INSTALLATION, OPERATION AND MAINTENANCE MANUAL

FOR

VERTICAL TURBINE
PUMPS

www.flowmoregroup.com
Dear Customer,

Congratulations and thank you for becoming a proud owner of a "FLOWMORE" Pump. We have a strong belief in satisfaction of our Valued Customers and your repeat purchases from us will reaffirm your confidence in FLOWMORE.

This is a new set of instructions for the Installation, Operation and Maintenance of Vertical Turbine Pumps manufactured by us and these instructions supersede the previous issue. In this new version, we have tried to cover majority of the technical details, procedures and work instructions pertaining to satisfactory and technically sound practice for Installation, Operation & Maintenance of our pumps. However, if you need any further technical assistance in a specific situation, we will be happy to provide the requisite feedback and make you comfortable in the event of such occurrence. Our team of highly experienced and technically competent field staff constantly endeavors to minimize the equipment down time and to ensure longer trouble free operation of the equipment supplied by us.

We again wish to convey our sincere thanks for your purchase and hope to receive your valuable feedback and suggestions for improvements of our products and services.

With Best Wishes,

Flowmore Limited
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1. **INTRODUCTION:**

"FLOWMORE" VERTICAL TURBINE PUMPS are designed to operate in a vertical configuration with the main pumping element, THE BOWL ASSEMBLY, submerged deep into water. The main advantages of a Vertical Pump over a Horizontal Pump are, lesser floor space requirement, absence of cumbersome piping and associated fittings; uniform distribution of radial forces because of 360° diffusion; absence of radial loads on shaft bearings due to vertically suspended configuration, hanging from the top. The Impeller design ranges from Francis to Mixed Flow Type based on different head and capacity requirements. These pumps can be supplied in single stage or multi stage construction for varying discharge head requirements. Owing to simplicity of operation and minimal mechanical friction, these pumps normally operate at high level of hydraulic efficiency.

"FLOWMORE" Vertical Turbine Pumps, when properly installed and operated with reasonable timely care and maintenance, will operate satisfactorily for a long period of service. Subsequent paragraphs explain the general principles which should be followed to ensure trouble free operation of the supplied unit.

Additional information for special pump designs/applications and situations which are not covered in this manual, can be furnished on request for specific requirements. While seeking technical information for such cases, make sure that correct information about Pump Serial No., Pump Figure and Size is furnished and these inputs can be easily taken from the name plate of the pump.

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2. **SAFETY INSTRUCTIONS:**

Centrifugal Pumps manufactured and supplied by Flowmore Limited are designed with Safety for Men and Material in mind. Where hazards cannot be eliminated, the risks are to be minimized by the use of guards and other design features. In case any of the hazards cannot be guarded, the Personnel involved must take full responsibility to use safe working practices as per prevalent Industry norms governed by the law of the land.

2.1. **SAFETY SYMBOLS AND EXPLANATIONS:**

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>LEGEND</th>
<th>EXPLANATION</th>
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<tbody>
<tr>
<td>⚠️</td>
<td>CAUTION</td>
<td>A hazardous situation that <em>may cause</em> minor or moderate injury, if not avoided.</td>
</tr>
<tr>
<td>⚠️</td>
<td>WARNING</td>
<td>A hazardous situation that <em>may cause</em> serious personal injury or even death, if adequate care is not taken.</td>
</tr>
<tr>
<td>⚠️</td>
<td>DANGER</td>
<td>A hazardous situation that <em>will cause</em> death or serious injury, if cautions are ignored.</td>
</tr>
<tr>
<td>⚠️⚡</td>
<td>ELECTRICAL HAZARD</td>
<td>There may be a possible risk of electricity related hazards, if precautionary measures are not followed properly.</td>
</tr>
</tbody>
</table>
2.2. SAFETY PRECAUTIONS:

<table>
<thead>
<tr>
<th>GENERAL PRECAUTIONS</th>
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</thead>
<tbody>
<tr>
<td><strong>CAUTION</strong></td>
</tr>
<tr>
<td>Read this manual carefully before installing and using the Pump Unit. Improper installation and unintended use of the pump can cause personal injury and damage to property, and may void the warranties.</td>
</tr>
<tr>
<td>If the agreed conditions of service are proposed to be changed, user must seek FLOWMORE’s written approval before start-up of the pump.</td>
</tr>
</tbody>
</table>

| **WARNING** |
| Use fasteners of the designated size and property grade to avoid any catastrophic failure of items during normal pump operation. |
| Clear and easy access to all controls, gauges and dials etc. must be maintained at all times. |
| Hazardous or flammable materials must be stored in safe areas or racks and in pilfer proof and spill proof containers. |
| Do not wear loose or frayed clothing or jewellery that could catch on the controls/knobs/handles or trapped in rotating equipment. |

| **DANGER** |
| Please do not operate the pump without coupling guard and other safety precautions. |
| Following personal protective equipment should be used as a minimum requisite, while working on the pump, |
| • Hand gloves |
| • Safety glasses |
| • Safety shoes |
| • Helmets |
| • Ear Plugs |
| Due care should be taken during hoisting and placement of heavy equipment. |

| **ELECTRICAL HAZARD** |
| All electrical connections are properly insulated and covered. |
| Before beginning any alignment procedure, please ensure driver power is disconnected from the source of power supply. |

3. STORAGE:

3.1. INSPECTION OF PACKAGES/EQUIPMENT:

i. Please inspect the physical condition of the packages/items immediately on receipt. In case the packing cases are found damaged the same should be opened in presence of the transporter’s representative.

ii. Inspect all the items for any physical damage/short supply as per the packing list. As a visual check, the main things to be looked for are; 
   a. Broken or cracked flanges of bowl assembly and discharge head 
   b. Broken or cracked base and discharge flange of surface discharge head 
   c. Bent or damaged pump and line shafts 
   d. For drive motor, check for the broken fan cover/shield, bent eye bolts, broken or cracked mounting flange and damaged terminal box.

iii. In case of any mismatch in Quantity/Quality of items received, take immediate steps to inform the nearest FLOWMORE representative, Transport Company responsible for delivery of the equipment and Insurance Company.

iv. In case the supplied equipment is to be used at a later date, please ensure proper storage of the items as described in the following paragraphs entitled “STORAGE REQUIREMENTS”.

Installation, Operational and Maintenance Manual
Document No.: 015-00-23E14-SC-RD
3.2. STORAGE REQUIREMENTS:
Storage requirements vary depending on the length of storage, the climatic conditions and the equipment. For storage periods of three months or longer, contact FLOWMORE for specific instructions. Improper storage may lead to invalid warranties.
Consider a unit in STORAGE when:
   a) It has been delivered to the job site and is awaiting installation.
   b) It has been installed but operation is delayed due to incomplete plant construction.
   c) There is long, 30 days or more, period between operation cycles.
   d) The plant or department is under shut down.

Following instructions should be followed to avoid any damage to the pump components under storage.

<table>
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<th>Condition</th>
<th>Requirements</th>
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<td>Indoor storage</td>
<td>FLOWMORE suggests that the storage area should be clean, dry and well ventilated with platforms/pallets for stacking of the pump components.</td>
</tr>
<tr>
<td>Outdoor storage</td>
<td>In this case, apart from the conditions as stated for indoor storage, components must be covered from all sides with weather proof black PVC/Plastic sheets or tarpaulins. Ingress of dust must be prevented to enter the covered areas to protect the stored items from the effect of corrosion.</td>
</tr>
<tr>
<td>Uncovered storage facilities such as uneven temperatures, higher humidity, and/or dusty conditions</td>
<td>Check and clean the pump/components periodically to ensure that the pump is free to rotate by hand and that all components are free from dust, rust and corrosion.</td>
</tr>
</tbody>
</table>
| Pump Rotation                                 | Rotate the pump shaft several rotations by hand every fortnight (two weeks). This will ensure  
                                                 1. Adequate coating of bearings with lubricant 
                                                 2. Retarding of oxidation/corrosion 
                                                 3. Prevention of possible false brinelling |
| Oil Lubricated Thrust Stand Assembly          | Make sure that the thrust bearing assembly is stored horizontally and the bearing housing is filled with suitable grade of lubricating oil upto the level marked on the oil level indicator. Ensure periodic rotation of thrust hub by hand as above. |

3.3. LONG TERM STORAGE:
Ensure that any rust prone surface is coated either with anti rust oil or a thin layer of grease. Actual condition of surface finish should be checked from time to time and requisite preventive measures taken to ensure due care of the delivered item/s. In addition, nearest FLOWMORE representative should be consulted for any specific instructions/guidelines for long term storage.
4. GENERAL APPLICATIONS

Vertical line shaft turbine pumps are designed to pump water when installed in either a deep well or an open sump. These pumps are ideally suited for applications like water supply, booster service, cooling tower, dewatering, irrigation and fire service to name a few.

5. BRIEF DESCRIPTION OF VERTICAL TURBINE PUMPS:
A Vertical Turbine Pump consists of five basic elements, namely, Pump Bowl Assembly, Column Pipe Assembly, Line Shafting, Surface Discharge Head and the Driver. Brief details on these elements are given below:

i. PUMP BOWL ASSEMBLY:
Bowl assembly of a vertical turbine pump is the main pumping element. The number of stages or pump bowls in an assembly is determined by the head requirements of individual installation. A typical single stage pump bowl assembly is made up of a suction case or bell, an impeller (enclosed or semi open type), a top intermediate bowl and a discharge case. Impellers are connected to the pump shaft by split cone shaped impeller lock collets or by key. The suction case/bell serves as the intake of pump bowl assembly. Liquid is moved by the impeller through the pump bowls. The top inter bowl acts as a diffuser and guides the flow into the discharge case which, in turn, gets delivered into the column pipe. For units of two or more stages, an intermediate bowl and an impeller are added for each additional stage. Every inter bowl acts as an inter stage diffuser and directs the fluid vertically to the next stage impeller. Pump shaft bearings are located in the Suction bell, top inter bowl/ discharge case, and in each inter bowl (for multi stage pumps) between stage impellers. Basic design features of a bowl assembly differ for different types of shaft lubrication arrangement, i.e., self water lubrication or oil lubrication. Typical construction arrangements for the two types are shown in figures 1 & 2 located at the end of manual.

ii. COLUMN PIPE ASSEMBLY:
The column pipe assembly conveys water from bowl assembly, located deep in the well or sump, to discharge head at ground level. Column pipe may either be threaded or flanged, depending upon pump figure, size or customers requirements. A threaded column features straight threads on both the column and column couplings. Straight threads for these components have been selected to ensure that the column ends of adjacent pipes butt solidly against each other.

Flanged column pipes have male and female spigots to ensure proper alignment of the two adjacent lengths of column pipes. The flanged column pipes are bolted together with a gasket between the flanges so that any possibility of leakage is eliminated.

iii. LINE SHAFTING:
A vertical turbine pump's line shaft assembly rotates inside the column pipe and transmits torque from the pump driver to the bowl pump assembly. Both ends are precision machined, threaded and two adjacent lengths are secured together with threaded couplings. A lead washer is inserted between the two shaft ends to facilitate dismantling the joint when necessary. This shafting is supported by bearings at specific intervals. The types of bearings used and how they are lubricated are described below:

- **OPEN LINE SHAFT:** The open line shaft design is such that the line shaft and bearings are exposed to the liquid being pumped. The line shaft is supported at intervals of not more than 3m by rubber bearings and these rubber bearings run on Stainless Steel shaft sleeves and get lubricated by the water being pumped. Provision of shaft sleeves protects the shaft from undue damage. Support for these bearings is supplied by bearing retainers. The outer hub of the retainer is seated between the two column ends. Refer Fig 3.

- **ENCLOSED LINE SHAFT- BRONZE BEARINGS:** In the enclosed line shaft design, the shafting is surrounded by tubing. This tubing protects both the shaft and shaft bearings form the pumped liquid and provides a channel for lubricating the shaft bearings. The bearings in this design are of bronze with grooves on the I.D. to allow
lubricating oil to flow from one bearing to the next. These bearings are also threaded on the outside diameter and are used to connect the 1.5m enclosing tube sections. Lubrication for this style is normally oil and is supplied by a solenoid oiler mounted on the Surface Discharge head. Intermediate tubes are supported by rubber spiders to reduce the risk of vibrations. Refer Fig 4.

iv. **SURFACE DISCHARGE HEADS:**
Surface Discharge heads perform multiple functions. Firstly, they provide a base from which the pump is suspended. Secondly, they direct the fluid flow from the pump column to piping system of the client; next, they provide a method for sealing the line shaft or enclosing tube.

v. **DRIVER:**
   a) A three phase induction motor is the most extensively used driver for vertical pumps. They are available in the following two designs:
      - **HOLLOW SHAFT DESIGN** – In this design the drive shaft of the motor is a hollow cylindrical shaft through which the pump top shaft passes right upto the top of motor. The driver and driven shafts are coupled together through a gib key. The drive motor is provided with a thrust bearing of ample capacity to cater to its own thrust load together with the thrust generated by the pump. Impeller adjusting nut sits on top of the motor coupling bush. Refer Fig 5 & 6
      - **SOLID SHAFT DESIGN** – Unlike the above design, the drive shaft of the motor is made of solid round bar. The shaft projects below the driver’s mounting base and is coupled to the pump top shaft through a flexible coupling. In addition, a separate thrust bearing has to be provided in the pump design to absorb the thrust generated by the pump during normal operation. The impeller adjusting nut is positioned between the two flanges of flexible coupling. Ref Fig 6(a) & 6(b)

6. **INSTALLATION:**

**MUST READ THIS SECTION CAREFULLY**

It is recommended that the services of a competent and experienced erection/commissioning engineer should be employed for installation and commissioning of the equipment. However any experienced contractor can install this equipment if the recommendations and instructions described herein are strictly adhered to. This section contains descriptions and instructions which are the results of carefully conducted engineering and research efforts. It is designed for the safe and efficient maintenance of FLOWMORE Vertical Pumps. Failure or neglect to properly operate or maintain your pump may result in personal injury, property damage to the pump.

6.1. **ESSENTIAL TOOLS AND EQUIPMENTS:**
Following is the list of tools and equipments which are needed for dismantling, re-assembly and erection work under maintenance of pumps:

- **OVERHEAD CRANE:** - The crane should be of ample capacity to handle the loads indicated in the G.A. drawing. There should be minimum clear height between the foundation and the top most position of the crane hook as indicated in the G.A. drawing supplied against the order. This will facilitate easy erection.
- Chain and wire rope slings with lifting hooks of adequate capacity.
- Straight edge of adequate length.
- Spirit level having an accuracy of 0.02 mm/m.
- V-Blocks and dial gauge with magnetic stand to check run out of shafts.
- Special column and tube clamps required for erection of vertical pumps are supplied with the pump.
- Collet driver to assist in dismantling and reassembly of the bowl assembly
- Shaft locating tool
- Jute ropes, crowbars and small pipes for leverage.
- Two sets of standard double ended D and Ring spanners.
- Adjustable slide wrench and screwdrivers, in 300 mm (12”) and 150 mm (6”) sizes.
- Set of pipe and chain wrenches.
- Two sets of standard double ended D and Ring spanners.
- Adjustable slide wrench and screwdrivers, in 300 mm (12”) and 150 mm (6”) sizes.
- Set of pipe and chain wrenches.
- Sets of taps and dies up to 25mm (1”).
- Chisel, machinist hammer, hand hacksaw, fitter’s vice etc
- Files: triangular, half-round and flat of different cuts and sizes
- Triangular scrapper
- Set of feeler gauges
- Small wire brush for cleaning threads of shafts and coupling
- Kerosene or thinner for cleaning of parts
- Threading compound
- Steel rule and measuring tape
- Emery paper, grease gun, thin roll of sheets of 0.03 to 0.05mm thickness for shims
- Adequate quantity of Lubricants as per designated make and grade

6.2. FOUNDATION:

The foundation for the pump should be sufficiently substantial to absorb any vibration and to form permanent rigid support. Foundation bolts of proper size should be located and embedded in the concrete as per the Approved General Arrangement Drawing or a template to match the drawing dimensions. Foundation pipe sleeves of diameter about 2.5 times larger than the foundation bolt, should preferably be used to allow final positioning, wherever required for higher pump sizes. It is recommended that the top of the foundation be finished reasonably smooth and the height be made 30 mm to 40 mm less than the desired finish level to allow for grouting.

Sole plate is an important item of the pump assembly which provides an interface between SD Head/Base plate and the Foundation. Proper grouting of sole plate over the foundation provides a leveled surface to mount the pump assembly and it ensures trouble free operation of the vertical pump. Normally Sole plate is supplied to the site duly blue matched and assembled with the SD head. However, it is a good practice to re-check its straightness before grouting. Ensure that bottom surface of the sole plate is clean. It is desirable that this surface may be painted with an anti corrosive paint. Remove the rust preventive from the sides of sole plate to ensure proper bonding of the grout.

When the pump is to be mounted over a pit on structural steel frame work, it should be located as close to the main structure as possible. Cross members should be used to prevent distortion and vibration of the structural mounting frame.

6.3. GROUTING:

i. Clean all the areas of the sole plate and the semi finished foundation top that will come into contact with the grout.
ii. Build a dam around the foundation.
iii. Lower the sole plate over the foundation taking care that the foundation bolts project out of the foundation holes of the sole plate.
iv. Using wedges placed close to foundation bolts and a spirit level, adjust the top of sole plate to make it uniformly horizontal in two perpendicular directions. Tighten the foundation nuts by hand to maintain the level.
v. Thoroughly wet the foundation that will come into contact with the grout using rich cement slurry.
vi. Pour the grout, a good quality Non Shrink Grout Mixture, through the grout hole into the gap between sole plate and semi finished foundation top. Adequate care should be taken, while pouring the grout, to avoid formation of air bubbles. This can be achieved either by stirring of the grout by a vibrator or directly pumping of the grout into place. Ensure that sole plate top level remains undisturbed.
vii. Allow the grout to set for at least 48 hours before full tightening of the foundation bolts.
6.4. WELL OR PIT INSPECTION:
Before installation, the well or pit must be cleaned of all loose material and debris and ensure that the dimensions of well or pit are as per approved General Arrangement Drawing.

6.5. INSTALLING PUMPING UNIT INTO THE WELL/ SUMP:
Upon receipt of the equipment at site, unpack and inspect all parts and assemblies carefully. During this inspection, all parts should be thoroughly cleaned and any burrs removed by filing. The pump bowl assembly, including the pump/line shaft coupling, is normally shipped completely assembled. Both the suction and discharge openings should be inspected for damage and for intrusion of foreign materials. The pump shaft should rotate freely by hand and should be moved in and out to check for end play. Place all parts in an orderly arrangement for convenient assembly. Lay out the bowl assembly, column pipes and line shafts over suitable wooden logs/ pallets with the coupling ends towards the well.

6.5.1. SUCTION PIPE AND STRAINER
i. If a suction pipe and strainer are to be used, thread the strainer into the strainer pipe coupling. Tighten a pipe clamp near the top end of this sub assembly.
ii. Lift the suction pipe assembly over the well and lower this assembly until the pipe clamp is resting on the foundation. Clean and lubricate the exposed threads.

6.5.2. BOWL ASSEMBLY

NOTE: Before proceeding, measure and record the bowl assembly end play.

CAUTION: The vertical turbine pump bowl assembly may be shipped with two pipe plugs threaded into the discharge bowl. If this is an enclosed line shaft installation these pipe plugs must be removed. Failure to remove the plugs will cause water to enter the enclosing tube and leak out at the discharge head. Bearing failure may result.

i. Attach a pipe clamp to the upper portion of the bowl assembly and carefully lift the assembly over the opening.

CAUTION: Careless handling and bumping may distort or break the bowl assembly. At this point, if a suction pipe is used, thread the bowl assembly over the suction pipe. Tighten the assembly with a strap or chain wrench. Remove the suction pipe clamp.

ii. Lower the assembly until the pipe clamp is resting on the foundation.
iii. Clean and lubricate the discharge head, column, enclosing tube and shaft coupling threads

6.5.3. COLUMN AND SHAFTING
Prior to dispatch from the factory, all shaft lengths are straightened within a maximum run out of 0.125mm for lengths upto 3000mm. It is advisable to recheck straightness of the shafts after decrating and before installation at site. Adequate care must be taken to ensure that straightness of shaft lengths is not disturbed during handling/ Installation.
a. **MAKING UP OF SHAFT-COUPLING JOINTS**

Examine and clean all threads carefully. Apply a thin film of light machine oil to the threads. Wipe off excess lubricant after making up shaft joints. Screw a coupling onto a shaft by hand, making sure the coupling is half way on the shaft. Forcing threads may cause misalignment of the coupled shaft.

Screw the mating shaft into the shaft coupling by hand. Wrenches should not be needed except for the last small fraction of a turn to make the joint rigid. Again, if force is required, look for damaged or dirty threads because forcing of threads may cause Misalignment. Make the joint rigid by turning the upper shaft into the coupling. Two wrenches are required, one on the coupling and one of the upper shaft. Make sure that the shaft ends are solidly butted together but do not use undue force in tightening.

**NOTE:** It is recommended that a thin lead washer be inserted between the two shaft ends to facilitate dismantling of joints as and when necessary.

Remove any burrs left by wrenches after tightening shaft joint. **Do not allow metal filings to drop into pump, tube or bearings.**

**A. COLUMN WITH ENCLOSED LINE SHAFT- BRONZE BEARINGS :**

a. When the line shaft is smaller than the basic pump shaft size, the pump shaft is turned down so that standard straight shaft coupling between pump and line shaft can be used. This combination may not require the first 1.5 mtr. section of enclosing tube to be oversized. In this case, a stepped connector bearing is threaded into this tube which will accept the standard size tube.

b. When the line shaft is larger than the basic pump shaft a stepped shaft coupling is required. A stepped tube connector bearing may also be required. Both of these special parts will be assembled on the pump bowl assembly.

c. Remove the end plugs from the ends of the assembled tube shaft assembly. Slide the shaft out of the tube about one foot. Insert this assembly into the first column section leaving about one foot of tube and two feet of shaft extending out of the column end that does not have the column coupling.

d. Using a rope, make two half hitches around the line shaft, two around the tube, and two half hitches around the column.

e. Position a column clamp just below the column coupling /flange as the case may be

**NOTE:** Be sure the column clamps have a smooth square surface for the column coupling/ flange to rest on. An irregular surface may cause coupling/ flange distortion.

f. With soft skid boards under the column to protect the threads, slowly lift the column, tube, and shaft assembly. Position this assembly and lower it until the shaft ends can be coupled together.

g. Make the shaft and coupling joint as per instructions given in ‘A’ above.

h. Lower the column tube assembly until the tube can be assembled onto the discharge bowl threaded bearing.

i. Thread the enclosing tube onto the connector bearing and remove the rope. Tighten the joint with pipe or chain wrenches.

j. Lower the column into position. Thread/bolt the column into the discharge bowl. Tighten this joint firmly.
k. Lift the complete assembly until the lower pipe clamp is free of the foundation. Remove the lower clamp and lower the assembly until the upper clamp is resting on the foundation.

l. Remove the top connector bearing from the oil tube and pour in one pint of lubrication oil for each 6 mtr. section. Also install a tube stabilizer over the tube.

m. Repeat the above procedure on succeeding column, tube and shaft sections.

6.5.4. COLUMN WITH OPEN LINE SHAFT

a. Open line shaft column sections normally require a bearing every 3 mtr. The top bearing retainer should not be put in place during the assembly of the column section to the pump.

b. Using a rope, make two half hitches around the line shaft, and two around the column (Other methods may be used to support the shaft during assembly, but be sure these methods can carry the load and will not damage or distort the machined surfaces).

c. Position the column clamp just below the column coupling/flange as the case may be. NOTE: Be sure the column clamps have a smooth square surface for the column coupling/flange to rest against. An irregular surface may cause the coupling/flange to distort making assembly difficult.

d. With soft skid boards under the column to protect the threads, slowly lift the column and shaft assembly. Position this assembly over the bowl assembly and lower it until the shaft ends can be coupled together.

e. Make the shaft and coupling joint as per instructions given in ‘A’ above.

f. Lower the column until it can be threaded/bolted into the discharge bowl. Assemble the column to the discharge bowl. Firmly seat the column using chain tongs in case of threaded column.

CAUTION: All column threads are right handed.

h. Raise the complete unit and remove the lower column clamp. Lower unit until the upper clamp rests on the foundation. Slip the bearing retainer over the shaft and slide it down until it seats against the column inside the column coupling/column flange seat.

CAUTION: Do not put any lubricant on the rubber bearings.

i. Thread the coupling onto the shaft. Refer ‘A’ above.

j. Repeat 1 through 7 on succeeding column, shaft and bearing retainer sections.

6.5.5. HEAD ASSEMBLY- COLUMN ATTACHMENT:

There are a number of optional arrangements for attaching a standard threaded/flanged column assembly to the discharge head. The proper arrangement is determined by the type of line shaft lubrication adopted, use of a two piece top shaft, depth of setting etc. All these options are suitable for various styles of discharge heads.
6.5.5.1. STANDARD COLUMN - ENCLOSED LINE SHAFT:

a. Build up the enclosing tube assembly using standard tube sections, except the last section which is the top enclosing tube. This tube is slightly longer or shorter than the standard tube and has an extra deep internal thread on one end. This section must be assembled so the "long threaded end" projects into the head.

b. Thread the column flange onto the upper end of the top column it seats against the column. Tighten this assembly.

**NOTE:** In case of flanged column, this step is not applicable since the flange is an integral part of column pipe.

c. Insert the tube and shaft assembly into the column with the shaft and tube extending out of the bottom end of the column and assemble as previously described. Be sure the top tube is positioned at the top end of the column.

d. Lift up the assembly and position it over the unit in the well using a column clamp located at least two feet below the column top flange.

e. Assemble this to the unit as previously described in the column section. Lower the unit until it rests on the column clamp.

f. Lightly coat the column flange with grease and position the column gasket.

g. Using the cable slings on the discharge head lifting lugs, position the head over the unit and tighten the joint between discharge head and top column pipe.

h. Lift the entire assembly, using the head lifting lugs, and remove the column clamp. Rotate head into the required position and lower onto the foundation, and remove the sling.

6.5.5.2. STANDARD COLUMN - OPEN LINE SHAFT

Follow the same procedure outlined for standard column - enclosed line shaft, except that there are no enclosing tubes.

6.5.6. HEAD ASSEMBLY - SHAFTING

6.5.6.1. ENCLOSED LINE SHAFT (Ref. Fig 6)

a. After the discharge head has been installed, before setting the driver in place, slip the enclosing tube head adapter gasket and enclosing tube head adopter over the shaft into place and fasten them down securely with the cap screws furnished.

b. Insert the two packing rings furnished with the end joints of the adjacent rings staggered about 180° apart. The packing will be forced into the tube threads, making a watertight seal, when the top tube tension nut is put in place and tightened down.

c. Slide the top tube tension nut over the shaft, with the centering fit and packing gland projection, on the lower side, and run it down on the tube threads to force the packing into place. **BE SURE TO GET ALL OF THE PACKINGS DOWN INTO THE POCKET.** Tighten down the tube tension nut securely.

d. Put the top tube bearing down over the shaft. Coat the threads with a good quality thread sealant and assemble it into the top tube. Fill with oil to the level of the lubrication line connecting port using the same grade of oil which is to be used to lubricate the pump when in operation.

**NOTE:** The final tightening of the tension nut, enough to induce sufficient tension in the enclosing tube to support the bearing rigidly in line, can be delayed until the driver is installed. For tensioning the tube, use a large pipe wrench with a piece of pipe of sufficient length on the handle to make a lever arm about 48”(1.2 mtr.) long from the center of the shaft. It will take as much pull as one man can exert on this extended wrench to get the nut threaded down sufficiently tight to obtain proper tension in the tube.
After the tube has been properly tightened, attach one end of the lubrication line and fittings to the top tube bearing.

6.5.6.2. OPEN LINE SHAFT (Ref fig. 5)

a. Having installed the Discharge Head, lightly grease the packing box gasket surface on the head and position the gasket. Slip the packing box over the shaft and position it on the head. Insert the bolts and tighten.
b. Insert one ring of packing at a time. Make sure each ring is properly seated and is so positioned that end joint is staggered by 90° w.r.t. the preceding ring.
c. Assemble the gland halves in case of split design and insert into the packing box. Position the gland bolts and the lock washers into the arms of the packing box and into the ears of the gland assembly. Tighten the gland nuts to press down the packing rings. Now loosen the gland nuts until they can be turned by hand.
d. Packing is designed to be lubricated by the liquid being pumped. This lubrication keeps the packing cool and prevents excessive wear of shaft sleeve. Using the grease fitting provided, grease the packing box with a good grade of insoluble grease.
e. Slip the shaft slinger (water deflector) over the shaft down against the packing box gland.
f. An outside source of lubricating water is required on open line shaft pumps with a static water level greater than 50 feet. This water is used to lubricate the rubber bearings before pumped water rises in the column to lubricate them. Either an outside pressurized source of water or a pre lubrication tank may be used. A tap hole 180° from the discharge flange is provided for connecting the tube system. If the pump is to be started under a closed valve, an air release valve in the discharge line between the head and the valve is required. If not provided, air in the column, will be forced into the pre lubrication line cutting of the water flow.

6.5.7. INSTALLATION OF DRIVE EQUIPMENT:
The procedure for installation and energization of drive motor should be carried out as per the recommendations of the motor manufacturer.

As mentioned above under "Brief Description of VT pumps", a three phase induction motor, either in hollow shaft or solid shaft construction is the most common type of driver used for these pumps. Having completed the pump installation upto the discharge head, a hollow shaft motor can be directly mounted over discharge head by following the instructions given below:

6.5.7.1. VERTICAL HOLLOW SHAFT DRIVERS:

a. Hoist the hollow shaft driver using slings/ nylon belts of adequate capacity and lower it over the top shaft taking due care not to damage the top shaft threads.
b. Mount the driver over its centering seat provided on top of SD head. Using requisite hardware tighten the driver in this position.
c. Remove the top cover of the motor.
d. Connect electric supply cables to the motor terminal box and check the direction of rotation.
e. Install gib key between pump and motor coupling bush on top of the motor shaft and screw down the top adjusting nut along the threaded end of top shaft projecting out of the motor coupling bush.
f. Adjust the impeller running clearance as per instructions described under relevant section of the manual. Place the top cover of drive motor in position

6.5.7.2. VERTICAL SOLID SHAFT DRIVERS

In case of vertical solid shaft drivers, the installation procedure is entirely different because this type of driver cannot be installed directly over the discharge head due to its projected shaft extension and other requirements detailed
under "Brief Description of VT Pumps". Under noted instructions should be meticulously followed to ensure proper installation of the driver over the pump;

a. Using slings and nylon belts lift the motor stool and position it on top of the discharge head making sure that it seats properly over the counter seat provided on the discharge head. Tighten the joint using appropriate hardware supplied with the pump.

b. Hoist the thrust stand assembly* and lower it over the top shaft taking due care not to damage the top shaft threads.

c. Mount the thrust stand assembly over its centering seat provided in the motor stool. Using requisite hardware tighten it in the position.

d. Push the lower coupling half over the top shaft so that it rests at its lowest position, not to forget placing of ratchet pins* in their respective cavities. Rotate the coupling half in position by hand to align respective keyways for assembling gib key and straight key. Lock the coupling half at this location by tightening retaining screw on to the straight key.

e. Screw down the Top Adjusting Nut along the top shaft till it snugs down against the top surface of the lower coupling half. Adjust the impeller running clearance as per instructions described under relevant section of this manual. Lock the adjusting nut in position with a retaining screw tightened into the keyway of straight key.

f. Tighten the flexible link assemblies on the lower half coupling, surrounding the adjusting nut.

**WARNING**

Utmost care should be taken while fixing the link assemblies to ensure that the links’ connection to the motor coupling half is ALWAYS LEADING irrespective of CW or CCW direction of pump rotation.

g. The top (motor) half of the flexible coupling is installed on the motor shaft by sliding it upwards above the motor shaft and inserting the motor key in the key way. Pull the coupling half down upto the level of motor shaft end face. Lock the motor coupling half in this position by tightening retaining screw on to the motor key.

h. Hoist the drive motor above the motor stand and lower it over the top shaft coupling, taking care that it seats into its respective centering spigot provided on the motor stand. The provision of centering seats between the motor and motor stand, the pump and motor coupling halves should come in line with each other.

i. Connect the power cables to the drive motor and check its direction of rotation.

j. Rotate the motor shaft coupling by hand to align and assemble with the link assemblies already installed over the pump half coupling.

k. Tighten the link assembly bolts securely between the pump half and motor half couplings to complete the flexible assembly*.

l. Securely bolt the motor in position on the motor stand.

In FLOWMORE Vertical Turbine Pumps, checking of coupling alignment by dial gauge is not necessary as the concentricity between the Pump Top Shaft and the Motor Shaft is automatically achieved due to provision of centering spigots at every joint of the pump assembly, particularly between SD head/ Motor Stool and Motor. Any minor misalignment is taken care by flexible link assembly between the coupling.

*: Detailed description and instructions about these sub assemblies are given at the end of this manual.

7. **DISCHARGE PIPING:**

i. Install companion flange over the client’s discharge pipe.

ii. Check that the discharge pipe is properly supported over rigid supports and aligned with the pump discharge outlet.

iii. Complete the flange connection between the discharge head and the client’s discharge pipe, ensuring that no piping strain is transmitted to the pump after tightening the pipe flange bolts.
8. IMPELLER ADJUSTMENT

Impeller adjustment is required for two reasons. First there is a preferred running position of the impeller within the pump bowl. Secondly the impellers impose a hydraulic thrust on the line shaft. This load will physically lengthen the line shaft, the amount of stretch increasing with increasing shaft length.

On all pumps, final assembled pump, end play must be measured and recorded. Using the top adjusting nut, start lifting up the line shaft assembly. Locate the point at which the shaft will rotate by hand. At this location the impellers have just cleared the bowl ring seats. Counting the number of turns, raise the line shaft up until resistance to rotation is felt. Impellers are now in their upper most position. Record the number of turns.

Cross check this value with the bowl end play originally checked before commencement of bowl assembly installation. It should be the same. If not, the cause of the variation must be located and suitably corrected. Lower the line shaft to a mid bowl setting, half the total number of turns recorded above.

It is important that only one drilled/tapped hole, out of the six provided on the adjusting nut, positioned nearest to the locking position is identified. By slightly turning the adjusting nut this drilled/tapped hole needs to be aligned with the locking position provided on the top shaft. Lock the adjusting nut at this position with appropriate split/cotter pin or a retaining screw. Bump start the unit to fully set the shaft joints together.

9. OILING SYSTEM FOR OIL LUBRICATED SHAFT BEARINGS:

The line shaft or series bearings are lubricated from the top of the unit by means of a separate oil line connected from an oiler to the enclosing tube top bearing.

A solenoid oiler along with a needle valve (with sight glass) supplied with the pump, may be used on a motor driven pump to feed oil to the shaft bearings. The solenoid opens and closes the needle valve automatically. The leads from the solenoid should be connected across one phase terminal of motor and the earth point so that as soon as the electric supply to the motor is switched on, the solenoid gets energized, raising the needle valve and allowing the oiler to function. If no oil flows from the lubricator after the current is turned on, the needle valve should be inspected as foreign matter may have clogged the opening or there may be no oil in the container.

On a new pump the oiler should be set to deliver approximately 14 to 16 drops per minute for operating speed up to 1500 RPM and 18 to 20 drops per minute for speeds over 1500 RPM for every 15 meters of column setting. After approximately 6 hours of operation this amount may be cut to 5 or 6 drops per 30 meters setting or less with one extra drop for each 10 meters addition column. In no case more than 10 drops per minute are required.

"Electrical information for installation of solenoid oiler"

<table>
<thead>
<tr>
<th>Volts</th>
<th>230</th>
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<tr>
<td>Hz</td>
<td>50</td>
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<tr>
<td>Current</td>
<td>AC</td>
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<td>6</td>
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The oiler is to operate from single phase 230 volts supply which means, one lead connected to a phase terminal in the motor starter and the other lead to be connected to Neutral in the motor starter.
10. OPERATION OF VERTICAL TURBINE PUMPS:
In order to ensure satisfactory operation of these pumps, carefully review and all the operations outlined as below:

10.1. PRECOMMISIONING CHECKS:
Inspect complete installation to insure that the installation instructions have been followed and that the installation is complete in all respects. Ensure that the drivers and gears, if applicable, are properly serviced.

10.1.1. LUBRICATION CHECKS:
- Check that all lubrication systems are in place to perform satisfactory functioning.
- All lubricant reservoirs should be filled with adequate quantities of recommended grade of lubricants.
- In addition to the above, it is advisable to check the motor bearings for lubrication. This should be done in accordance with the motor manufacturer's recommendations as listed in the motor installation manual.

10.1.2. ROTATION CHECK:
Ensure that the direction of rotation of the driver has been ascertained as described under "Installation of Drive Equipment". The electrical motors are usually of poly-phase design and can be operated in either direction of rotation by merely interchanging any two of the phase connections at motor terminal box. It is extremely important that the motor rotates in the correct direction of rotation to match the pump rotation. Standard direction of rotation of these pumps is CCW (Counter Clock-wise) when viewed from the coupling end.

10.2. INITIAL START UP AND OPERATING INSTRUCTIONS
Many variations may exist both, in the equipment used with these pumps and in the pump's particular installation. Therefore, specific operating instructions are beyond the scope of this manual. However, there are some general and some specific rules that do apply to most of the situations. Adherence to these measures will help ensure the safe operation of the pump and avoid possible damage caused by improper operation.

10.2.1. INITIAL START UP:
On oil lube shaft installation, open the lubrication valve and allow oil to be fed into the tube for 10 minutes for each 30 mtr. of shafting. Initial lubrication should be 18 to 20 drops per minute for each 30 mtr. of shafting. After the first 6 hours of operation, reduce the flow rate to 6 drops per minute plus 1 additional drops for each 10 mtr. of shafting.

**NOTE:** Feed adjustment should be checked and suitably altered with changing ambient temperatures. Cold weather will cause the oil to thicken and reduce the flow rate.

On water lubricated systems having a tank system, open the lube valve and allow one half in the tank to flow into the pump. At this point start the pump immediately. Leave the valve open until the pump has refilled the tank. On water lubricated units with a pressurized lubrication system, open the lube valve before the pump is started to allow the water to flow for one minute, plus 15 seconds for each 30 mtr. of shafting, before starting the pump. Do not shut-off water supply until water is being pumped out of the discharge head.

If starting against a closed system or a closed discharge valve, be sure an air relief valve is installed between the pump head and the discharge valve or check valve.

If starting against an open system with a discharge valve, be sure the discharge valve is fully open.

On open line shaft equipped with a packing box, adjust the packing box gland to allow a generous amount of water to flow from the packing.

**CAUTION:** Water lubricates and cools the packings. Over tightening the gland and reducing this flow can result in packing failure and damaged shaft and shaft sleeve.
Check the driver and other necessary equipment for satisfactory operation following their manuals. Check the foundation for signs of deterioration. After the first shutdown, repeat the impeller adjustment. Running may have tightened up some of the shaft joints, changing the original setting.

10.2.2. NORMAL OPERATION:

When the Pump is first started and during normal operation, it is advisable to periodically observe the pump behavior for development of any trouble and to follow remedial measures as listed under TROUBLE SHOOTING.

Monitor the following during running cycles:

i. Unit vibration or noise
ii. Driver and pump lubrication levels and flow
iii. Packing box leakage

Check the following before normal start-up:

i. Prelube system function and water level
ii. Oil levels, in pump oilers, driver, gear etc.
iii. General condition of all equipment.

Start up after a week or more down time. Repeat those procedure covered by initial start-up.

11. MAINTENANCE OF VERTICAL TURBINE PUMPS:
These pumps, like any other machine, require maintenance under two situations, namely Preventive maintenance and Breakdown maintenance.
While preventive maintenance involves routine periodic checks to avoid breakdowns and to ensure trouble free operation, the breakdown maintenance is an emergency situation to locate, identify and rectify the fault in the shortest possible time.

11.1. PREVENTIVE MAINTENANCE:
Routine maintenance checks under preventive maintenance are recommended to be carried out at regular intervals as listed below:

11.1.1. DAILY INSPECTIONS:
Perform following daily checks during routine maintenance activity:

i. Check and record pump operating parameters like discharge pressure gauge readings, bearing temperature, noise and vibrations. In case of increasing trend in vibration values, analyze cause and take corrective steps.
ii. Check amount of lubricant in respective chambers to ensure adequate lubrication of bearings and sleeves.
iii. Check dripping of lubricant from the lubricating line joints and take requisite corrective action.
iv. Check the pump and piping for leaks and rectify as necessary.
v. Check for adequate leakage of liquid from the stuffing box. Excessive leakage needs to be arrested.

11.1.2. QUARTERLY INSPECTIONS:
Following checks during tri monthly maintenance activities are recommended:

i. Check that the foundation bolts and the hold-down bolts are tight.
ii. Check the shaft alignment, and realign as required.
iii. In case of Pumps supplied with Thrust Stand Assembly, ensure that the lubrication schedule described under relevant section is strictly adhered to.
iv. Change the lubricant every six months or after 2000 operating hours whichever is less.
v. Change the lubricant more often if the pumps are operating under adverse atmospheric or other conditions that might contaminate the lubricant.
vi. Under special situations, it may be necessary to partly dismantle the pump for attending to an adverse observation during any of the above inspection schedules.

11.1.3. ANNUAL INSPECTION:
Excessive drop in pump performance and persistent high levels of sound and vibrations are reasons enough to go for detailed investigations under annual inspection. Such an inspection will normally amount to complete dismantling of pump to look for internal wear tear and damage to pump components. This also covers an eventuality of rectification of a defect observed under daily and quarterly inspections but could not be attended due to system requirement. Extent of dismantling needs to be carefully assessed based on work involved for tackling the identified problem. Before taking a decision for dismantling the pump, check and record the pump operating parameters as listed under daily inspection.

11.2. BREAKDOWN MAINTENANCE:
Guidelines listed under ANNUAL INSPECTION AND REPLACEMENT OF PARTS should be meticulously followed to address problems of equipment breakdown. Except in cases involving breakage or extreme wear of pump internals normally, normally it may not be necessary to remove and dismantle the bowl assembly. However if need be, following procedure is given as a guide to ensure ease of disassembly of the bowl assembly.

CAUTION:
Never pick up the bowl assembly by its shaft to avoid bending of pump shaft or other damage.

i. Place the bowl assembly in a horizontal position with a support under the first bowl above the suction case.
ii. Measure and record the projection and axial play of the shaft.
iii. Remove the suction case plug.
iv. Remove cap screws from suction case flange.
v. Slide suction case off the pump shaft.
vi. Loosen set screws in suction case and slide sand collar off end of pump shaft.
vii. Use collet driver to drive impeller collet toward discharge case of bowl assembly.
viii. Slide impeller off pump shaft.
ix. Spread split collet with the screwdriver and slide collect off pump shaft.
x. Remove capscrews from the pump bowl. Move support to under next bowl. Slide the pump bowl off pump shaft.
xi. Repeat steps 7 through 10 to remove remainder of bowls including the top bowl.
xii. Slide the discharge case off the pump shaft.

After the components are disassembled, each part should be thoroughly cleaned and inspected for wear and physical damage. Any part showing signs of excessive wear or damage should be replaced with genuine spare parts supplied by FLOWMORE.

During reassembly of the bowl assembly, use of shaft locating tool and collet driver is mandatory. The assembly should be completed by following disassembly procedure, step by step, in the reverse order.
12. REPLACEMENT OF PARTS
An adequate inventory of spare parts is dependent upon the individual requirements of an installation. Consideration should be given to such variables as the extent of field maintenance anticipated, the severity of service conditions, the importance of minimizing downtime, and the number of units in service. In general, a spare for each moving part, bearing, or seal should be readily available in stock for possible replacement.

13. ORDERING SPARE PARTS
When ordering spare or replacement parts for FLOWMORE Vertical Turbine Pump, the figure number, size, item number and serial number are required. Refer to the drawings and parts list at the back of this manual to be sure of the correct name and item number. Each part carries number and symbols that will be correct replacement part, your order may be forwarded to the nearest FLOWMORE branch office or directly to the FLOWMORE Head Office.

14. RETURNING OF PARTS
All materials or parts returned to the factory must have prior approval and company’s "Returned Goods Tag", to accompany them. Unnecessary delays and wasted efforts will be avoided by using the proper procedure in returning parts or equipment.

Contact your nearest authorized distributor listing the material to be returned and the reasons for the return. He will contact the factory to obtain approval for the return and to obtain the necessary "Returned goods tag". If the return is approved. You will be notified of the reasons if the approval is not given.

All material to be returned should be carefully packed to avoid damage in route from rough handling or exposure to weather. The "Returned goods tag", give shipping instructions. All material to be returned freight prepaid unless otherwise instructed.

**NOTE:**

i. WE RESERVE THE RIGHT TO CHANGE DESIGN AND SPECIFICATIONS OF PRODUCTS AT ANY TIME.

ii. AN INTERCHANGEABLE OR ADAPTABLE PART, NOT IDENTICAL IN APPEARANCE, MAY STILL BE SUBSTITUTED IF THE PART ORDERED HAS BEEN IMPROVED OR OTHERWISE MODIFIED.

15. CRITICAL ASSEMBLIES:

A. THRUST STAND ASSEMBLY:
Thrust Stand Assembly is hoisted over the top shaft and lowered into position and bolted down on Surface Discharge Head/ Motor Pedestal. Exercise due care to avoid damaging top shaft when installing Thrust Stand unit. Inspect the joint at the bottom of the unit to be certain that a uniform fit all around has been achieved. Foreign matter or sharp edges between the mating surfaces can cause an imperfect fit. This will result in misalignment and subsequent trouble when the pump is in operation.

In case of oil lubricated bearings fill the reservoir of bearing housing with a good grade of light oil, such as SAE 30, through the oil fill port. There is a mark on the side of each oil level indicator/sight glass window indicating the proper oil level. Fill the reservoir to this mark only and always check the oil level when the pump is in a stationary condition. Oil level in the sump should never exceed the maximum mark.

Do not add oil when the pump is running. During normal operation, the oil is pumped up through the bearings, which may show a false oil level in the level indicator but there is sufficient oil going through the bearings.
When working on the Thrust Stand Assembly or replacing the bearings, the oil in the reservoir should be completely drained first. Before replacing the new bearings the oil reservoir must be thoroughly flushed out with gasoline and thoroughly dried before refilling.

In actual practice, oil gets dirty and a gradual accumulation of fine particles of dirt will injure the fine polished surface of the bearings as the oil flows through them. Bearing oil should be changed at the end of first 50 hours and 1500 hours of operation. Further, oil should be changed at least once every six months of operation. In many cases where the pump is used only three or four months during the pumping season, then an oil change just before the season starts, is sufficient to keep the bearing lubrication in good condition.

Where grease lubricated bearing are used, ensure that only 2/3rd space of bearing housing to be filled by grease. HP Make, MP2 or MP3 or equivalent to be used.

B. NON REVERSE RATCHETS:
In order to operate properly, the non-reverse ratchet pins must be kept clean. Oil or grease on the pins may cause them to stick and prevent them from dropping into the ratchet slots during reverse rotation of the pump. The small holes in the periphery of the lower coupling half are not oil holes and must never be used as such. These holes merely serve as air vent holes to permit free up-down sliding movement of the non reverse pins in their respective pockets.

C. FLEXIBLE COUPLING ASSEMBLY:
When the Thrust Stand and lower coupling have been secured in place apply the adjusting nut and adjust the impeller (see impeller adjustment).

Place the Link assembly on the drive pins (link bolts) in the Lower half of the flexible coupling. Pull the coupling links into position so that the open end is to the left of the end placed on the lower coupling half drive pin when viewed from the top. This will allow the links to carry the torque load in tension. They have been designed to pull the load and will not push it.

Place the motor stool (in case provided separately) over the Thrust Stand Assembly and fasten it down. Inspect joints to make certain that a uniform fit has been obtained all around.

Fasten the coupling upper half to the shaft of the driver with the key and set screws provided with the unit. The drive pins should project downward to engage the free end of the link assembly installed on the lower half. Set the drive/motor in place on the motor stool/SD head/Pedestal. When lower driver with coupling half attached, be careful to avoid damage to the coupling links. The coupling link assembly (pin block) will have a very close clearance fit on the pins.

The motor stool/SD head/Pedestal and upper coupling half are so designed that the impeller may be adjusted without removing the driver. To accomplish this, loosen the set screws on the driver shaft and slide the upper coupling half towards the driver to disengage the drive pins and link assemblies. The adjusting nut will now be accessible.

D. COOLING COIL ARRANGEMENT:
Provision for cooling water circulation is also available in higher rating thrust stands for which a cooling coil is incorporated in bearing housing. To determine if cooling water is required, operate for about 1-1/2 hour and then take the oil temperature. After this test, circulate cooling water for about 1-1/2 hour and again test the temperature of the oil. The use of cooling water will usually lower the oil temperature by up to 5°C.

NOTE: OIL TEMPERATURE AS HIGH AS 90°C ARE NOT DANGEROUS

The oil cooled by circulating water through copper coil tubing by connecting the inlet of the coil to cool water supply form the discharge outlet of the pump with a rubber or plastic hose. From the other opening in the cooling coil, run a hose to a spillway. If there should not be sufficient pressure in the pump to start flow, the water can be started by siphoning through the drive. The end of the discharge hose should be about 12 inches below the discharge pipe. The quantity of cooling water required will be about 5 to 20 LPM depending upon the size of coil, operating conditions and the temperature of the water.
16. TROUBLE SHOOTING:

A. LOW PRESSURE OR FLOW
   i. Air or gas in water
   ii. Low water level
   iii. Wrong driver speed
   iv. Wrong rotation
   v. Clogged suction or suction strainer
   vi. Clogged impellers or bowls
   vii. Worn impeller or bowls
   viii. Discharge column leaking

B. EXCESSIVE POWER CONSUMPTION
   i. Improper voltage to driver
   ii. High rotating speed
   iii. Not operating at design condition
   iv. Pumping foreign material
   v. Improper impeller adjustment causing rubbing
   vi. Bent shaft
   vii. Column misalignment
   viii. Pump out of alignment
   ix. Bearing badly worn

C. WATER IN OIL TUBE
   i. Plugged bypass parts in discharge bowl
   ii. Worn top intermediate bowl or lower discharge bowl bush.
   iii. Defective oil tube or connector bearing threads
   iv. Improper assembly of top tube tension nut.

   NOTE: Some water in the lower sections of the enclosing tube is normal

D. EXCESSIVE LEAKAGE FROM PACKING BOX:
   i. Gland not properly tightened
   ii. Ends of packing not staggered
   iii. Worn packings or sleeves
### PART LIST

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>PART NAME</th>
<th>PART NUMBER</th>
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<tbody>
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<td>41</td>
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<td>1B</td>
<td>STRAINER (BASKET TYPE)</td>
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<td>3C</td>
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**NOTE:**
For material of construction and quantity of the parts, refer cross-sectional drawing submitted against individual case.