded or flanged. A strainer can be provided to keep unwanted debris from entering the pump.

A FloWise *enclosed* lineshaft vertical turbine pump has the same basic features, plus an oil tube that encloses the lineshaft. An oil reservoir at the surface keeps the lineshaft lubricated.

More details can be found in Figure 2 below.

Figure 2 – General Column Layout



Receiving

Perform a thorough inspection of the shipping crates for damage or signs of improper handling before unpacking. Then unpack and check all items for damage. Take extra care to ensure that all shafting is straight, threads are undamaged, and that all items are present and match the bill of lading (BOL). Report any damage and/or missing items from the BOL immediately to your freight carrier. Also immediately report any damage and/or missing items (whether they were present on the BOL or not) to your local FloWise representative.

Storage

Short-Term (< 2 Months)

If the pump and components are to be stored in a dry, indoor environment for less than 2 months, standard factory shipping packaging will be adequate for protection. No less than once a month, the shaft shall be turned counterclockwise several times and left in a different position than it was before the rotation. The impellers shall not be allowed to rest on the top or bottom of the bowls (lateral shall not be at min or max).

Long-Term (2-12 Months)

For storing the pump and components in a dry, indoor environment for 2 to 12 months, follow the instructions below:

- Construct a new solid wood skid that will elevate the pump and equipment no less than 3" off the ground and safely support the weight of all equipment. Ensure that there is room in the skid to allow the baseplate or discharge head base to pass through, while still being supported.
- Cover the wood skid with industrial polyethylene shrink wrap.
- Set the pump on top of the shrink wrap and wood skid.
- Install a bolt, washer, and rubber bushing from the bottom of the wood skid, through the shrink wrap, through the discharge head

mounting holes, and secure with a hex nut. Continue installing bolts in this manner to adequately secure the equipment to the wood skid.

- When the equipment is all secured to the wood skid, place desiccant bags around the equipment (on top of the shrink wrap).
- Wrap the shrink wrap over the pump and apply heat to seal completely. Entrapped moisture will be absorbed by the desiccant.
- No less than once a month, the shaft shall be turned counterclockwise several times and left in a different position than it was before the rotation. The impellers shall not be allowed to rest on the top or bottom of the bowls (lateral shall not be at min or max). After rotation, reseal the shrink wrap.


Uncontrolled Storage

If storage is to be outside, subject to relative humidity >50%, subject to dust, or subject to other potentially damaging environments, it is considered uncontrolled.

For uncontrolled storage, take the steps listed above for long term storage and follow the additional instructions below:

- Seal all pipe threads with tape.
- Do not store in an area subject to flooding or pooling of water.
- Tarps or other weatherproof coverings used shall be flame resistant and tied down securely.
- Any stacking of components shall be such that all weight is supported by the crates, rack, etc. and no weight is transferred to the components.
- If outdoors, equipment should be stored under a roof or shed when possible.

Handling

In handling the pump and its components, great care must be taken to ensure that none of the precision machined parts are damaged. Damage to any parts  may result in failure or malfunction of the pump. Never allow the pump or components to be dropped from the carrier vehicle to the ground.

Always ensure that lifting devices and equipment are rated and suitable for the equipment being handled. Also, always make sure all lifting devices are securely fastened.

If the pump is not immediately installed during delivery to the jobsite, create an installation area that is clean and convenient. To keep column pipe from getting dirty or damaged, you may lay them on suitable timbers.

Ideally you can point the lineshaft couplings at the well or install site for convenience during installation. Leave the pump assembly in its crating and protect any power cables or motor leads from damage. Make sure all components are present and identify them as needed to prevent confusion with other on-site equipment.

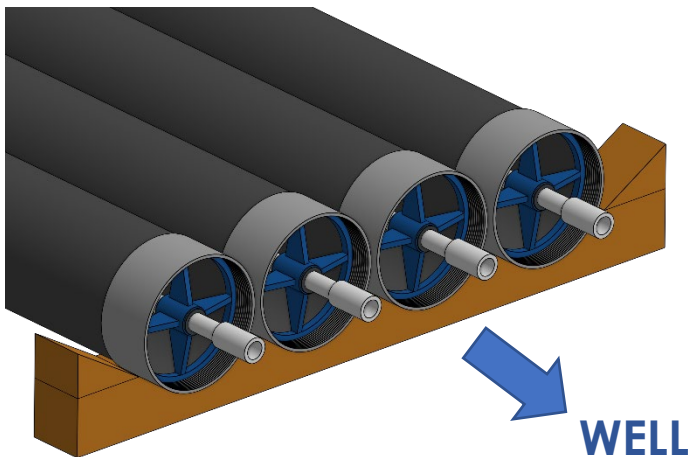


Figure 3 – Column Storage

Well Design

Ensure that the well is large enough to accommodate the largest pump component diameter without rubbing or damaging the pump during installation. Sand, mud, and debris must be removed prior to the installation of the FloWise vertical turbine pump. This is typically done with a secondary pump and referred to as “test pumping”. If test pumping is not performed, sand/mud/debris may damage the pump and void the warranty.

The well should be capable of producing more than the highest expected flow from the pump. Test pumping should not only clear the well of debris, but also confirm the expected production of the well and lowest drawdown level.

The pump will drawdown the immediate groundwater level around the well. For well installations, the suction of the pump must be submerged 10ft below the lowest drawdown level.

Ensure that the well is deep enough to accommodate the overall assembled length of the pump (including the strainer). The pump should have 10ft of clearance from the bottom of the well. If debris enters the well, this space may allow it to settle to the bottom, rather than enter the pump.

Sump Design

Proper sump design is critical to the performance of your pump. The sump inlet and shape, pump spacing, and pump operation characteristics can result in vortexing or turbulent flow patterns. Improper sump design may result in pump noise, vibration, or damage. Prior to creating the sump or installing your pump into an existing sump, we recommend you consult the Standards of the Hydraulic Institute as well as a professional with sump design experience. Also, you should follow these steps before installing your pump:

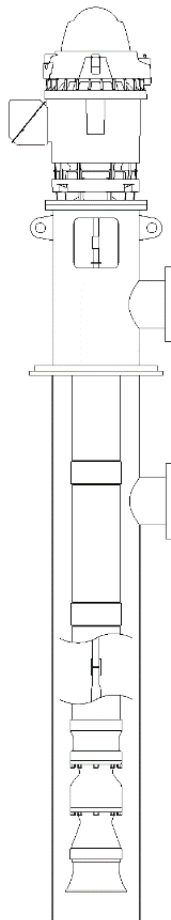
- Ensure that the sump dimensions are adequate to receive the pump.

- Inspect the inlet for any blockages or debris. Clear anything that may cause damage or clog the pump.
- Screen the sump inlet when possible.
- Make sure the sump is clean and free of trash and debris.

Suction Barrels

The suction barrel is a pump installation type that provides a preconfigured pump casing. See Figure 4 for reference. This casing is usually provided and designed by the factory. Since the design of the casing will impact pump performance and longevity, any casing provided by others must be reviewed and approved by the FloWise factory or the pump warranty will be void.

Figure 4 – General Suction Barrel Layout



The barrel may be installed above ground, below ground with anti-flotation countermeasures, or encased in concrete. In all cases, the barrel must be straight, with the top flange level within 0 to 0.005 inches per linear foot.

Installation

Preparation

Gather the tools, material, and equipment necessary for installation. Required equipment may vary with pump size and the installation. The following list is intended to serve as a guide.

Materials

Thread Compound
 Anti-galling Lubricant
 Lubrication Oil

Grease

Equipment

Crane
 Drag Line
 Lifting Bail for Threaded Column
 Elevator Clamps

Clevises

Timbers

I-Beams

Hand Tools

Pipe Wrenches
 Feeler Gauges
 Mechanics Toolset Including: Files, Wire Brush, Pliers, Wire Cutters, Pocket Knife

Clean Rags

Dial Indicator to Assist in Pump/Motor Alignment

Machinist Level

New Baseplate

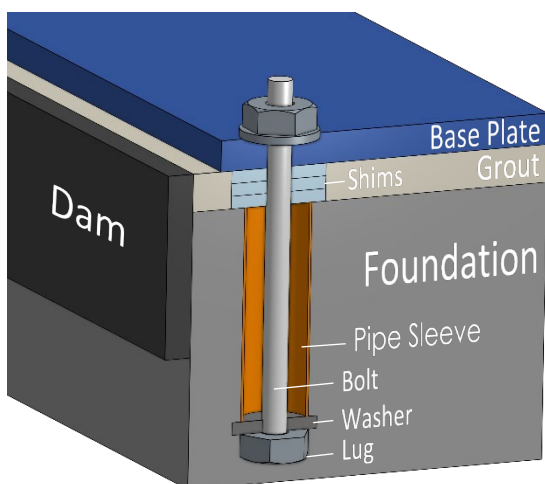
1. Prior to starting installation, make sure there will be adequate space for installation, operation, and maintenance of the pump and driver.

Typical pump foundations consist of a steel plate mounted in grout or bolted to a structure. This plate is often referred to as a “foundation plate”, “sole plate”, “sub-base”, or “base plate”. In this manual, we will refer to the plate as “base plate”.

The foundation must be able to withstand the weight of the pump plus the weight of the liquid flowing through it. It must also be able to absorb vibration and provide a rigid support for the entire pump assembly and driver.

A typical base plate installation is shown in Figure 5 below. A pipe sleeve is embedded into the concrete foundation with a bolt passing through. The bolt secures the base plate to the grout, shims/leveling wedges, and foundation. The sleeve allows for some movement of the bolt and aids in alignment with the base plate holes. The pipe sleeve diameter is typically 2.5 times the bolt diameter.

Figure 5 – Base Plate and Foundation



2. Make sure the pipe sleeves are free from water and then carefully lower the base plate onto the foundation, making sure to line up all the foundation bolts with the bolt holes in the base plate. Install the nuts and washers on each bolt and hand tighten.
3. Level the base plate. Use leveling wedges, shims, nuts, or jackscrews to level the base plate. If using shims, make sure all anchor bolts have a shim installed nearby in order to prevent binding the base plate. If the baseplate twists and binds, it will likely be impossible to level.
4. Ensure the plate is clean and free of dust and contaminants. Use a machinist level in two directions at 90 degrees to check level. Level tolerance is 0.005in per foot.
5. Once leveled, tighten all anchor bolts. After tightening, re-check the base plate for level. If tightening the anchor bolts has moved the base plate level out of tolerance, loosen the bolts, adjust the leveling devices until the base plate level is within tolerance, and re-tighten the anchor bolts. Repeat until the anchor bolts are tightened and the base plate level is within tolerance.
6. Build a dam around the foundation in preparation for grouting. Pour grout into the space between the base plate and foundation until the space is filled and level with the top of the dam. Make sure no air bubbles remain trapped in the grout and allow to cure. After curing, make sure no voids have formed and remove any leveling wedges, shims, nuts or jackscrews.

Existing Baseplate

If using an existing baseplate, use the discharge flange of the pump to check level. First, install the pump on the existing baseplate using the appropriate directions in the Pump Installation section of this manual. Then

use a machinist level in two directions at 90 degrees on the discharge flange to check level. If level is out of tolerance, add or remove shims between the discharge head and the baseplate.

Assembled Pump Installation

The following installation instructions are for a factory assembled pump unit. If your pump shipped unassembled, skip to the “Unassembled Pump Installation” section of this manual.

1. Sling through the discharge head lifting holes and carefully raise the pump into a vertical position.



Ensure that slings are rated in excess of the equipment weight.

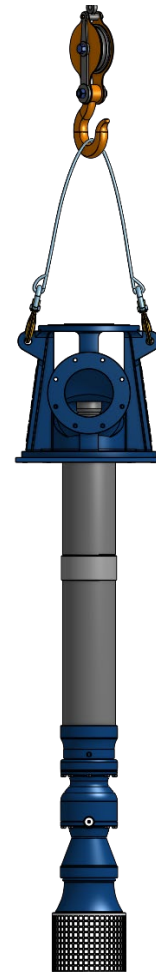
While lifting, take care not to damage the pump strainer or cause undue stress on the column pipe.

2. Position the pump over the foundation and prepare to lower in place. Ensure that the pump is under control before lowering.
3. Lower the pump onto the foundation while carefully guiding it through the base plate hole. Do not allow the lower pump assembly or column to contact the base plate during installation.
4. When the discharge head is firmly resting on the base plate with full contact, install the mounting bolts.

Unassembled Pump Installation

1. Prepare the bowl assembly.
 - a. Make sure all bolts are securely fastened.
 - b. Rotate the shaft to make sure it spins freely.


Figure 6 – Lifting



- c. Ensure that the assembly is clean, all debris is removed from the area, and all bleed ports are clean and unobstructed (if applicable).
 - d. Measure and note available impeller end play or axial movement (commonly referred to as “pump lateral”).
 - e. Install pump strainer if provided.
2. Prepare the installation site. Place two support beams across the foundation or base plate. Make sure the beams are capable of withstanding the total weight of all equipment. The beams should be clamped firmly together with threaded rods and nuts.
3. Install a friction clamp below the discharge threads and under a convenient shoulder. Attach a cable sling to either side of the friction

clamp. Make sure the sling is long enough to avoid damage to the bowlshaft from the lifting hook. Make sure sling attachments are far enough out from the bowl assembly in order to be removed after the friction clamp is set on the support beams.

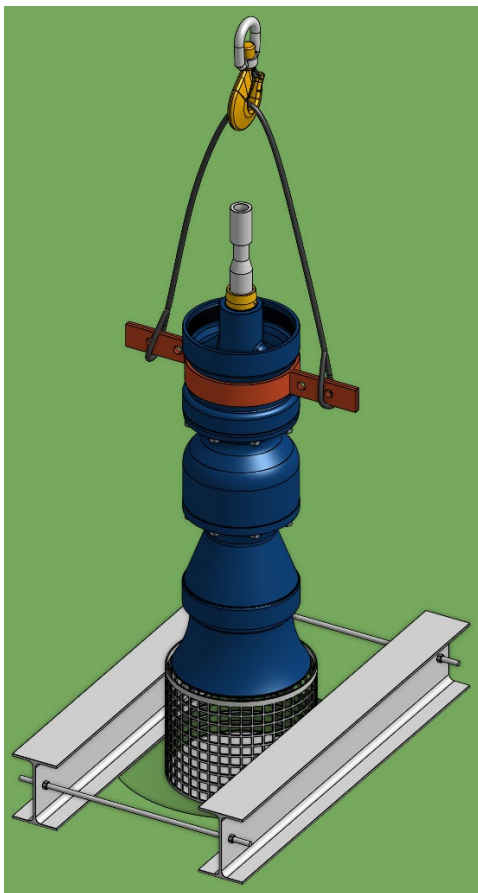
- Carefully raise the pump into a vertical position.

 **WARNING** Ensure that slings are rated in excess of the equipment weight.

While lifting, take care not to damage the pump strainer or suction case.


A tail rope may be used to help prevent swinging and guide the bowl assembly into place. See Figure 7 for a general layout.

Figure 7 – Bowl Assembly Lifting



- Lower the pump until the friction clamp ears rest fully on the support beams. Do not allow the bowl assembly or strainer to contact the opening during installation.
- Remove the cable sling.

- Cover the pump with a clean cloth to prevent debris from falling into the pump before the column is installed.

 **CAUTION** Do not allow any foreign objects or debris to fall into the pump while awaiting installation of the column pipe.

Column

It is important to first identify the proper sequence of top column, intermediate column, and bottom column. Then determine the proper sequence of top lineshaft, intermediate lineshaft, and bottom lineshaft. Refer to the certified factory drawings provided.

Open Lineshaft

- Thread a lineshaft coupling onto the lineshaft or wrap a clean rag around the threads to protect them during installation into the column pipe. Slide the lineshaft into the column pipe so that the lineshaft protrudes about 12" through the bottom end of the column. If there is a shaft sleeve, make sure it is at the top end of the column pipe. Remove the lineshaft coupling or rag from the lineshaft.
- For threaded column, install a friction clamp below the column coupling. For flanged column, install a friction clamp 6" below the flange to allow room for installing the flange bolts later. Attach a sling to the ears of the friction clamp.
- Using a $\frac{3}{4}$ " rope, tie a series of half-hitch knots on the bottom end of the column pipe and lineshaft. This will prevent the lineshaft from sliding out when the column is lifted vertically for installation.
- Thread a lineshaft coupling onto the bottom end of the lineshaft (where rope was secured in step 3). If the lineshaft slips out of the column while handling, the coupling may prevent damage to the shaft face and threads. Note: The shaft would then have to be thoroughly checked with a dial indicator to confirm

straightness. Average total run out should not exceed 0.0005" Total Indicator Reading (TIR) per foot, or 0.005" TIR for 10ft.

5. Hoist the column pipe and lineshaft assembly into the vertical position. Ensure that the lineshaft and column pipe threads are not strained or damaged during lifting. The shaft should be supported by hand or using a pipe wrench to ensure that it does not slip.
6. Align the column pipe over the discharge case of the bowl assembly or the receiving column pipe. Remove the protective coupling from the lineshaft being installed. Maintain shaft alignment and lower the column assembly just until the shaft being installed engages the coupling. Turn the shaft by hand until the two shafts butt.
7. Place a pipe wrench on the shaft being installed and another pipe wrench on the coupling. Have one technician simultaneously push and pull the wrenches to tighten.
8. Check that equal amounts of threads are visible above and below the coupling.
9. If the connection is threaded, apply thread compound to both threads and lower the column until the threads engage. Thread the column into the bowl manually with chain tongs. The column assembly should be lowered slowly while tightening the threads.

If the connection is flanged, apply a thin, even coat of thread compound to the flange faces. Lower the column assembly, maintaining alignment of the studs or bolt holes, until the flanges seat. Once the flanges are together, install hex nuts and/or bolts. If this is the bowl assembly connection, install the lubrication line if required.

10. Once the connection is made, hoist the unit slightly, allowing the removal of the lower

friction clamp. Move the support beams out in order to allow the unit to be lowered.

11. Lower the assembly until the upper friction clamp nears the support beams. Halt lowering and move the support beams back into position. Lower the assembly until the friction clamp rests on the support beams. Remove the sling.
12. Place the spider or bearing retainer over the shaft and seat it in the column coupling recess or flange recess.
13. Ensure that the shaft is centered within the bearing. Move the shaft around as needed to center it within the bearing. If excessive force is required to center the shaft, the shaft may be bent or improperly butted. Correct this problem before proceeding.
14. Repeat the previous steps until all column assemblies have been installed. The top column section will have two welded lugs on the exterior, near the top. When installing the friction clamp on this section, place it immediately under these lugs.

Enclosed Lineshaft

1. Insert tube and shaft sections into their matching column sections. Allow the tubing to protrude about 15" past the bottom end of the column pipe. Allow the shaft to protrude about 9" from the end of the tube.
2. Install a friction clamp immediately below and butted against the column coupling. For flanged column, install a friction clamp 6" below the flange to allow room for installing the flange bolts later. Attach a sling to the ears of the friction clamp.
3. Using a 3/4" rope, tie a series of half-hitch knots on the bottom end of the column pipe, tube, and lineshaft. This will prevent the tube and lineshaft from sliding out when the column is hoisted vertically for installation.
4. Hoist the column pipe and lineshaft assembly into the vertical position. Ensure that the lineshaft and column pipe threads are not strained or damaged during lifting. The shaft

and tube should be supported by hand or using two pipe wrenches to ensure that it does not slip.

5. Align the column pipe over the discharge case of the bowl assembly or the receiving column pipe. Maintain shaft alignment and lower the column assembly just until the shaft being installed engages the coupling. Turn the shaft by hand until the two shafts butt.
6. Place a pipe wrench on the shaft being installed and another pipe wrench on the coupling. Have one technician simultaneously push and pull the wrenches to tighten.
7. Check that equal amounts of threads are visible above and below the coupling.
8. Lower the assembly until the tube threads engage with the bearing box or line shaft bearing. Remove the rope. Apply thread compound to the exterior tube bearing threads.
9. Place a pipe wrench on the tube. If installing into the bowl assembly, place a second pipe wrench on the bearing box shoulder. If installing into column, place the second pipe wrench on the lower tube. Have one technician simultaneously push and pull the wrenches to tighten.
10. If the connection is threaded, apply thread compound to external threads and lower the column until the threads engage. Thread the column into the bowl manually with chain tongs. The column assembly should be lowered slowly while tightening the threads.

If the connection is flanged, apply a thin, even coat of thread compound to the flange faces. Lower the column assembly, maintaining alignment of the studs or bolt holes, until the flanges seat. Once the flanges are together, install hex nuts and/or bolts.

11. For oil lubricated assemblies: after each piece of column is installed and the friction clamp is resting firmly on the support beams, remove the exposed lineshaft bearing and pour oil into the tubing. Reinstall the lineshaft bearing. Use the table below for the required amount of oil per pour.

Note: It is not necessary to oil forced water lubricated assemblies.

Table 1 – Oil Per Installed Section

Tube Size	Amount of Oil Per Section	
	10 ft. Sections	20 ft. Sections
1-1/4, 1-1/2, 2	1/2 Cup	1 Cup
2-1/2, 3, 3-1/2	1 Cup	1/2 Quart
4 and larger	1/2 Quart	1 Quart

12. If the column connection is threaded, apply thread compound to external threads and lower the column until the threads engage with the column coupling or discharge bowl. Thread the column into the coupling or bowl manually with chain tongs. The column assembly should be lowered slowly while tightening the threads.

If the connection is flanged, apply a thin, even coat of thread compound to the flange faces. Lower the column assembly, maintaining alignment of the studs or bolt holes, until the flanges seat. Once the flanges are together, install hex nuts and/or bolts. If this is the bowl assembly connection, install the lubrication line if required.
13. Once the connection is made, hoist the unit slightly, allowing the removal of the lower friction clamp. Move the support beams out in order to allow the unit to be lowered.
14. Lower the assembly until the upper friction clamp nears the support beams. Halt lowering and move the support beams back into position. Lower the assembly until the friction clamp rests on the support beams. Remove the sling.
15. Repeat the previous steps until all column assemblies have been installed. A tube

stabilizer, commonly referred to as a spider, should be installed every 40 feet. Stabilizers should be 20' away from the discharge head and 20' away from the bowl assembly. Make sure spiders are snug in the column and around the tube.

Figure 8 – Open Lineshaft Bowl Connection

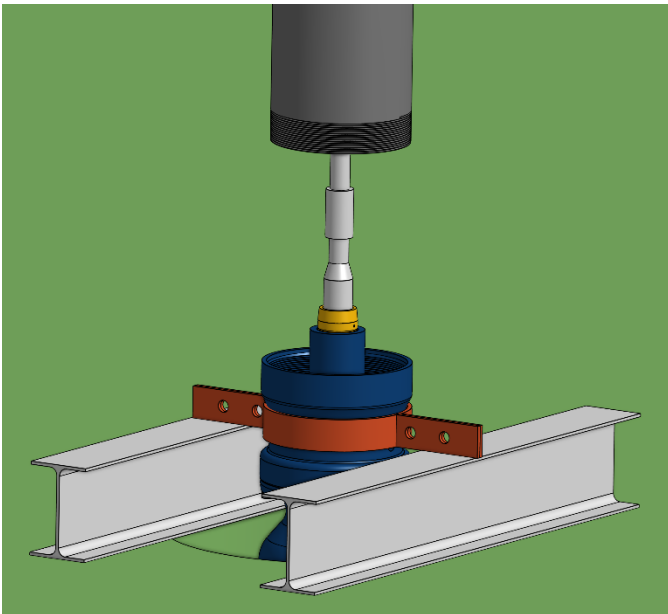
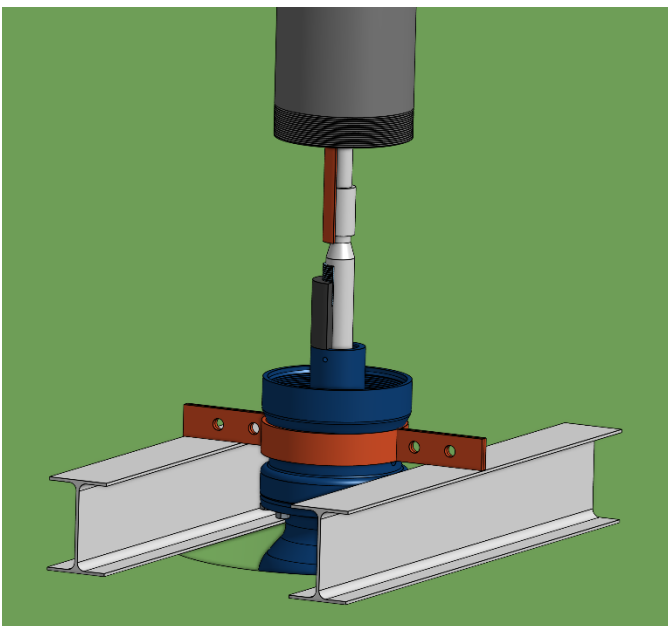


Figure 9 – Enclosed Lineshaft Bowl Connection



Discharge Head

1. Remove the stuffing box if already assembled to the head.
2. If attaching the head to threaded column, make sure the column flange is securely fastened to the bottom of the discharge head.
3. Attach a sling to the lifting lugs on the side of the discharge head. Hoist the discharge over the top shaft and orient to the required position. Lower the head over the top shaft, taking care not to damage the shaft threads. Continue lowering until the column flange threads on the bottom of the discharge head engage with the threaded column. Use chain tongs to hold the column pipe and rotate the discharge head until fully seated onto the column pipe. You may use a long pipe placed through the discharge head windows to further tighten, however, be very cautious to avoid damaging the protruding shaft).

If attaching the discharge head to a flanged column, attach a sling to the lifting lugs on the side of the discharge head. Hoist the discharge over the top shaft and orient to the required position. Lower the head over the top shaft, taking care not to damage the shaft threads. Ensure that the column pipe flange holes are aligned with the discharge head flange holes. Continue lowering until the discharge head rests on the flange. Install and tighten all fasteners.

4. Use the lifting lugs to hoist the discharge head high enough to remove the friction coupling on the column.
5. Remove the support beams and clean the foundation / base plate. Make sure the discharge head is in the proper orientation for connecting to discharge pipe.



WARNING The sling attached to the discharge head will now be bearing the full weight of the pump

assembly. Make sure the slings are rated in excess of the total equipment weight.

6. Lower the discharge head onto the base plate and secure with fasteners.
7. Check that the shaft is in the center of the stuffing box bore and that it is perpendicular to the driver mounting flange in two directions, 90 degrees apart.
8. Check that the top of the discharge head (driver mount) is level within 0 to 0.005 inches per linear foot in two directions, 90 degrees apart. If it is out of tolerance, level the baseplate according to the previous instructions on page 7 of this manual. Both the baseplate and discharge head must be level within tolerance.

Stuffing Box / Stretch Assembly

Open Line Shaft – Stuffing Box

1. Clean the underside of the stuffing box and remove the packing.
2. Install the stuffing box over the protruding top shaft and into the bore. Rotate the stuffing box so that its ports are in the desired position.
3. Lift the stuffing box and apply a liberal amount of thread compound to the discharge head mating surface.
4. Lower the stuffing box back into place and secure with cap screws.
5. If the stuffing box does not fit into the bore without pushing on the shaft, then the discharge head is out of alignment.
6. Finalize the stuffing box assembly. See Figure 10 for details.

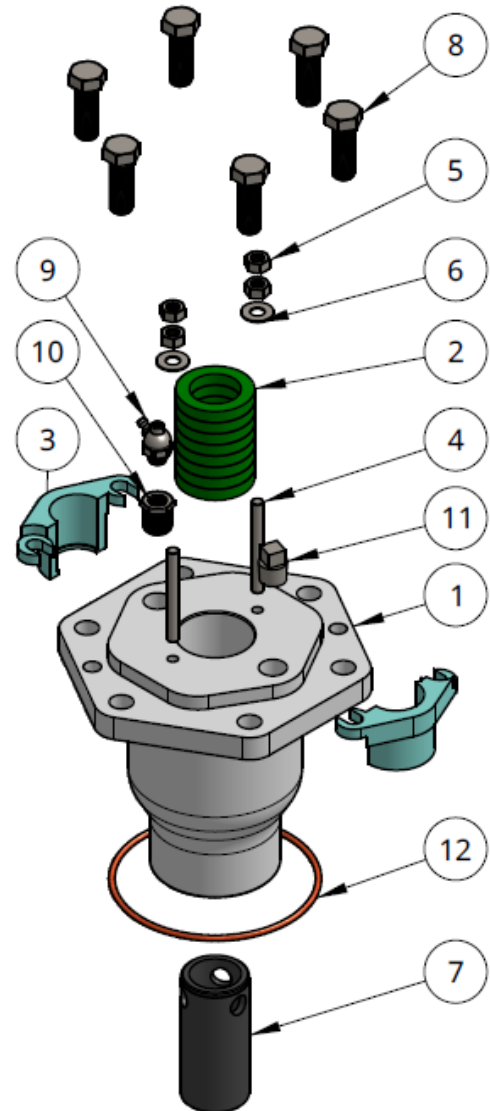


Figure 10 – Stuffing Box Assembly

Item No.	Quantity	Description
1	1	Stuffing Box
2	8	Packing
3	2	Packing Gland
4	2	Stud
5	4	Hex Nut
6	2	Washer
7	1	Bearing
8	6	Capscrews
9	1	Grease Port
10	1	Grease Port Bushing
11	1	Plug
12	1	O-Ring

Enclosed Line Shaft – Stretch Assembly

Install stretch assembly using one of the two methods below. See Figure 11 for details.

Direct Pull with Hoist and Dynamometer

1. Install the tension plate manually but do not tighten.
2. Thread the tube tension adapter (special fitting available from the factory) onto the top of the tube until it is fully engaged.
3. Attach the dynamometer to the tube tension adapter and the hoist hook.
4. Lift the hoist until proper tension is read on the dynamometer. You will notice that the tension plate will lift off the discharge head.
5. Manually thread the tension plate until it engages with the discharge head. Align the tension plate screw holes with the discharge head mounting holes.
6. Lower the hoist to release tension and remove the dynamometer and tube tension adapter.
7. Install tension plate capscrews and securely tighten.
8. Install packing and thread the tension nut over the top of the projecting tube. Tighten the tension nut firmly against the packing.
9. If the tube is too short for the tension nut, the tube must be replaced. If the tube is too long for the tension nut, the tube must be cut and rethreaded. Either way, the pump must be reinstalled and leveled.
10. Install the lock plate and lock screw.

Manual Wrench

1. Create a spanner wrench that engages two opposing screw holes in the tension plate while straddling the top of the tube projection. Ensure that your wrench will not damage the threads of the exposed tubing.

2. Use the wrench to turn the tension plate counterclockwise. The wrench should have a 3ft lever arm. Use full strength on the lever arm to tighten the tension plate, making sure to align the tension plate screw holes with the discharge head mounting holes.
3. Install tension plate capscrews and securely tighten.
4. Install packing and thread the tension nut over the top of the projecting tube. Tighten the tension nut firmly against the packing.
5. If the tube is too short for the tension nut, the tube must be replaced. If the tube is too long for the tension nut, the tube must be cut and rethreaded. Either way, the pump must be reinstalled and leveled.
6. Install the lock plate and lock screw.

Driver and Coupling

Vertical Hollow Shaft

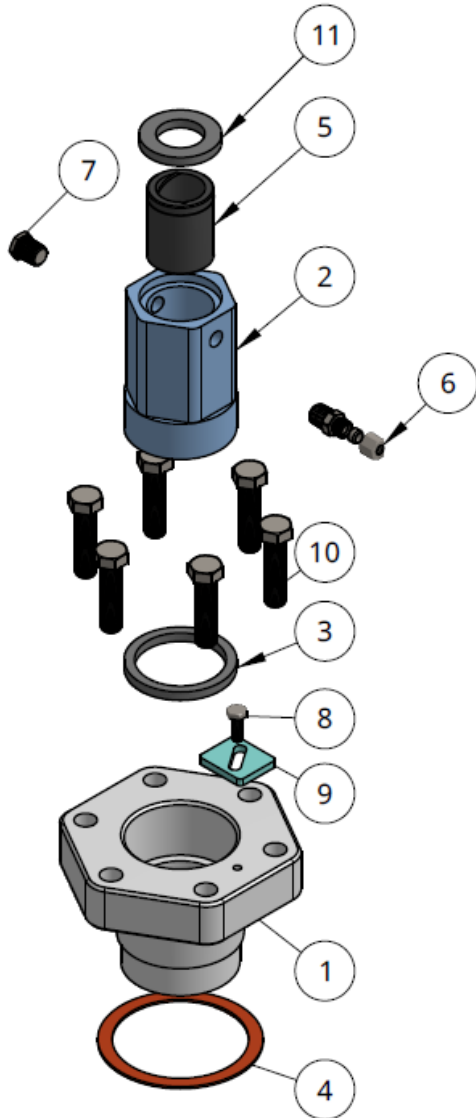


Figure 11 – Stretch Assembly

Item No.	Quantity	Description
1	1	Tension Plate
2	1	Tension Nut
3	1	Packing
4	1	Gasket
5	1	Bearing
6	1	Lubrication Connection
7	1	Plug
8	1	Lock Screw
9	1	Lock Plate
10	6	Capscrews
11	1	Bearing Retainer

1. Leave the motor on its skid and move it to a convenient location near the discharge head. Remove the top driver cover cap screws and cap. Ensure that no foreign objects or debris can enter the motor.
2. Remove the drive coupling and any other loose parts in the top of the motor.
3. Use the lifting trunnions on the motor to hoist it into position over the discharge head.
4. Lower the motor slowly until the bottom of the motor engages the discharge head register but leave the weight of the motor on the hoist.
5. Rotate the motor so that the junction box is in the desired position and the mounting holes are aligned with the discharge head.
6. Start the mounting cap screws by hand.
7. Slowly transfer the weight of the motor from the lifting equipment to the discharge head. Uniformly secure all cap screws.



WARNING Never use the motor trunnions to lift the entire pump assembly. Motor trunnions are only rated for the weight of the motor. The pump assembly must only be lifted by the lifting trunnions on the discharge head.

8. Note the motor power requirements on the nameplate and wire accordingly. Also note the type of thrust bearing supplied with the motor. If it is a spherical roller bearing, make sure that the motor is never brought to normal speed without a thrust load. Take extra caution when checking rotation of the motor with this type of bearing and only bump the switch.

If your motor does not have a spherical roller bearing, you may buzz start the motor to check rotation and observe free operation and balance. A buzz start is a quick on and then off start of the motor.

9. The motor must spin counterclockwise when viewed from the top. If rotation was observed as clockwise when viewed from the top, it is backwards. Disconnect power and interchange any two leads (for three-phase motors). Follow manufacturer's instructions for single phase motors.
10. Once rotation is correct, mark the motor terminals and leads. Make permanent power connections in accordance with all applicable electrical codes and regulations.
11. Loosen the cap screws securing the packing box or tensioner to the head.
12. Locate your headshaft and thoroughly clean the body, threads, keyway, and end faces. With the keyway up, slide the headshaft down through the top of the motor, taking care not to damage it. As the shaft exits the bottom of the motor, install the slinger ring to the bottom of the shaft (if supplied).
13. Screw the headshaft into the top shaft coupling (projecting from the stuffing box). If the top shaft coupling is inside the discharge head, lower the headshaft through the packing box/tensioner until it seats into the coupling. You may need to reach through the discharge opening and support the headshaft while you are seating the headshaft into the top coupling.
14. Tighten the coupling.
15. Check that the headshaft is centered in the motor quill shaft within 0.06". If it is not, there is misalignment from a bent headshaft, burrs, foreign material inside the shaft couplings, or a mating flange that is out of level (motor to discharge head, discharge head to base plate, or the baseplate itself). Do not proceed until the headshaft is centered within tolerance.
16. Tighten the packing box/tensioner cap screws to secure them to the discharge head.
17. Check that the drive key has a sliding fit in the head shaft and drive coupling keyways. The drive key can be dressed until a sliding fit is achieved. Do not file the keyways.
18. Install the drive coupling on it's register, making sure it is flat.
19. Install the drive key into the coupling and make sure the top of the key is below the adjusting nut seat.
20. Install the adjusting nut (LH threads). Tighten just until the shaft weight is fully captured by the nut. The impellers will have just lifted from the bottom of the bowls and the shaft should turn by hand. When the nut is slightly loosened, you should feel the impellers start to lightly drag on the bottom of the bowls. Note this break point on the adjusting nut/driver coupling.
21. Set the lateral as per factory recommendation.
22. Install the lock screw.
23. If your motor has a spherical bearing, skip this step. Otherwise, energize the pump starter and bump start the motor to tighten the shaft joints. If you are using an engine or other driver, follow the startup procedure and bring the pump just slightly up to speed and then release the power.
24. De-energize the pump starter and remove the adjusting nut lock screw. Loosen the adjusting nut to the break point and check if it has changed. Whether it has changed or not, punch mark the new or existing break free point for a permanent reference.
25. Re-set the lateral and re-install the lock screw.
26. Install the motor cap and check the motor lubricant levels. Refer to the motor manufacturer's recommendations for lubricant and/or coolant.
27. Do not re-energize the motor starter until all work has been performed and you are ready to operate the pump.

Vertical Solid Shaft

1. Place beams or blocks in a stable position on the discharge head to support the weight of the motor. The beams should provide adequate clearance between the motor shaft and the pump shaft.
2. Use the lifting trunnions on the motor to hoist it into position over the discharge head.



Never use the motor trunnions to lift the entire pump assembly. Motor trunnions are only rated for the weight of the motor. The pump assembly must only be lifted by the lifting trunnions on the discharge head.

3. Lower the motor slowly until the bottom of the motor rests on the beams or blocks and is stable.
4. Prepare to check shaft rotation. First secure the motor with chains or cable restraints to prevent reactive torque or twisting.
5. Note the motor power requirements on the nameplate and wire accordingly. Also note the type of thrust bearing supplied with the motor. If it is a spherical roller bearing, make sure that the motor is never brought to normal speed without a thrust load. Take extra caution when checking rotation of the motor with this type of bearing and only bump the switch.

If your motor does not have a spherical roller bearing, you may buzz start the motor to check rotation and observe free operation and balance. A buzz start is a quick on and then off start of the motor.

6. The motor must spin counterclockwise when viewed from the top. If rotation was observed as clockwise when viewed from the top, it is backwards. Disconnect power and interchange any two leads (for three-phase motors). Follow manufacturer's instructions for single phase motors.
7. Inspect the motor shaft for any damage. Clean the shaft and apply a very thin coat of oil.
8. Locate the shaft coupling parts and clean thoroughly.
9. Check that the drive shaft key has a sliding fit in the drive shaft and top half coupling keyways. The drive key can be dressed until a sliding fit is achieved. Do not file the keyways.
10. Check that the thrust collar has a sliding fit in the shaft groove.
11. Check that the driver half coupling has a sliding fit on the motor shaft.

12. While the motor still rests on the blocks, install the drive shaft key and driver half coupling (flange face down). Lift the driver half coupling above the motor shaft ring groove and assemble both halves of the thrust collar in the groove. Slide the driver half coupling back down until the thrust collar rests in the coupling recess. Install the setscrew and tighten securely.
13. For pumps with mechanical seals, you will typically have a spacer spool. If you have this spool, install it to the driver half coupling now. Only use the nuts and bolts provided as the assembly may have been balanced at the factory.
14. Clean the top shaft threads and apply a small amount of thread lubricant. Check all keys as described in steps 9-11.
15. Install the pump shaft key and pump half coupling (flange face up). Slide the pump half coupling down past the shaft threads. Install the adjusting nut (rimmed end up) until at least two threads protrude through the top. Remove the cap screws securing the packing box/tensioner.
16. Lift the motor slightly and remove the beams or blocks.
17. Lower the motor slowly until the bottom of the motor engages the discharge head register but leave the weight of the motor on the hoist.
18. Rotate the motor so that the junction box is in the desired position and the mounting holes are aligned with the discharge head.
19. Start the mounting cap screws by hand.
20. Slowly transfer the weight of the motor from the lifting equipment to the discharge head. Uniformly secure all cap screws.
21. Screw the adjusting nut clockwise until the space between the driver coupling flange and the top of the adjusting nut is equal to the required lateral setting shown in Table X.
22. Slide the pump coupling up and secure with the provided flange bolts and nuts. Machine oil may be used on the bolt threads.
23. Check shaft alignment by examining the outer edges of all flanges. All flange faces must be

even with no overlap at the circumference. Use a dial indicator on the motor and pump shafts to ensure that the alignment is within 0.003 inches T.I.R.

24. Torque all bolts to 500 in-lb. Check pump shaft key is flush with coupling and then tighten setscrew.
25. Re-install packing box/tensioner cap screws and tighten securely.

Lubrication

Oil-Lubricated

If your pump is oil-lubricated, install the reservoir and bracket onto the discharge head. Connect the ¼" copper tube from the reservoir to the stuffing box inlet. Fill the reservoir with the appropriate oil.

Water-Lubricated

Some pumps have a water pre-lube system to lubricate the bearings as the pump comes up to speed. If your pump has a water pre-lube, connect the tubing from the water reservoir to the pre-lube connection on the stuffing box.



CAUTION Never use tubing that is smaller in diameter than the connection on the stuffing box.

Make sure that the tubing does not freeze.

Water pre-lube should be set to run for 15 seconds plus 15 seconds per 100ft of column pipe *PRIOR* to pump start.

If the distance from the bottom of the discharge head to the water level is 100ft or greater, and your pump does not have a non-reverse ratchet, the pump must be lubricated at shutdown. This post-lubrication should continue until the shaft comes to rest. It is recommended to automate the post-lubrication with a "fail open" valve. In the event of power loss, the valve will open and lubricate the pump as it spins down. Note that a fail open valve in combination with a water tank may result in a drained tank. Precautions must be taken

to ensure that the pump cannot run or shut down without adequate pre/post lubrication. Ideally, the water supply will come from a pressurized source with constant supply.

Start-Up

Start-Up Checklist

- All instructions were followed in the preceding sections of this manual.
- All miscellaneous and auxiliary equipment has been installed properly.
- The motor or driver has been properly serviced according to its manufacturer instructions.
- If an air release valve is installed, make sure its isolation valve is open.
- Downstream valves are in the proper position.
 - If discharging into a pressurized pipe, install a check valve to prevent reverse flow during start-up.
 - If filling a pipe system or operating with low head at start-up, the discharge valve can remain partially closed to create back-pressure or "artificial head". The valve can be fully opened once the system has come up to pressure.
- Shaft stretch has been considered and calculated into the impeller setting.
- The system still matches the initial design. Changes to system design can alter the flow and pressure required, potentially causing damage to the pump.
- All lubricants have been applied/filled as necessary. Oil lubricated systems should have the reservoir open and lubricating 20 minutes prior to initial start-up for every 100ft of column. i.e. For 250ft of column, the system should lubricate for 50 minutes prior to initial startup. Ensure that the lubricator is adjusted for the flow rate shown in Table 2. For lubrication systems with a solenoid valve that cannot be activated, the valve stem must be

removed to allow oil to flow for initial lubrication.

- If equipped with a pressurized water pre-lube, the water should flow for 15 seconds plus 15 seconds per 100ft of column pipe immediately *PRIOR* to pump start.
- If equipped with a reservoir water pre-lube, allow water to flow from the reservoir to the pump until about half of the reservoir has drained immediately *PRIOR* to pump start.
- Water pre-lube valves should remain open during pump start unless pump discharge pressure will cause damage to the pre-lube system.

Manual water pre-lube systems can be turned off once the pump is at operating pressure.

Check that the motor or driver is operating according to the manufacturer’s recommendation.

Allow the pump to run until the water runs clear. Short On-Off cycles may cause a repeated intake of sand or debris that can clog the pump.

After the first pump shutdown, adjust the impellers to ensure that pump operation did not change the initial adjustment.

Table 2 – Lubrication Regulation (Drops Per Minute)

Shaft Size (in.)	Drops per Minute	Additional drops per minute per 100ft setting
0.75 – 1.1875	5	2
1.50 – 1.6875	7	3
1.9375 – 2.4375	10	4
2.6875 and larger	12	5

For oil-lubricated pumps, monitor the oil reservoir level and refill as necessary. Do not allow the pump to run with a dry oil reservoir.

For water-lubricated pumps with reservoir supply, monitor the water level and refill as necessary. Do not allow the pump to run with a dry reservoir.

Initial Start-Up

Once the checklist is complete, energize the motor starter.

Shutdown the pump immediately if any abnormal noises or vibration are observed.

Allow the pump to come up to speed and all the air to vent. Adjust any discharge valves as necessary.

Packing must leak in order to properly lubricate the shaft. During the first day of operation, adjust the stuffing box packing gland to allow a liberal amount of water to leak past the packing. After the first day of operation, gradually tighten the packing gland to reduce, but not stop, the leakage. **Leakage past the packing must never be stopped completely. This will overheat the packing and cause damage to the shaft.**

On pumps with packing, periodically check for adequate flow past the packing and adjust the packing gland only as required.

Grease the stuffing box one pump for every 24hrs of equipment run time. Over time, the packing will wear and compress. It may be possible to add up to two additional rings of packing before replacing the packing entirely. If it is difficult to adjust the packing gland after installing additional packing rings, discard all packing and replace.

Replacing the Packing

1. Remove all old packing, separation rings, and lantern ring. A packing hook can be used to remove the packing. A small piece of stiff wire can be used to hook the separation rings and lantern ring.

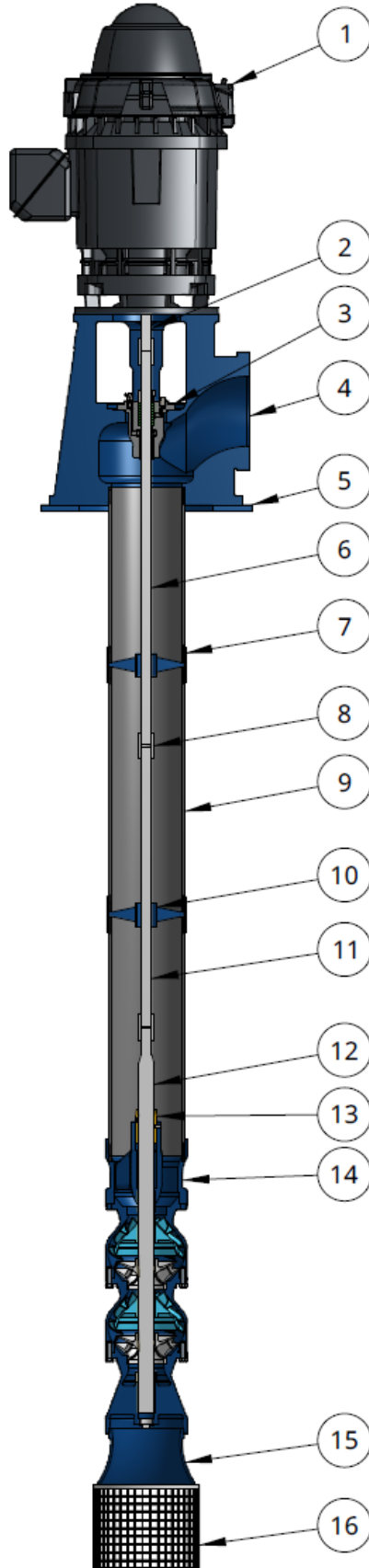
2. If necessary, use a mirror to view your work inside the stuffing box.
3. Place the separation rings and lantern ring in a safe place where they won't be lost or damaged.
4. Clean the stuffing box and check the shaft for scoring. If the shaft is scored, it may need replaced.
5. Install the new packing along with the existing separation rings and lantern ring. Use Figure 10 as a reference. Adjust the packing gland as described on this page under "Initial Start-Up".

Troubleshooting		
ISSUE	POSSIBLE CAUSE	SOLUTION
1. Pump will not start	A. Inadequate or incomplete electrical circuit	A. Check electrical circuit and make necessary corrections.
	B. Improper electrical connections	B. Check electrical connections and make necessary corrections.
	C. Impeller interference with bowls due to improper lateral adjustment	C. Repeat impeller adjustment.
	D. Motor defect	D. Consult motor supplier or factory.
2. Pump is not producing design flow	A. Pump rotation is backwards	A. Confirm rotation is backwards (rotation should be CCW when viewed from above) then swap any two motor leads (for a three phase motor).
	B. Actual system head is greater than design	B. Check system design calculations. Consult factory for additional stages / impeller diameter changes that may be available.
	C. Well level is below the lowest impeller	C. Increase pump length or raise the well level to ensure proper submergence.
	D. Inadequate Net Positive Suction Head Available (NPSHa)	D. Confirm NPSHa > NPSH required by the pump for design point. If there is inadequate NPSHa, consult factory.
	E. Blockage at pump inlet, strainer, impeller, or other pump component	E. Modify inlet design to keep fibrous material and solids away from the pump inlet.
	F. Broken or disconnected pump shaft	F. Remove pump and repair all damaged or disconnected components
	G. Discharge valve partially closed	G. Adjust discharge valve as necessary for design condition.
	H. Pump speed is too low	H. If motor is across-the-line, check that the motor is receiving full voltage. If motor is using a variable frequency drive, adjust speed as necessary to achieve design speed.
	I. Damaged or worn bowl assembly components	I. Remove pump and repair/replace all damaged components. Consult factory for required parts.
	J. Improper impeller diameter	J. Consult factory for required parts. Remove pump and replace impeller(s).
	K. Entrained air	K. Check for vortexing in the well and install vortex breakers as required. Check that minimum submergence is met.

3. <i>Pump is not producing design head / pressure</i>	Follow possible causes and solutions found in Issue 2	
4. <i>Pump is not producing any flow</i>	Follow possible causes and solutions found in Issue 2: A-J	
5. <i>Pump only operates for a short period</i>	A. Undersized motor	A. Increase motor to larger HP. Consult factory.
	B. Blockage of pump suction	B. Remove pump and clear strainer / well as required.
	C. Excess well level drawdown	C. Check well level and adjust pump length as required.
	D. Air lock	D. Check for vortexing in the well and install vortex breakers as required. Check that minimum submergence is met. Install air release valves on discharge as required.
	E. Misalignment	E. Remove pump and check bearings and impellers for damage. Misalignment can cause the shaft to drag.
6. <i>Excessive pump noise</i>	A. Cavitation	A. See Issue 2:D
	B. Bent shaft	B. Straighten or replace as required.
	C. Worn bearings	C. Replace as necessary
	D. Resonant vibration	D. Relieve any piping strain from the discharge and consult factory
	E. Impeller interference with bowls	E. Remove pump and inspect impellers for damage. Replace as necessary and readjust.
7. <i>Excessive bearing noise</i>	A. Contamination of the bearing by foreign material	A. Clean the outside of the bearing housings and carefully remove bearings. Use solvent and flushing oil to clean the bearings. Clean inside the bearing housings. Check all oil seals and replace as necessary. Reinstall cleaned or new bearings.
	B. Damage to the bearing from shock during installation. This damage will typically present as indentations in the ball races.	B. Remove and replace the damaged bearing. Do not shock bearing during installation, instead provide even pressure against the inner bearing ring.
	C. Damage to the bearing from vibration. This damage will typically present as multiple indentations along the ball races from the bearing balls chattering.	C. Identify and correct the vibration. Remove and replace the damaged bearing. Follow long term storage guidelines in this manual to prevent bearing seize during startup that could result in this type of damage.

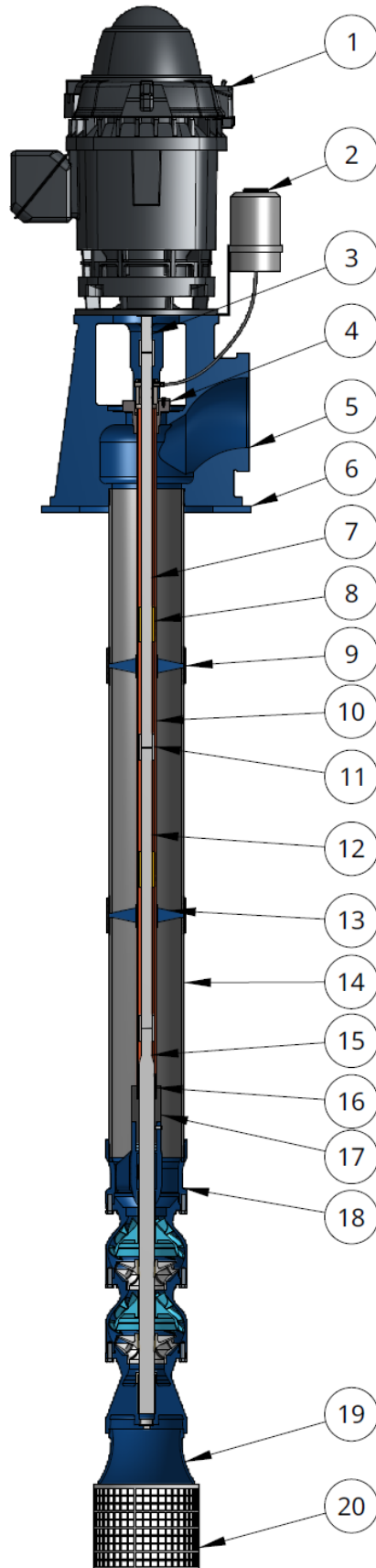
	D. Damage to the bearing from excess thrust loads. This damage will typically present as metal shavings inside the bearing race or a fractured bearing.	D. Remove and replace damaged bearings. This damage typically occurs from misaligned bearing faces. Take care to properly install bearings.
	E. Damage to the bearing from shaft voltages. Variable Frequency Drives can induce electrical voltage along the shafting. This damage typically presents as pitting of the bearing rings.	E. Use a grounding ring to mitigate shaft voltages.
	F. Damage to the bearing from improper lubrication. This damage typically presents as a discoloration of the bearing races with rigid, cracked grease.	F. Ensure that the bearings are always provided with clean lubricant in sufficient quantity.
8. Excessive leak at stuffing box	A. Worn packing	A. Remove worn packing and replace.
	B. Incorrect packing type	B. Remove incorrect packing and replace.
9. Excessive temperature at stuffing box	A. Packing is too tight	A. See packing adjustment instructions provided in this manual. Packing must be able to leak in order to maintain adequate lubrication.
	B. Improper packing lubrication	B. Replace damaged packing and re-grease as required.
	C. Incorrect packing type	C. Remove incorrect packing and replace.
	D. Improper packing of stuffing box	D. Remove packing and replace.
10. Excessive packing wear	A. Follow possible causes and solutions found in Issue 9	
	B. Worn shaft or shaft sleeve	B. Replace shaft and/or shaft sleeve.

Typical Pump Assembly Layout – Open Lineshaft



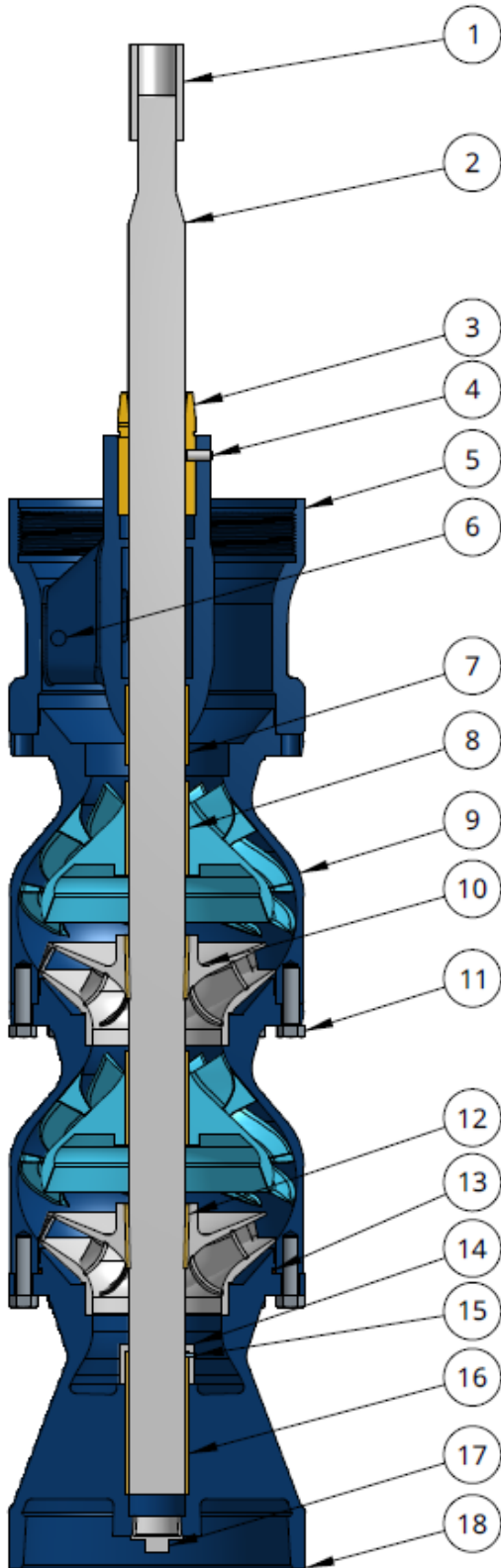
Item No.	Description
1	Vertical Hollowshaft Motor
2	Headshaft
3	Stuffing Box Assembly
4	Discharge Head
5	Foundation Plate
6	Lineshaft - Top
7	Column Coupling
8	Shaft Coupling
9	Column Pipe
10	Spider
11	Lineshaft - Intermediate
12	Bowl Shaft
13	Bearing - Discharge Case Upper
14	Bowl Assembly
15	Suction Bell
16	Strainer

Typical Pump Assembly Layout – Enclosed Lineshaft



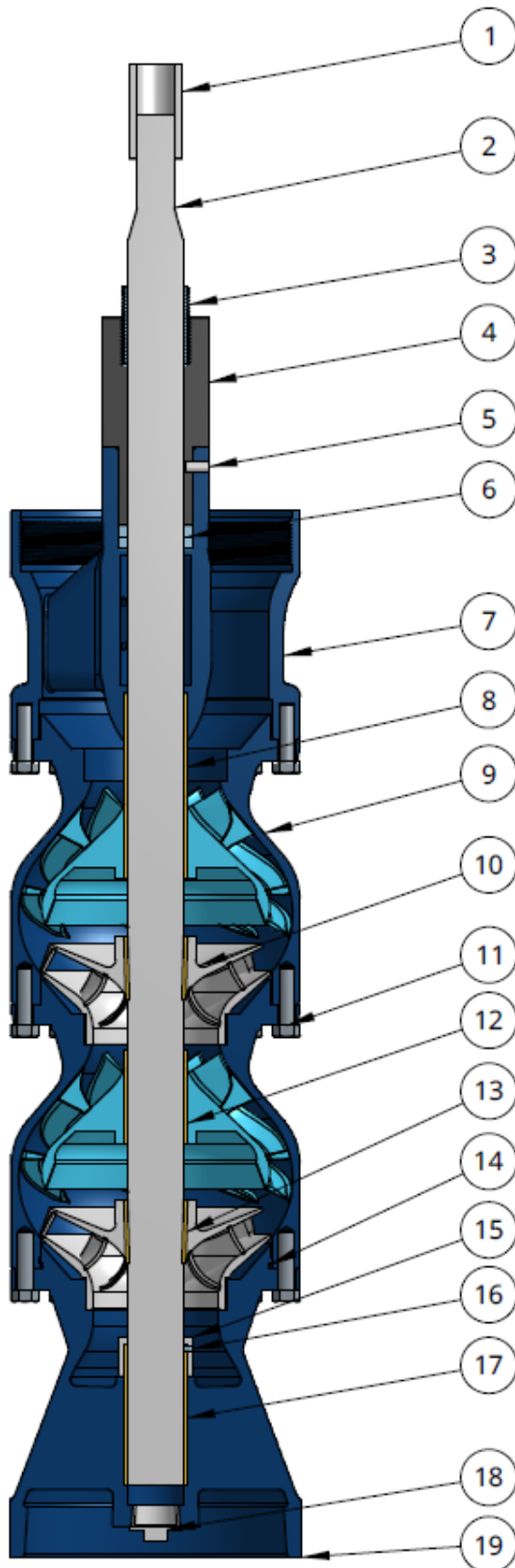
Item No.	Description
1	Vertical Hollowshaft Motor
2	Oil Reservoir
3	Headshaft
4	Oil Tensioner Assembly
5	Discharge Head
6	Foundation Plate
7	Lineshaft - Top
8	Lineshaft Bearing
9	Column Coupling
10	Oil Tube
11	Shaft Coupling
12	Lineshaft - Intermediate
13	Spider
14	Column Pipe
15	Bowl Shaft
16	Bearing - Lineshaft
17	Inner Column Adapter
18	Bowl Assembly
19	Suction Bell
20	Strainer

Typical Bowl Assembly Layout – Open Lineshaft

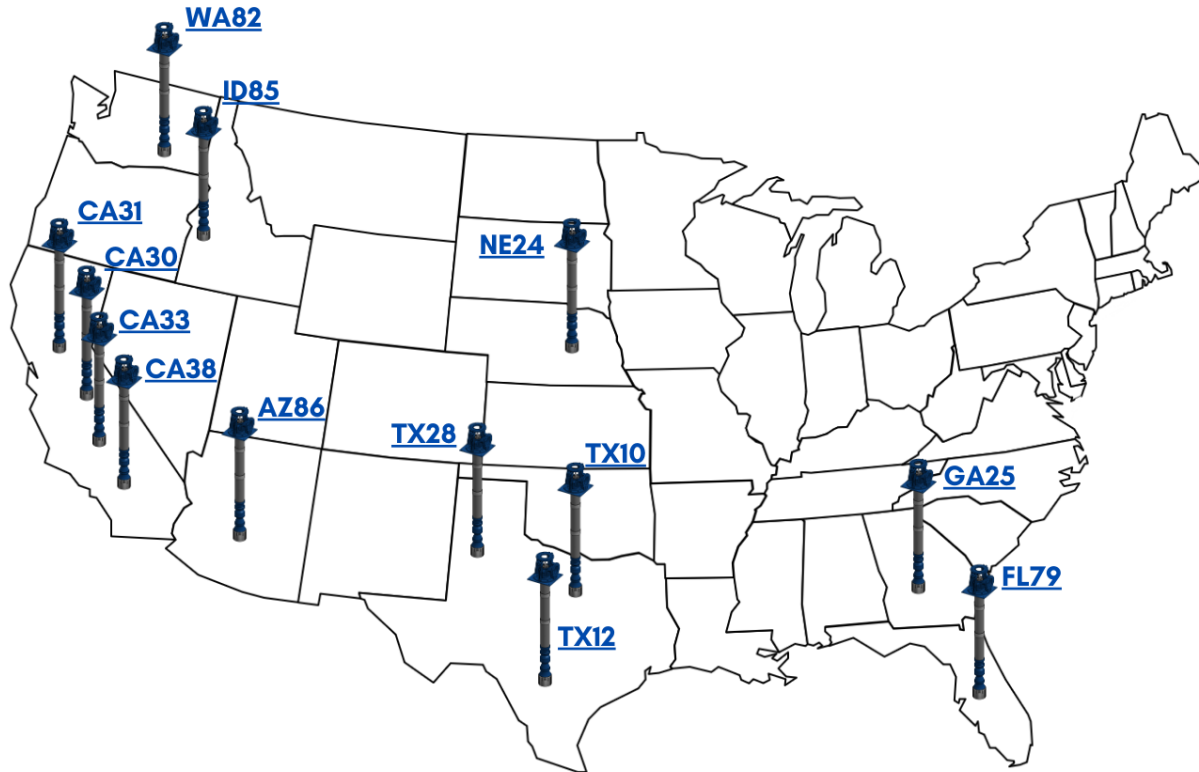


Item No.	Description
1	Lineshaft Coupling
2	Bowl Shaft
3	Bearing - Discharge Case Upper
4	Set Screw - Discharge Case
5	Discharge Case
6	Plug - Discharge Case
7	Bearing - Discharge Case Lower
8	Bearing - Bowl
9	Bowl
10	Impeller - Enclosed or Semi Open
11	Capscrew
12	Collet
13	O-Ring
14	Sand Cap
15	Set Screw - Sand Cap
16	Bearing - Suction Case
17	Plug - Suction Case
18	Suction Case

Typical Bowl Assembly Layout – Enclosed Lineshaft



Item No.	Description
1	Lineshaft Coupling
2	Bowl Shaft
3	Bearing - Lineshaft
4	Inner Column Adapter
5	Set Screw - Discharge Case
6	Lip Seal
7	Discharge Case
8	Bearing - Discharge Case
9	Bowl
10	Impeller - Enclosed or Semi Open
11	Capscrew
12	Bearing - Bowl
13	Collet
14	O-Ring
15	Sand Cap
16	Set Screw - Sand Cap
17	Bearing - Suction Case
18	Plug - Suction Case
19	Suction Case



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jpiasecki@preferredpump.com

Branch CA38
 410 Business Center Ct.
 Redlands, CA 92373
 909-793-2336
 909-793-6125 (Fax)
Main Contact: Jose Rojas - Manager
jrojas@preferredpump.com

Branch TX10
 5140 SE Loop 820
 Ft. Worth, TX 76140
 817-483-9700
 817-483-9463 (Fax)
Main Contact Paul Lund - Manager
plund@preferredpump.com

Branch CA31
 4631 Beloit Drive
 Sacramento, CA 95838
 916-921-2154
 916-921-2523 (Fax)
Main Contact: Floyd Nelms - Manager
fnelms@preferredpump.com

Branch FL79
 3939 Progress Dr.
 Lakeland, FL 33811
 863-607-4200
 863-607-4250 (Fax)
Main Contact: Dean Wallace - Manager
dwallace@preferredpump.com

Branch TX12
 13660 Old FM 471 W
 San Antonio, TX 78253
 210-688-9301
 210-688-0581 (Fax)
Main Contact: Jim Hopkins - Regional
jhopkins@preferredpump.com

Branch CA30
 4510 S. Maple Ave.
 Fresno, CA 93725
 559-268-1928
 559-268-1909 (Fax)
Main Contact: Dennis Quindt - Manager
dquindt@preferredpump.com

Branch GA25
 920 Old Cordele Rd.
 Vienna, GA 31092
 229-268-7000
 229-268-8352 (Fax)
Main Contact: Sheila Cape - Manager
scape@preferredpump.com

Branch TX28
 524 32nd St.
 Lubbock, TX 79404
 806-762-1196
 806-762-6544 (Fax)
Main Contact: Tommy Ford - Manager
tford@preferredpump.com

Branch CA33
 5311 Woodmere Dr.
 Bakersfield, CA 93313
 661-832-6975
 661-832-7768 (Fax)
Main Contact: Butch Dunham - Manager
bdunham@preferredpump.com

Branch ID85
 4003 Skyway Street
 Caldwell, ID 83605
 833-383-6917
 208-454-2653(Fax)
Main Contact: Seth Sheets - Manager
sheets@preferredpump.com

Branch WA82
 2305 N. Capitol Ave.
 Pasco, WA 99301
 509-543-7241
 509-542-9036 (Fax)
Main Contact: Cesar Jimenez - Manager
cjimenez@preferredpump.com

Branch NE24
 4808 Gold Core Road
 Grand Island, NE 68801
 308-384-4713
 308-384-2065 (Fax)
Main Contact: Victor Silva - Manager
vsilva@preferredpump.com