INSTALLATION, OPERATION & MAINTENANCE MANUAL FOR 'JYOTI' VERTICAL TURBINE TYPE PUMPS

For Correspondence or enquiries related to Pumps, Motors, or Turbines:

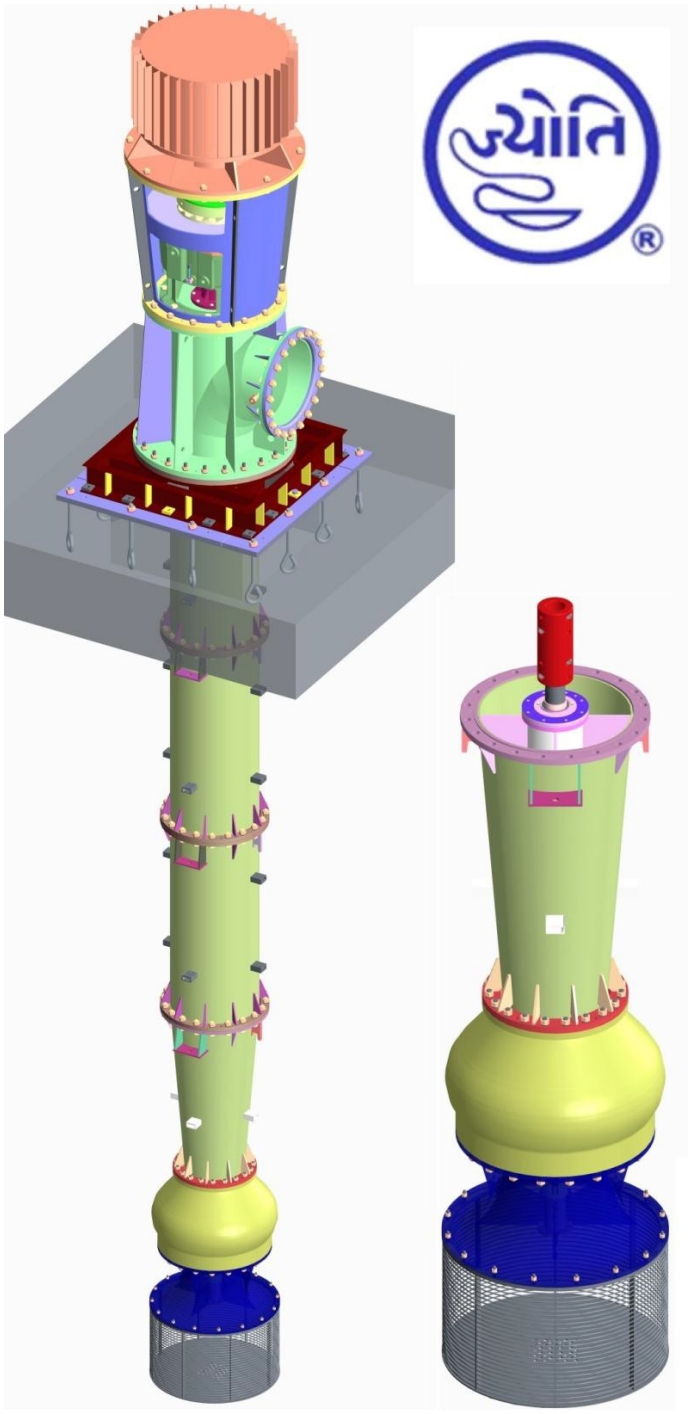
Jyoti Limited,
Nanubhai Amin Marg,
Industrial Area,
P.O. Chemical Industries,
Vadodara - 390 003,
Gujarat, India.

Telephone No (EPABX):
+91-265-3054631 to 3054639,
+91-265-3054444 (Hunting Line)

Fax:
+91-265-2281871
+91-265-2280671

Website:
www.jyoti.com

E-mail:
pumps@jyoti.com



CONTENTS:

1. INTRODUCTION 4

1.1 PURPOSE OF DOCUMENT 4
1.2 SCOPE OF DOCUMENT 4
1.3 PUMP APPLICATIONS 4

2. SAFETY INSTRUCTIONS, PRECAUTIONS AND GENERAL INFORMATION 5

2.1 SAFETY INSTRUCTIONS 5
2.1.1 General Safety Instructions 5
2.1.2 Electrical Safety Instructions 5
2.1.3 Safety Devices to be used 6
2.1.4 Maintenance Safety 6
2.2 GENERAL SAFETY PRECAUTIONS 6
2.3 GENERAL INFORMATION 6

3. RECEIPT, UNLOADING AND STORAGE OF PUMP AND ITS PARTS 7

3.1 MATERIALS AND EQUIPMENTS (TOOLS AND TACKLES) REQUIRED 7
3.2 UNLOADING THE PARTS 7
3.3 CHECK-POINTS ON RECEIPT OF PUMP PACKAGES 8
3.4 LIST OF MOST CRITICAL PARTS OF PUMP ASSEMBLY 8
3.5 PUMP HOUSE LAYOUT 9
3.6 PUMP HOUSE REQUIREMENTS 9
3.7 STORAGE 9
3.7.1 Short Term Storage 10
3.7.2 Long Term Storage 10

4. PRE-INSTALLATION PRECAUTIONS AND CHECKS 11

4.1 COMPONENT ORIENTATION CONSIDERATIONS BEFORE AND AT INSTALLATION 11
4.2 CLEARANCE INSPECTION IN IMPELLER SHAFT AND BOWL BEARING 12
4.3 PREPARATION OF FOUNDATION 12

5. INSTALLATION / ASSEMBLY METHODS AT SITE 13

5.1 LEVELLING THE PUMP 13
5.2 INSTALLING THE BOWL UNIT FOR SMALL SIZED PUMPS 14
5.3 INSTALLING SHAFT AND COLUMN PIPE FOR SMALL SIZED PUMPS 16
5.4 ASSEMBLING THE ADDITIONAL COLUMN PIPES IN SMALL SIZED PUMPS 18
5.5 INSTALLATION OF BOWL AND COLUMN ASSEMBLIES FOR LARGE SIZED PUMPS 19
5.5.1 Lifting the Bowl Assembly for Large sized pumps 19
5.5.2 Lowering the Bowl Assembly of Large Sized Pumps in the Sump: 20
5.5.3 Assembling the Line Shafts and Column Pipes of Large Sized Pumps 21
5.6 INSTALLATION OF DISCHARGE HEAD 22
5.7 SEALING ARRANGEMENT AT TOP SHAFT / DISCHARGE PIPE 23
5.7.1 Installing Standard Stuffing Box 23
5.7.2 Installing Mechanical Seal 24

6. DRIVE UNIT, COUPLING INSTALLATION & IMPELLER ADJUSTMENT 25

6.1 COUPLING INSTALLATION 25
6.2 INSTALLATION OF SOLID SHAFT MOTOR 25
6.3 INSTALLATION OF HOLLOW SHAFT MOTOR 26
6.4 IMPELLER ADJUSTMENT IN SOLID SHAFT DRIVE 27
6.5 IMPELLER ADJUSTMENT IN HOLLOW SHAFT DRIVE 28

7. PUMP DISASSEMBLY PROCEDURE FOR MAINTENANCE / REPAIRS 29

7.1 General Considerations / Checks before starting Disassembly 29
7.2 Carrying out the Disassembly of Pump 29

8. TECHNICAL DATA 30

8.1 Direction of rotation 30
8.2 Details of bearings used in Bearing Unit Assembly 30
8.3 Details Of Bearings Used In Bowl & Column Assembly 30
8.4 Gasket Details 30
8.5 Oils And Their Respective Grades 30

9. PUMP START-UP, OPERATION AND SHUT-DOWN 31

9.1 Pump Pre-Start Procedure 31
9.2 Starting the Pump 32
9.3 Pump in Operation 32
9.4 Shut-Down Procedure 32

10. MAINTENANCE, INSPECTION AND SPARES 33

10.1 Daily Checks 33
10.2 Periodical Checks 33
10.3 Overhauling 33
10.4 List of Recommended Essential Spares 33

11. SYSTEM AND INSTALLATION INSPECTION CHECKLIST 35

12. TROUBLE SHOOTING TIPS WITH PROBABLE CAUSES 37

12.1 Trouble Indicators and Possible Causes 37
12.2 Trouble Shooting Tips 38

13. TYPICAL CONSTRUCTION AND CLASSIFICATION DETAILS OF A VERTICAL TURBINE PUMP 41

13.1 Classification of Different types of Vertical Pumps 41
13.1.1 Classification based on the number of Stages 41
13.1.2 Classification based on the types of Impellers 42
13.1.3 Classification based on Delivery Location 43
13.1.3 Classification based on the Lubrication System of Bearings 44
13.2 Components in Different types of classified pumps 47
13.2.1 Bowl Assembly 50
13.2.2 Column Pipe Assembly 51
13.2.3 Discharge Head Assembly 52

14. TABLE OF FIGURES AND ILLUSTRATIONS 53

15. DECLARATIONS AND DISCLAIMER 54

1. Introduction :

1.1 Purpose of Document :

The main focus of this document is to understand the installation, operation and maintenance procedure of 'Jyoti' Vertical Turbine Type Pumps (Radial Flow, Mixed Flow and Axial Flow types) for their consistent performance and enhanced life. This document also briefly explains these various types of Turbine Pumps based on their construction, operation and application.

It is highly **recommended / advised** to proceed for Vertical Pump Installation procedure **ONLY** after reading this document in order to carry out the installation procedure smoothly.

1.2 Scope of Document :

Scope of this document extends for main types of Vertical Turbine Pumps namely:

- Vertical Pumps with Radial Flow
- Vertical Pumps with Mixed Flow
- Vertical Pumps with Axial Flow

This single manual act as a reference guide all above mentioned Vertical Pumps of 'Jyoti' make.

Along with this manual, all the instructions mentioned in the General Arrangement Drawing supplied with the pump and / or pre-approved from the Customer must be referred and followed.

1.3 Pump Applications :

Vertical Pumps are used in various applications like:

- Irrigation
- Urban and rural water supply
- Sea water application
- Cooling Tower
- Fire fighting
- Flood control
- Mine dewatering
- Power industry (i.e.: Thermal and Nuclear Power Stations)
- Condensate extraction
- General & Process water in industries
- Oil field water services and host of other needs
- Fertilizers and chemicals

⚠CAUTION This instruction manual covers the general requirements of installation, operation and maintenance; however end user should refer to the specific general arrangement/foundation & cross sectional drawings and documents if supplied against specific order.

'Jyoti Ltd.' reserves the right to change / redesign / re-arrange the layout as well as the assembly of these pumps for performance and / or aesthetic enhancement without prior notice.

2. Safety Instructions, Precautions and General Information :

2.1 Safety Instructions :

It is mandatory to follow the below listed safety Instructions in order to avoid any sort damage to personnel or property. For any further clarification of doubts / ambiguities regarding these, concerned Jyoti Ltd. person can be contacted for related specific information of the Pump.

⚠CAUTION Jyoti Ltd. will not be liable for any damages or delay caused by failure to comply with the provisions of this Instruction Manual.

2.1.1 General Safety Instructions :

To avoid any serious or fatal Personal Injury or Major Property Damage, read and follow all the Safety Instructions in the manual and on the Pump. Please follow the below mentioned symbols showing Warnings and Cautions indicated on the Pump:

	This is a SAFETY ALERT symbol. When you see this symbol on the pump or in the manual, look for one of the following signal words and be alert to the potential for personal injury or property damage.
	**DANGER** - Warns of Hazards that WILL CAUSE SERIOUS PERSONAL INJURY, DEATH OR MAJOR PROPERTY DAMAGE.
⚠WARNING	Warns of Hazards that CAN CAUSE SERIOUS PERSONAL INJURY, DEATH OR MAJOR PROPERTY DAMAGE.
⚠CAUTION	Warns of Hazards that CAN CAUSE SERIOUS PERSONAL INJURY OR MAJOR PROPERTY DAMAGE.
⚠NOTICE	INDICATES SPECIAL INSTRUCTIONS WHICH ARE VERY IMPORTANT AND MUST BE FOLLOWED.
THIS MANUAL IS INTENDED TO ASSIST IN THE INSTALLATION AND OPERATION OF THIS UNIT. IT IS HIGHLY ADVISED TO THOROUGHLY REVIEW ALL INSTRUCTIONS AND WARNINGS PRIOR TO PERFORMING ANY WORK ON THIS PUMP. MAINTAIN ALL THE SAFETY DECALS.	

2.1.2 Electrical Safety Instructions :

		Installation, Connections and Earthing to all electrical equipments should be according to local and National Electrical Code Requirements.
		Disconnect electrical supply and lock all electrical equipments before installing or servicing the pump.
		Single phase pump motors are equipped with an automatic thermal protector, which breaks the motor's closed electrical circuit when an overload condition exists. This can cause the pump to stop unexpectedly. Please identify such motors.

2.1.3 Safety Devices to be used :

Below is the list of Personal Protective Equipments (PPE) to be mandatorily used while working on the Installation and / or maintenance of the Pump System:

	Insulated Hand Gloves while working on electrical systems.
	Safety glasses for eye protection
	Steel-toed Shoes for foot protection when handling parts, heavy tools, etc.
	Hard Hat or Helmet must be used to avoid any serious head injury.

2.1.4 Maintenance Safety :

⚠ WARNING	Personal Injuries will result if procedures outlined in this manual are not followed.
⚠ CAUTION	Electrical Supply MUST match pump's nameplate specifications. Incorrect voltage can cause fire, damage to motor and voids warranty.

2.2 General Safety Precautions :

⚠ WARNING	Personal Injuries will result if procedures outlined in this manual are not followed.
⚠ CAUTION	Electrical Supply MUST match pump's nameplate specifications. Incorrect voltage can cause fire, damage to motor and voids warranty.

2.3 General Information :

THE INFORMATION IN THIS MANUAL IS TO BE USED AS GUIDELINES ONLY. IF YOU ARE IN ANY DOUBT, IT IS ADVISED TO CONSULT THE CONCERNED REPRESENTATIVE OF 'JYOTI LTD.' FOR SPECIFIC INFORMATION REGARDING THE PUMP.

The design, material and workmanship incorporated in the construction of Jyoti Make Pumps, makes them capable of giving long, trouble free service. The life and satisfactory service of any mechanical unit, however, is enhanced and extended by correct application, proper installation, periodic inspection and careful maintenance. This instruction manual is prepared to assist operators in understand the construction and correct methods of installing, operating and maintaining these pumps.

Rotating components of the Pump Assembly must be covered with suitable rigid protective guard to prevent injury to personnel. **Carefully follow all the Instructions for proper installation and operation of pump. For questions on trouble shooting and maintenance; see the "Preventive Maintenance" section. Keep this Instruction Manual readily available for necessary reference as and when required.**

3. Receipt, Unloading And Storage of Pump And Its Parts :

Following things must be kept in mind before any start up procedure for Installation of Jyoti Vertical Pumps at the time of receipt of the Equipment:

3.1 Materials and Equipments (Tools and Tackles) Required :

The material and equipments necessary for installation of the pump will vary with the size of the pump and the type of Installation.
The following list of standard tools and supplies is offered only as a guide:

- Bulk Material
  - Anti-Galling Lubricant (eg. MOLYKOTE, LOCTITE, ANABOND, etc.)
  - Thread Compound
  - Lubrication elements like Oil of Specific Grade, Grease, etc.
  - Rust preventive coating (eg. Tectyl – 506 or equivalent)
  - Mineral Spirits or Petroleum Solvents to remove rust preventive coatings (eg. Acetone, etc.)
  - Gasket Rubber (just in case)
- Hand Tools
  - Assembly tools like Spanners, Pipe Wrench, Metallic and Nylon Hammer, clean rags, etc.
  - Feeler Gauges, Spirit Level and other related gauges
  - Set of Mechanical Tools including: files, wire brush, pliers, wire-cutters, pocket knife, etc.
  - Measurement Devices like scales, Vernier Calipers, Micrometer and Dial Indicator to assist in any kind of measurement involved in the installation procedure.
- Material Handling Equipments
  - Mobile Hoist, travelling crane
  - Wooden Blocks
  - Clamps, Eye-bolts, Nylon Ropes, Shackles, etc.
  - I-beams or Wooden planks to support pump over installation

3.2 Unloading the parts :

It is strongly recommended that the pump parts that are too heavy, to be lifted by a suitable hoist / crane from the transporting vehicle. If the arrangement of hoist or crane is not possible, these parts may be unloaded by slowly and CAREFULLY skidding them down an incline. Condition of lifting chains or cables must be inspected first for their sustainability and only then they must be commissioned. Such lifting apparatus must not be allowed to be in contact with machined surfaces. These parts must not be uncrated until conditions are favorable for safe installation. Parts which are provided with lifting lugs, lifting ears or eye bolts must be lifted from these points only.
Column Shaft Sections must be handled with utmost care. These parts are machined to achieve precision alignment. If dropped, bent or otherwise mistreated, these parts will be misaligned in the assembly and will result in malfunction of the pump. Shafts are very sensitive to handling abuse. Bent or dropped shafts must not be used. Installation of such abused shafts in the assembly will cause malfunction or even failure of pump and the system will not deliver desired performance.

Dismantle the Basket Strainer (if provided as per customer requirement) from Suction Bell prior to lifting the pump assembly (if it is supplied in the assembled condition). This action will prevent damage to the strainer, ensuring the mesh device is not used as a pivot point during lifting.

3.3 Check-points on Receipt of Pump Packages :

The pump parts packed in boxes must be carefully supported prior to unloading from the vehicle at site or at Store / go-down. Handle all components carefully. Shipping crate must be inspected for damages prior to unpacking the pump. After unpacking, visually inspect the pump and check the following:

- Check all the packing boxes received for any type of damage before unpacking the material.
- All documents, certificates and concerned drawings are available.
- All material is received as per packing list and placed purchase order.
- After unpacking, ensure all the material is received in good condition.
- Material is matching to the specifications.
- In case of any damages, record it on the material inspection report.
- Make a proper, discreet inspection report in case of following:
  - Any damage to the material received.
  - Short supply in quantity received.
  - Wrong supply of material.

Any shortages or damages must be immediately brought to attention of local transport agency by which the material has arrived & proper reporting to be made on the bill / invoice. This will prevent any controversy when claim is made and facilitate prompt, satisfactory adjustment.

3.4 List of Most Critical Parts of Pump Assembly :

Below is the list of most critical parts that are to be taken utmost care of at the time of transportation, unloading, material handling as well as assembly. The condition and quality of these parts will directly affect the performance of the pump.

All the rotating parts like:

- Impeller
- Impeller Shaft
- Impeller Shaft Coupling
- Line Shaft
- Line Shaft Couplings and
- Motor and Pump Couplings

Apart from these, stationary parts like the following are also very critical:

- Suction Bell
- Bowl Bearings as well as Line Shaft Bearings
- Stuffing Box Assembly
- Bearing Unit in Discharge Assembly.
- All types of sealing used in the Complete Pumping Arrangement

3.5 Pump House Layout :

Turbulence, air entrainment and high velocity of liquid should be avoided at the suction of the pump.

Tank should be designed so as to provide, enough storage capacity to avoid fluctuations in liquid level. Formation of eddies, vortices turbulence air entrainment at the suction of the pump should be avoided. When numbers of pumps are present in a tank of the pump house, care must be taken to provide appropriate distance from each pump and its piping systems, from walls of the tank and from the floor. In such a case, it is advisable to refer pump manufacturer.

High liquid level and minimum submergence level should be maintained as specified in the respective general arrangement drawing.

3.6 Pump House Requirements :

- Sufficient height of the pump house as mentioned/suggested in the general arrangement drawing, as assembly of the vertical turbine pump is done vertically
- Overhead crane / chain pulley block with appropriate capacity
- Sufficient distance should be maintain between adjacent pumps so as to avoid transmission of vibration
- Sufficient floor area is desirable for maintenance of the pumps, during overhauling
- Floor should be sturdy enough to carry total load of all the adjacent pump sets and its auxiliary piping system

3.7 Storage :

If the site is not yet ready to carry out the installation / erection and commissioning procedure for the equipment, the equipment has to be stored in a specific manner so as to avoid any damage to the respective components. This can be classified into short term storage and long term storage of the equipment and / or its sub-assemblies or components.

In general, below steps must be followed in order to store the equipment without inflicting any damages or distortion / deformation in its components for operation:

- Do not place packages one over the other
- Keep the parts on wooden pallets, blocks with properly maintained level
- Storing place should be free from dust, heat, reactive and hazardous chemicals
- Equipment must be kept isolated from corrosive environment
- Flooring should be levelled
- Keep all rubber and composite components away from VOCs (Volatile Organic Compounds)

If the site can be prepared for installation within 3-4 weeks after delivery of the equipment, steps for short term storage can be carried out. Else, if the site is going to take longer time for the preparation, then, steps for long term storage have to be carried out.

These steps are mentioned below:

3.7.1 Short Term Storage :

In addition to the points listed above, below steps have to be followed in order to store the equipment for short term:

- Unpack the components / units from wooden boxes and keep them appropriately on wooden platform / pallets / blocks prior to retaining the components on them.
- Shafts to be held in V-blocks at suitable intervals to prevent any damage / deformation.
- All machined surfaces must be cleaned through and single coat (about 200-250µ) of 'Tectyl - 506' or equivalent protection to be applied to prevent corrosion.
- All the components must be covered with waterproof tarpaulin sheets to avoid any contact with external atmosphere.
- Components must be inspected for any corrosion or deformation at every 3-5 days interval.

3.7.2 Long Term Storage :

This storage method must be applied if the equipment is to be installed / erected and commissioned after longer period of time. In addition to the steps mentioned above, following points must be taken care of when storing the equipment and respective components:

- An appropriate storage area to be identified that is least susceptible to accidents and or environmental extremities.
- Racks / Fixtures must be made in order to retain the equipment and / or components without any damage or deformation.
- All the machined surfaces must be cleaned and made free from oil and dust, so that 'Tectyl' protection can be applied on these uniformly.
- At least two coats (450-500 µ) of 'Tectyl – 506' or equivalent must be applied on these machined surfaces uniformly ensuring no machined surface exposed to the atmosphere.
- It must be ensured that no enamel is peeling out from any painted surface. If so, necessary paints must be applied on exposed surfaces to prevent corrosion.
- The stored / preserved components must be inspected about every 2 weeks for above mentioned points.

In any case, no components must be kept exposed to environment as it may lead to damage, deformation, deterioration and / or misplacement of the components / equipment.

4. Pre-Installation Precautions and Checks :

Pre-Installation precautions or the precautions to be taken before the Assembly of Pump:

- Ensure that the Pump handles the liquid as mentioned in the order only.
- Ensure all Column and Shaft Sections are not bent or kept hanging.
- Ensure all machined and mating surfaces are well in condition without any dent or scratch marks.
- Ensure Shaft threads and coupling threads are in good condition.
- The shaft ends may be threaded to engage in a threaded coupling, or they may have a keyway and ring groove for a split ring coupling. Check the condition of these parameters.
- DO NOT step or walk on the shafts. DO NOT place other parts or equipment on the shafts.
- Use appropriate solvent (eg. Petrol or Acetone or some other thinner) to wash off any protective coating from the shaft sections, and wipe thoroughly clean and dry.
- Clean the shaft coupling threads using a wire-brush and solvent and cover both shaft ends.
- DO NOT try to assemble the pump in horizontal condition on the ground. This may cause damage to the shaft sections, tubing (if applicable) and probably the column pipe also. Damage to these parts will directly affect the performance of the pump.
- The pump must be assembled in vertical condition only.
- The well or sump must be thoroughly cleaned and ensured of absence of dirt, debris and contaminants before installing the pump. Dirt, sand, etc. will cause premature wear on the critical pump internal surfaces resulting in reduced performance of pump and further breakdowns.

4.1 Component Orientation considerations before and at Installation:

- All the components / sub-assemblies of the Pump must be oriented in such a way so as to aide very easy and damage free lifting and installation of the Pump.
- Suction Strainer (if provided) must be dismantled from the Bowl Assembly, if delivered in pre-assembled condition, and must be re-assembled only after lifting the Bowl Assembly.
- Shafts for non-threaded (split-ring) couplings may have an internal threaded section on one end; this end is oriented in upward direction.
- In a flanged column pump, the intermediate column sections have identical ends; either end may be upward. However, the top and bottom sections may not have identical ends.
- Refer to the assembly drawing for the proper orientation. If the flanged column has an integral bearing housing, that end faces upward.
- The preferred method is to install the shaft and couple it, and then install the column over the shaft--provided that head room permits.
- If head room is limited, insert the shaft sections into the column sections so that the shaft extends about a foot above the top end of the column.
- Lifting the assemblies and components must be very carried out very steadily so as to prevent any damage on the components / assemblies due to any kind of impact.
- DO NOT, repeat, DO NOT try to lift the Bowl Assembly with the protruding end of Impeller Shaft as this will damage the shaft and thus put the performance of Pump in jeopardy.

When inserting the shaft sections into the column section, take care not to bend the shaft or damage the threads.

4.2 Clearance Inspection in Impeller Shaft and Bowl Bearing :

For smooth and effective operation of the pump, minimum clearance must be maintained between the Bowl Bearing and Impeller Shaft (or Impeller Shaft Sleeve if provided). This clearance ensures proper alignment of Impeller shaft and control in vibrations when the pump is in operation.

Below is the range of recommended running clearances between the Bowl Bearing and Impeller Shaft for various sizes of Shaft / Bearing:

Table 1 – Recommended Range of Clearances for various sizes of Bearings:

Sr. No.	Shaft / Bearing Size (mm)	Range of Clearances (µ)
1.	Above Ø 30 to Ø 50	80 µ to 160 µ (0.08mm to 0.16mm)
2.	Above Ø 51 to Ø 80	100 µ to 190 µ (0.10mm to 0.19mm)
3.	Above Ø 81 to Ø 120	120 µ to 230 µ (0.12mm to 0.23mm)
4.	Above Ø 121 to Ø 180	150 µ to 270 µ (0.15mm to 0.27mm)

The above clearances in Bowl Assembly **are recommended** before installation and regularly at the time of regular maintenance of the Pump.

Lower than the specified clearances will cause the pump to draw more power from the motor for rotation (or operation). This also accounts for excessive wear and tear of the Impeller Shaft and / or Bowl Bearing.

Clearances, higher than the specified, will cause the pump to operate with vibrations. Also, there will be excessive and uneven wear and tear in the Bowl Bearing as well as Impeller. The pump operation will not be smooth as desired.

4.3 Preparation of Foundation :

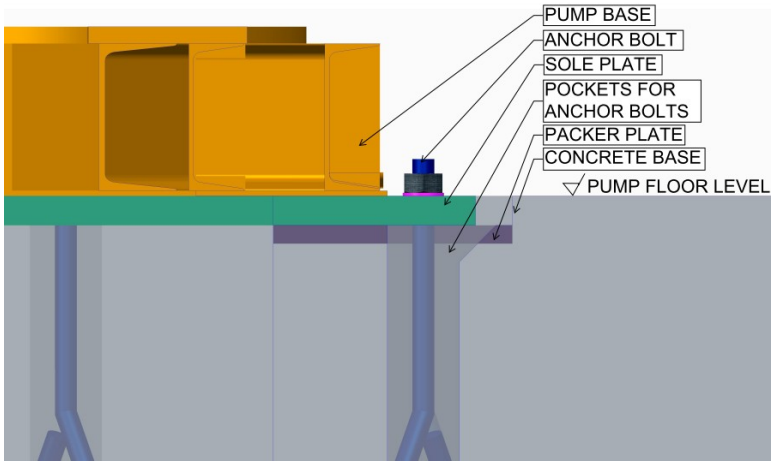


Figure 1 – Cross Section of Typical Foundation for Pump

It must be ensured that the Foundation has been prepared properly. All the loads are transferred to foundation. If the foundation is weak, or not able to withstand the loads, there would be excessive vibrations in the pump while in operation and there are chances of damage to the pump as well as foundation.

Figure 1 shows the cross section of a typical construction of foundation of pump. The whole Pump Assembly with Base Plate (or Pump Base) rests on the Sole Plate. Packer Plates are available for levelling the foundation / sole plates. The Loads of Pump are transferred from Pump Base to Sole Plate and from Sole Plate to Foundation Base.

5. Installation / Assembly Methods at Site :

5.1 Levelling the pump :

Remove the supporting girders, rope and/or any other equipment from the top of the foundation. Cover the discharge head to protect it from dust, and clean the foundation. **If the sole plate is not already grouted in place, ensure that the grouting done around the foundation opening is in place before lowering the pump assembly onto the foundation.** Lower the pump until the base of the discharge head or sole-plate is just above the foundation bolts; then, orient the pump so that the discharge outlet is in the desired direction and the position of holes in the base matches with the position of foundation bolts. Continue to lower the pump until the bolts just enter the holes in the base. If the foundation is concrete, place the wedges/shims (furnished with the pump) under the discharge head or sole plate, adjacent to the bolt holes, one under each of the four sides. For structural foundations (made up of I-beams or H-beams), use flat shims under the corners. Continue to slowly lower the pump until the base of the discharge head or sole plate rests on the shims or anchor bolts with washers and nuts. Accurate alignment of the discharge head in relation to the pump shaft is absolutely essential for a smoothly operating and trouble free pumping system**.**

By using the wedges, shims or washers and nuts on the anchor bolts, adjust the discharge head flange centreline to the correct elevation.

While maintaining the correct elevation, adjust the nuts and washers or shims to achieve the specified levelness (0.04mm per meter) in both directions. The levelness should be measured by placing a precision level on the machined face of the discharge head.

Never attempt to align the discharge head using a spirit (carpenter's) level. If the pump column does not hang freely in the well, as might be the case when the sump floor is not constructed with proper levelling, levelling the discharge head with respect to constructed floor will not ensure the necessary shaft alignment and clearance in the driver shaft. The discharge head base must be exactly perpendicular with the pump shaft regardless of the result indicated by a spirit level. If this levelling is not ensured properly, it may lead to shaft bent, causing early pump failure and expensive repair.

Place a machinist's level on the driver mounting surface of the discharge head, orienting it parallel with one of the edges of the base. Move the wedges or add more shims as necessary until the level reading reaches 0.04mm per meter.

Reorient the level on the same surface, 90° from the original position. Again adjust the wedges or shims until a 0.04mm level reading is reached, taking care not to upset the levelness is the first direction. After each adjustment, check for levelness in both directions. Push in or add to any loose shims to distribute the weight evenly. The discharge head must be level within 0.04mm with all wedges or shims bearing tightly against the base or sole plate.

Install nuts on the foundation bolts and tighten them gradually and uniformly. Re-check the level readings in both directions. If necessary, loosen the foundation bolts and re-adjust the wedges or shims, tighten the bolts again and re-check the level readings.

5.2 Installing the bowl unit for small sized pumps:

Figure 2 – Resting the Bowl Assembly

First of all, rest the bowl assembly as shown in the Figure 2 on two wooden planks for preparation of Installation of Bowl Assembly.

Then, mount the elevator clamps as shown in Figure 3. Wrap the lifting chain around the Bowl Assembly as shown in the figure and attach the chain to the hook of lifting crane. Lift the Bowl Assembly gradually in such a way that there is no drag or bump, thus avoiding any damages to the assembly.

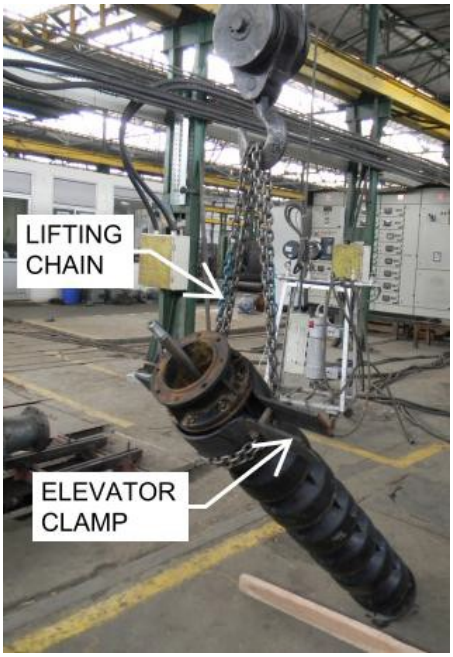


Figure 3 – Lifting the Bowl Assembly

While the bowl is in the lifted / vertical position, install the strainer, if provided. See Figure 4 for reference.

Figure 4 – Assembling the Suction Strainer

For very large size Bowl Assemblies, please refer to the next sections.

Never attempt to handle or lift the bowl unit by the shaft protruding from the upper end. This could result in bending of the shaft.

Lower the bowl assembly until it rests securely on the support beams as shown in Figure 5.

Take care not to drop tools, screws, nuts, or any other foreign objects into the bowl unit or sump. Such an object could impair pump performance or damage the impellers. If passed by the pump into the discharge piping, a solid object could cause serious damage to downstream components.

Figure 5 – Bowl Resting on Support Beams

After resting the Bowl Assembly on the support beams, apply some grease on the threads at the protruding end of Impeller Shaft for assembly of threaded coupling. Anti-galling paste or anti-seize paste like 'MOLYKOTE' or 'LOCTITE' (Food Grade or Marine Grade) can be applied here instead of grease wherever applicable. Refer Figure 6 below.

Figure 6 – Applying Anti-Seize Paste on the Threaded end of Impeller Shaft

After that, assemble the threaded coupling on to the Impeller shaft. Then apply some grease on the inside surfaces of open end of Threaded coupling and Flange surface of Bowl Assembly. Refer Figure 7 below.

Figure 7 – Mounting Threaded Coupling on shaft and applying Grease over flange faces

5.3 Installing Shaft and Column Pipe for small sized pumps:

Rest the Column pipe as shown in Figure 8, similar to how Bowl Assembly had been rested on the wooden planks. Then, as shown in the Figure 9, mount the eyebolts on to the top flange of Column pipe and attach lifting chain shackles to these eyebolts.

Figure 8 – Resting Column Pipe on Wooden Planks

Figure 9 – Mounting Eye-bolts, chain & shackles on Top Flange face

Figure 10 – Lifting the Column Pipe

Then, gradually lift the column pipe in such a way that there is no drag, impact of damage to the column pipe in any way. See Figure 10 for reference.

Now, first line shaft has to be assembled on the Bowl Assembly before installing the column pipe on it. For that, insert the top end of line shaft in the lifted column pipe and then screw the bottom end of line shaft into the open end of coupling in the Bowl Assembly. Refer Figure 11. Ensure proper tightening of line shaft and coupling before lowering down the column pipe for further assembly.

This method is applied when the column pipes have integrated Bearing Housings to support the line shafts.

If the assembly has bearing holders between two column pipes, then before assembling the line shaft, these bearing holders must be located on the Bowl assembly or the column pipe depending on the location of these bearing holders. Only then, next line shaft has to be assembled followed by next column pipe.

Figure 11 – Assembly of Line Shaft in Bowl Assembly

Below figures (Figure 12 to Figure 14) show the assembly of Column Pipe over the Bowl Assembly after installing the Line Shaft. The bolts on the flanges of Column Pipe and Bowl Assembly Adapter / Taper Column Pipe must be tightened in diametrical fashion simultaneously.

In Figure 12, it can be seen that the Column Pipe and Column Pipe adaptor are assembled with bolts and nuts. The fasteners are being pre tightened in diametric fashion, i.e. two opposite bolts at the same time. This method of pre tightening ensures a proper fitment of column pipe and adaptor without damaging the socket and spigot arrangement of the respective components, thus, ensuring no misalignment in the assembly of Column Pipe with respect to Bowl Assembly.

Figure 12 – Assembling the Column Pipe with Bowl Assembly

Figure 13 – Tightening the fasteners in diametrical fashion in the assembly

Figure 13 shows the final tightening of respective fasteners of Column Pipe and Bowl Assembly with proper tools and tackles. Here also, the fasteners must be tightened in the diametrical fashion for the same reason as mentioned above.

In the Figure 14 below, lowering of the Assembly with Column Pipe can be seen.

Figure 14 – Lowering the entire assembly

5.4 Assembling the additional Column Pipes in small sized pumps :

The column pipes mentioned above have integrated bearing housings that have bearings pre-assembled bearings in them. However, in some cases, bearing retainers are provided additionally between the two column sections. Below Figure 15 shows a typical bearing retainer along with the bearing.

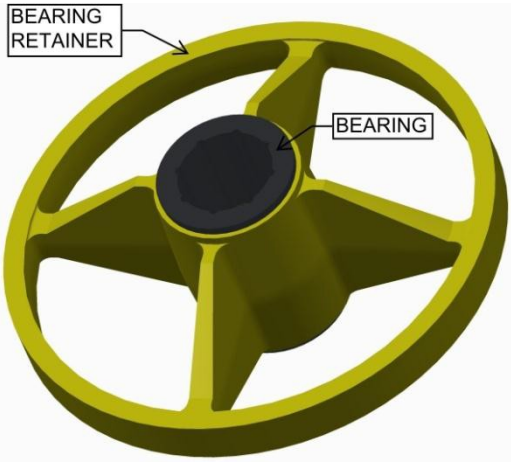


Figure 15 – Bearing Retainer

Below image shows how this bearing retainer is assembled between the two column pipes and how it supports the line shaft and coupling. In this type of arrangement, the line shaft coupling acts as a bearing sleeve for this kind of hydrodynamic bearing arrangement.

The bowl assembly along with previously fitted column pipe (Figure 12 to Figure 14) after lowering down to half of its height, is fitted with elevator clamps, in a similar way the bowl assembly was fitted with elevator clamps). Then the complete bowl and column pipe assembly is rested on these elevator clamps in similar way as shown in Figure 11 to Figure 13.

Now, the exposed threaded end of the line shaft in the lowered down assembly has to be treated with grease as shown in Figure 6. And the line shaft coupling is then assembled onto the line shaft as shown in Figure 7. Now, the bearing retainer has to be assembled in the female groove provided in the column pipe of the lowered down pump assembly. See Figure 16 for reference.

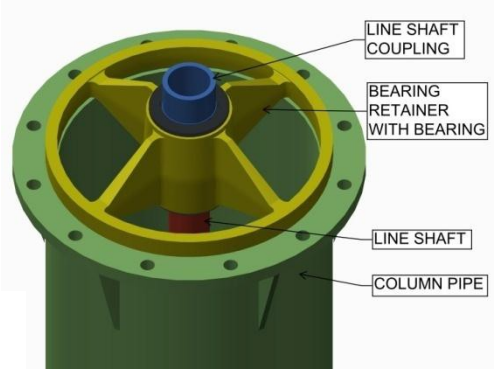


Figure 16 – Assembling Bearing Retainer and Line Shaft Coupling

Then, next line shaft has to be assembled in this coupling after treating the threaded end with grease. After the assembly of next line shaft as shown in the Figure 17, additional column pipe has to be assembled as shown in Figure 18. Refer Figure 13 for tightening instructions of assembly.

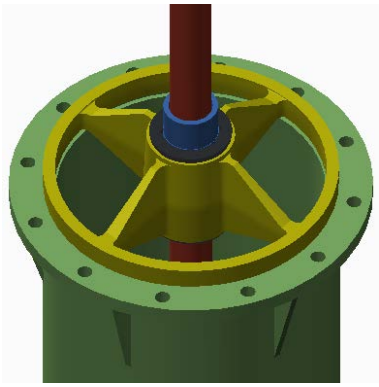


Figure 17 – Assembling Additional Line Shaft

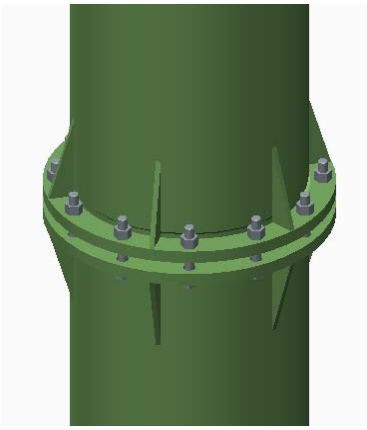


Figure 18 – Assembling Additional Column Pipe

5.5 Installation of Bowl and Column Assemblies for Large sized pumps:

5.5.1 Lifting the Bowl Assembly for Large sized pumps:

The Bowl Assembly must be lifted very gradually and without any jerks to ensure no damage is caused to the internal as well as the external components. DO NOT USE the extended region of Impeller shaft for lifting or tilting the Bowl Assembly, doing so will damage the impeller shaft, impeller, wearing / sealing rings, bearings inside the bowl assembly.

Dismantle the Strainer, if provided, in pre-assembled condition on the Bowl Assembly, before lifting the Bowl Assembly. Lifting the Bowl Assembly with the strainer still attached to it, may damage the strainer beyond repairs. Re-assemble the strainer when the Bowl Assembly is still in lifted but stable condition.

The Bowl Assembly must be gradually lifted using proper cables with proper loops or by mounting two suitable eye-bolts on the flange of taper column pipe diametrically with cables having sling and hooks. Then these slings / cables must be attached to hook of the crane that is to lift the entire Bowl Assembly. Refer Figure 19 for reference.

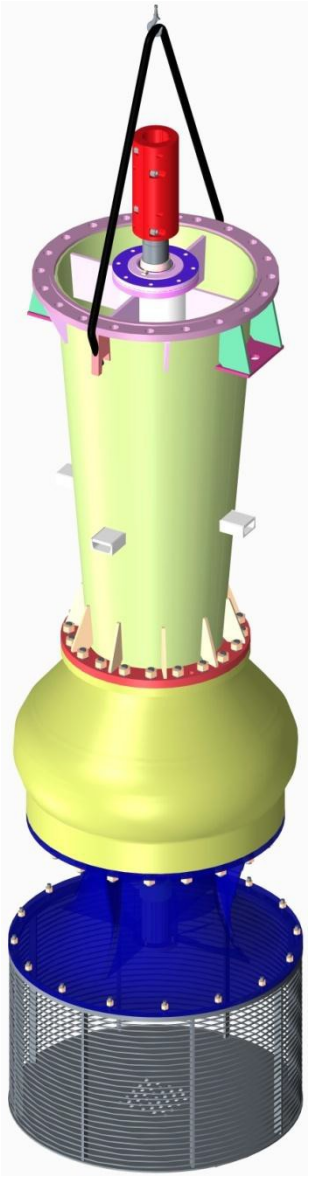


Figure 19 – Lifting the Bowl Assembly of Large Sized Pumps

5.5.2 Lowering the Bowl Assembly of Large Sized Pumps in the Sump:

First of all, ensure the level of sole plate and pump base onto which the whole pump is going to be installed, are levelled properly. Before lowering down the Bowl Assembly, please rectify / clean the surface of base mounting where the pump is to be installed.

Gradually, lower down the Bowl Assembly through the central opening of pump base. Take utmost care that no axial or radial impact is encountered by the Bowl Assembly while it is being lowered down in the sump. Any such impact can cause fatal damage to the foundation as well as the Bowl Assembly and can directly affect the performance of the pump. See Figure 20 for reference.

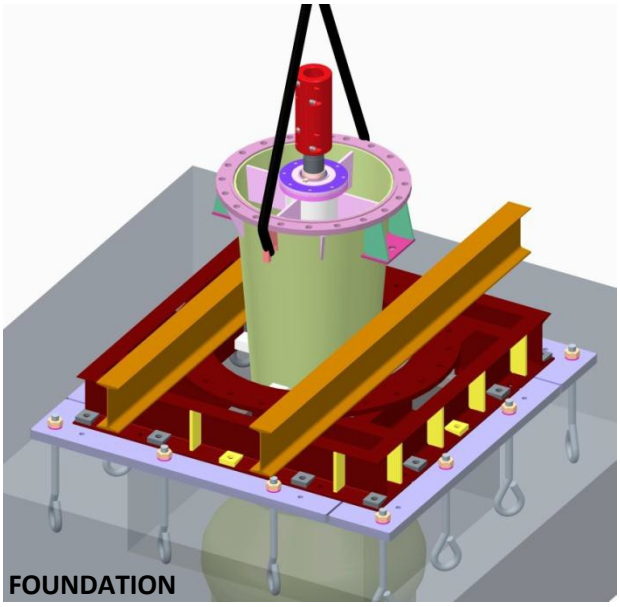


Figure 20 – Lowering Down the Bowl Assembly into the Sump

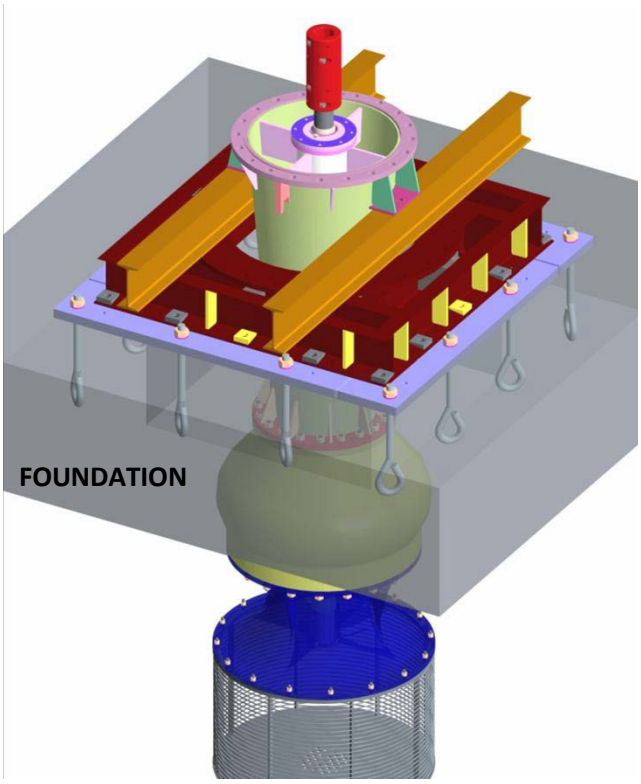


Figure 21 – Bowl Assembly Resting on Girder / Channel

Do not lower the Bowl Assembly completely. Lower the Bowl Assembly to an extent that girders / channels can be placed on the pump base for resting the entire assembly. Only after resting the entire Bowl Assembly on the girders / channels, and ensuring the stability of the rested Bowl Assembly, assembly of Line Shaft and Column Pipe can be started. See Figure 21 for reference.

5.5.3 Assembling the Line Shafts and Column Pipes of Large Sized Pumps:

Assemble an eye-bolt of suitable size in the top centre hole of the line shaft. Lift the Line Shaft assembly with this eye-bolt and position it over the lowered down Bowl Assembly. Couple the Line Shaft with the Impeller Shaft using the coupling on the end of Impeller shaft. See Figure 22 for reference.

If the pump has forced lubrication, then assemble the Shaft enclosing tube in similar way.

After, assembling the line shaft, lift the column pipe in a way similar to that used while lifting the Bowl Assembly (refer Figure 19). Lift the Column Pipe high enough so that the line shaft assembled on the Bowl Assembly is clear and no collision can occur between the two.

Before assembling the Column Pipe, install the gasket or sealant paste (whichever is provided) on the mating flange surfaces. Carefully, position the Column pipe in such a way that the line shaft enters the lifted column pipe without hitting anywhere. Any collision between installed line shaft (and or Shaft Enclosing tube) and lifted column pipe can damage the alignment / straightness of the line shaft, thus directly affecting the performance of the pump.

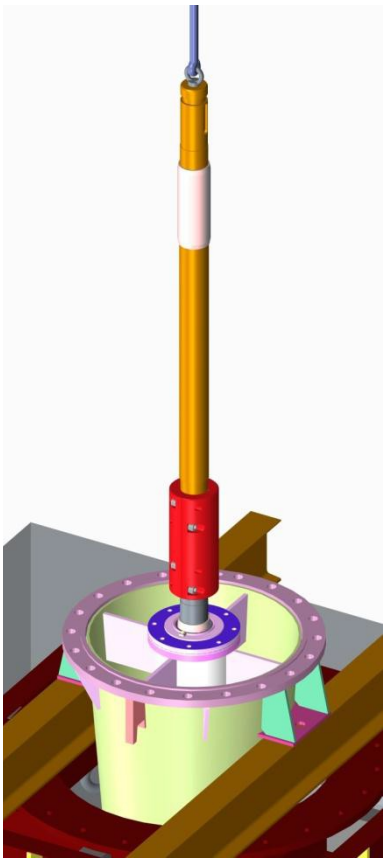


Figure 22 – Line Shaft Installation

After ensuring proper assembly between the lowered Bowl Assembly and Column Pipe, lift the entire assembly, so as to remove the girders. Then, lower down the entire assembly partially, again place the girders for the entire assembly to rest on, and then rest the assembly on these girders. See Figure 23 for further reference.

For assembly of rest of the column sections, follow the same procedure.

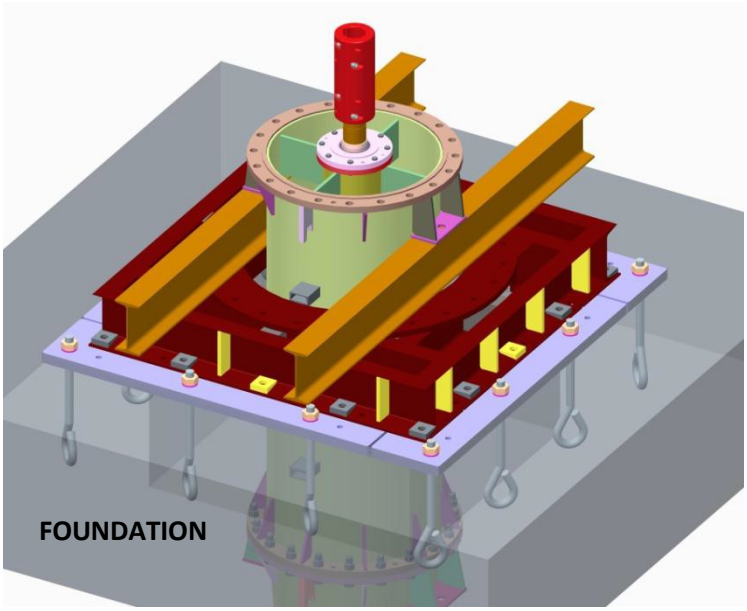


Figure 23 – Lowering the Column Assembly

5.6 Installation of Discharge Head :

With the pump and all the standard length column and shaft sections installed in the sump, the next step is to prepare the discharge head and top column section for installation.

Exceeding the load limitations of the overhead crane capacity may result in failure of the discharge head, serious damage to other parts of the pump, and injury to nearby personnel. Please refer to the technical details or GA / CS drawing of the pump supplied, for getting the details of pump components weights to be handled with overhead crane.

The discharge head may be transported from the factory without the driver assembled to it. Place the discharge head on a clean work surface near the sump. If the discharge head has become dirty in shipping and handling, clean it thoroughly, inside and outside. If a sole plate is to be used and has not yet been installed and grouted, check the mounting surface at the top of the sole plate for possible damage or debris. Remove any burrs and clean the surface thoroughly. If the sole plate has been painted with rust preventive, remove it from **both** the machined and the un-machined surfaces. Mount the discharge head on the machined side of the sole plate, and fasten it with the fasteners provided.

Figure 24 – Assembly of Top Shaft

Ensure the levelling of sole plate & discharge head. Ensure the discharge orientation is correct as per delivery pipe layout.

Install the top shaft (or head shaft) and the top column section in the same manner as for the standard sections. See Figure 24.

DO NOT LOWER THE TOP COLUMN SECTION INTO THE SUMP AT THIS TIME.

When lowering the top column section over the top shaft (or head shaft), take care not to touch the shaft. This could bend the shaft and/or damage the shaft threads.

Install eyebolts in two of the driver mounting holes on the top of the discharge head. For proper balance, use two holes diametrically opposite. Attach the sling to the eyebolts and hoist the discharge head over the pump (lifting ears are **NOT** to be used for lifting the discharge head when it is not attached to the pump). See Figure 25 for reference.

Figure 25 – Lifting the Discharge Head

If gaskets are provided, place one on the upper flange of the top column section. If gaskets are not required, apply the flange sealant on the mating surfaces of the column flange and the discharge head flange. Lower the discharge head slowly, centering the shaft in the discharge head so that there will not be any contact with the shaft to avoid any damage to shaft. Continue to lower the discharge head until the studs enter the holes in the flange of the top column section and the discharge head is correctly located in place. Fasten the nuts on the studs, tightening them gradually and uniformly. Raise the entire unit a few inches and remove the box clamp.

After the discharge head is installed on the pump column, always use the lifting ears on the discharge head for hoisting the pump. If discharge head does not have lifting ears, pass the slings through the hand holes, taking care that slings do not touch the shaft.

Never attempt to lift the pump by means of eyebolts screwed into the driver mounting holes because the bolts are not strong enough to carry the weight of the entire pump.

5.7 Sealing Arrangement at Top Shaft / Discharge Pipe :

5.7.1 Installing Standard Stuffing Box :

Position the gasket on discharge head. Slide stuffing box housing down over shaft and into position on the gasket. Fit stuffing box with fasteners provided.

Insert packing washer into the stuffing box if provided. (Usually packing washer is not required on shaft sizes 55mm and larger.) Grease the gland packing rings for easier installation. (It is recommended to dip the Gland Packing Rings in Oil overnight before assembly for their better performance and life.) Twist the packing ring sideways to get it around the shaft easily. Start the first ring into the stuffing box. When the entire ring is worked in using the fingers, push it down using a split wooden bushing (or equal) and push the packing ring down firmly. It must seal on the shaft and bore of the stuffing box. Install all 5 rings in this manner (the 6th ring may be set aside until the packing is adjusted for leakage after the first start-up). Stagger ring joints 90° apart. The split gland may be used as a tamper for the top ring. Install the split gland and thread nuts on split gland studs. Tighten nuts then relieve the nuts and tighten finger tight. Attach bypass line to tube fitting in the stuffing box. Final adjustment of the stuffing box must be made at pump start up. This final adjustment applies to all stuffing box styles.

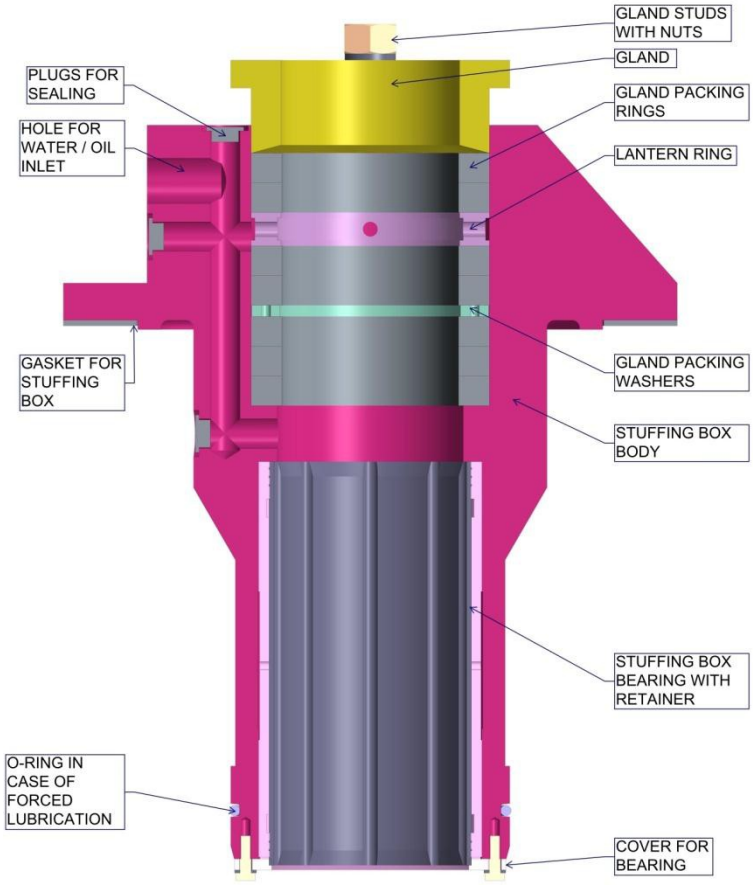


Figure 26 – General Cross Section of Stuffing Box And Gland Assembly

Check that the split gland is perpendicular in the stuffing box. Uneven contact of split gland contact with top packing ring can cause uneven compression of packing and damage to the shaft or sleeve. Do not over tighten packing or excessive wear can occur on the shaft or sleeve. A properly packed stuffing box should be loose enough to allow the shaft to be turned manually.

Figure 26 **shows general components of Stuffing Box Assembly with Gland parts.**

Preparing and Installing Gland Packing Rings into Stuffing Box:

The Gland Packing Material often comes in a single form of spool / roll. These rings have to be cut into appropriate sizes prior to installation into the Stuffing Box. The best method to prepare / cut these Gland Packing Rings is rolling the Gland Packing Strip on a mandrel that is about 1.5mm to 3mm smaller in diameter than that of the shaft / shaft sleeve. Figure 27 shows two different methods of preparing the Gland Packing Rings for Stuffing Box. Rings are to be cut on the mandrel only to get proper joint angle. If the rings are cut over sized, there are chances of overlapping over each other when installed in the stuffing box that may induce leakage, non-uniform wear and tear and damage the rings as well as shaft.

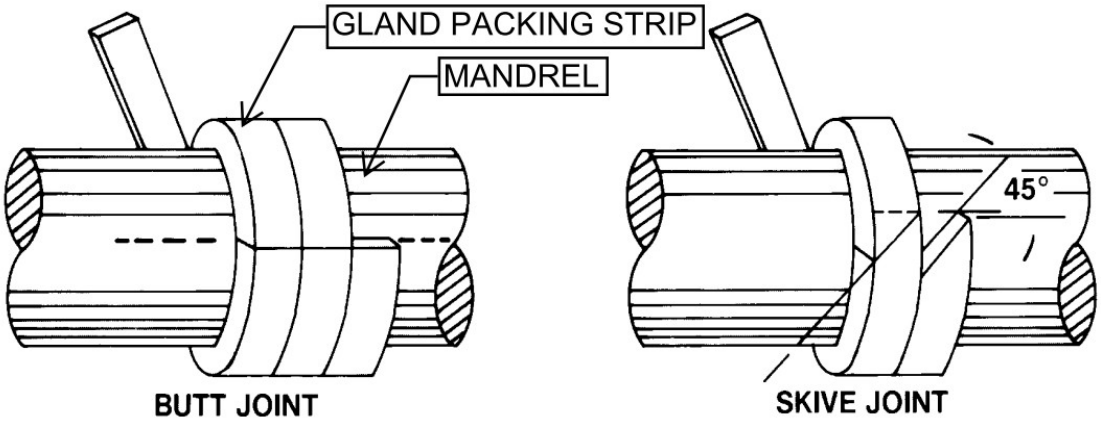


Figure 27 – Preparing Gland Packing Rings for Stuffing Box

5.7.2 Installing Mechanical Seal :

The Mechanical Seal is an optional fitment in the 'Jyoti' Vertical Pump that is supplied only if the Customer has specifically ordered for it.

The Mechanical Seal assembly comes pre-assembled from 'Jyoti' Work shop. Still if need may arise to disassemble and reassemble the Mechanical Seal, the process must be carried out with utmost care as the seal surfaces are lapped and any non-uniformity or distortion on these surfaces may induce leakage in the seal.

Please refer to the Instruction Manual provided by the OEM of Mechanical Seal provided along with this IOM Manual when the pump is supplied with Mechanical Seal (on special order from the Customer).

6. Drive Unit, Coupling Installation & Impeller Adjustment :

6.1 Coupling Installation :

- Apply a thin film of oil on the pump key and insert key into head shaft keyway seat.
- Gently lower pump hub of coupling onto head shaft.
- Thread the adjusting plate onto the head shaft until flush with top of the head shaft.
- Apply a thin film of oil to the driver key and insert key into drive shaft keyway seat. Place the driver hub onto the drive shaft and with key slide it up the drive shaft until the annular groove is exposed. Install split ring in the groove & slide driver hub down over the split ring to capture it.
- If the pump is supplied with an adjustable spacer coupling, install spacer between head shaft and driveshaft hubs. Secure with cap screws and hex nuts.

6.2 Installation of Solid Shaft Motor :

The coupling between pump and motor may be a Non spacer type flexible, spacer type flexible or rigid type depending on requirement. Spacer type flexible coupling is used on pumps fitted with a mechanical seal. This supports for servicing of the mechanical seal without disturbing of the driver mounting.

Motor stool / Motor Skirt / Driver support: When a Motor stool / Motor Skirt / Driver support is furnished and not installed, proceed as follows:

- Lift the Motor stool / Motor Skirt / Driver support with overhead crane, inspect the mounting surfaces, and clean these surfaces thoroughly.
- Install Motor stool / Motor Skirt / Driver support on discharge head and fasten it with the fasteners provided.
- Attach a sling to the lifting lugs of pump driver (Motor), lift it up, inspect the mounting surface, and shaft extension, and clean these surfaces thoroughly. If any burrs are found, remove burrs with a smooth file, cleaning thoroughly after removing the burrs is must.
- Orient the motor terminal box in the required position. Align the motor mounting holes with the mating tapped holes on the Motor stool / Motor Skirt / Driver support or discharge head in case of direct mounting. Lower the motor until it rests on the Motor stool / Motor Skirt / Driver support or discharge head. Uniformly fasten the motor with fasteners provided.
- On drivers having a non-reverse ratchet or pins, manually turn the driver shaft clockwise viewed from the top until the non-reverse ratchet or pins fully engage.
- Lubricate motor bearings in accordance with instructions given on motor name plate fitted on the motor or as given in motor IOM manual. **Please read and follow the motor IOM before lubricating the motor bearings. Too much lubricant can cause the bearings to overheat and fail prematurely.**

The motor must not be tested for direction of rotation when coupled to the pump. If pump should rotate in the wrong direction, serious damage to the pump and motor would result. Also serious injury to personnel could result.

6.3 Installation of Hollow Shaft Motor :

Please refer the Figure 28 for Installation of Hollow Shaft Motor.

The driveshaft projecting through the quill or hollow shaft of the motor is separate from the pump shaft and connected to same by a rigid flanged coupling or threaded coupling.

Motor stool / Motor Skirt / Driver support: When a Motor stool / Motor Skirt / Driver support is furnished and not installed, proceed as follows:

1. Lift the Motor stool / Motor Skirt / Driver support with overhead crane, inspect the mounting surfaces, and clean these surfaces thoroughly.
2. Install Motor stool / Motor Skirt / Driver support on discharge head and fasten it with the fasteners provided.
3. Attach a sling to the lifting lugs of pump driver (Motor), lift it up, inspect the mounting surface, and shaft extension, and clean these surfaces thoroughly. If any burrs are found, remove burrs with a smooth file, cleaning thoroughly after removing the burrs is must.

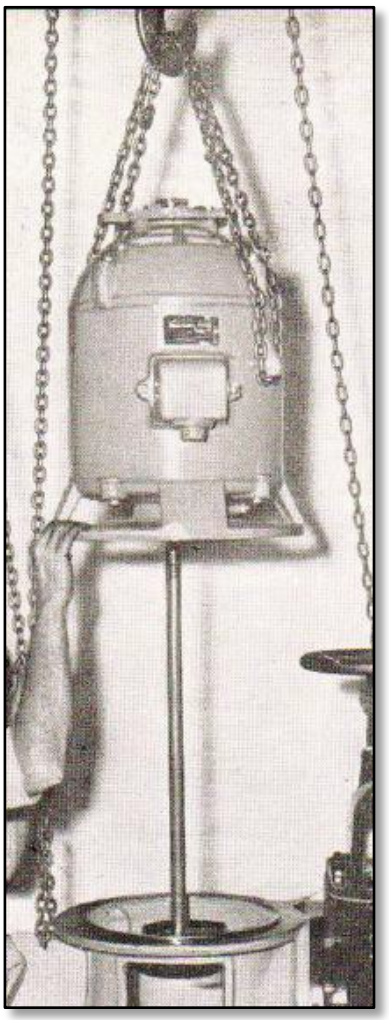


Figure 28 – Installing Hollow Shaft Motor

4. Orient the motor terminal box in the required position. Align the motor mounting holes with the mating tapped holes on the Motor stool / Motor Skirt / Driver support or discharge head in case of direct mounting. Lower the motor until it rests on the Motor stool / Motor Skirt / Driver support or discharge head. Uniformly fasten the motor with fasteners provided.
5. On motors having a non-reverse ratchet or pins, manually turn the driver shaft clockwise viewed from the top until the non-reverse ratchet or pins fully engage.
6. Lubricate motor bearings in accordance with instructions given on motor name plate fitted on the motor or as given in motor IOM manual.

Please read and follow the motor IOM before lubricating the motor bearings. Too much lubricant can cause the bearings to overheat and fail prematurely.

The motor must not be tested for direction of rotation when coupled to the pump. If pump should rotate in the wrong direction, serious damage to the pump and motor would result. Also serious injury to personnel could result.

The drive shaft extends up through the quill or hollow-shaft of the motor and is held in place by an adjusting nut, which not only carries all the static and hydraulic thrust of the impellers and shaft but also provides the adjustment for the impeller clearances.

After lowering and orienting the motor and/or gear drive as explained above, remove the drive coupling and hold down bolts. Screw the adjusting nut loosely onto the end of driveshaft. Clean thoroughly and attach a light line below the nut. Lower the driveshaft through the motor quill shaft. Examine closely for dirt or burrs between shaft ends.

6.4 Impeller Adjustment in Solid Shaft Drive :

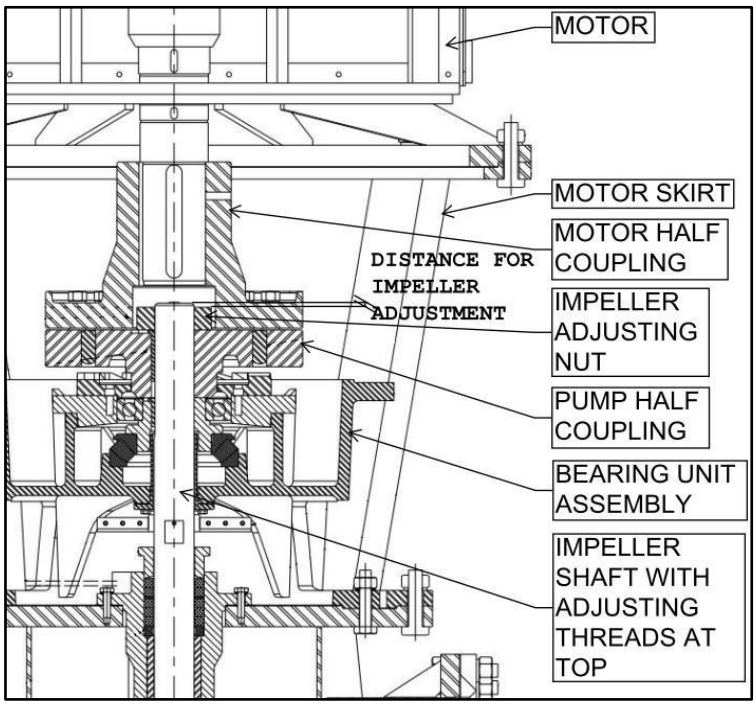


Figure 29 – Impeller Adjustment Mechanism Type 1

Clearance between Impeller and Suction Bell is adjusted by lifting the whole rotating assembly with the help of Impeller Adjusting Nut. **Improper impeller adjustment could cause contact between the rotating and stationary parts, resulting in rubbing of internal components, vibrations, noise and heat generation / temperature rise.**

For suitable adjustment of Impeller height from Suction Bell, tighten the Impeller Adjusting Nut (i.e. lift the whole rotating assembly) onto the Top Shaft such that the rotating assembly can have just free rotation.

Figure 29 will describe the Impeller Adjusting Mechanism Type 1.

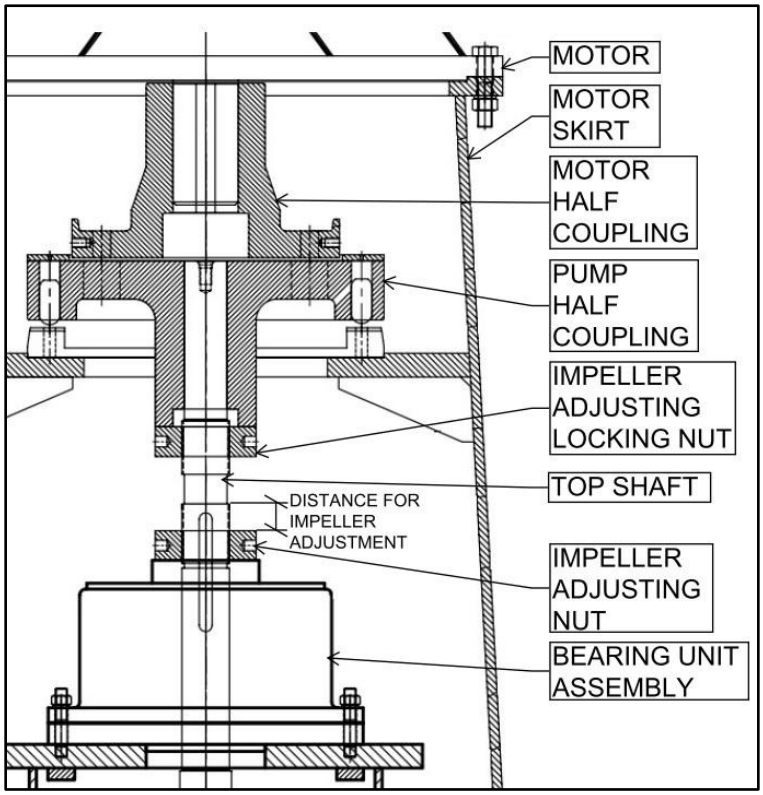


Figure 30 – Impeller Adjustment Mechanism Type 2

There is another type of Impeller lifting mechanism that is shown in Figure 30. Basic Principle of Impeller adjustment is the same as in first case, but an additional Impeller Adjustment Locking Nut is provided just below the Pump Half Coupling in type 2. In type 1 the Impeller Adjustment Nut is just above the Pump Half Coupling accommodated in the socket of Motor Half coupling. In type 2, Impeller Adjustment Nut is accessible directly from the Motor Skirt opening.

6.5 Impeller Adjustment in Hollow Shaft Drive :

In the Hollow Shaft Drive, the Impeller Adjusting Nut is located at the open end of Top Shaft above the motor. It is locked at the ratchet for locking / stopping the reverse rotation. Once the Hollow Shaft Motor has been installed properly, the height of impeller has to be adjusted appropriately for better performance and enhanced life of pump and its components. Figure 31 shows a cross section explaining the Impeller Adjustment Mechanism in Pump driven by Hollow Shaft Motor.

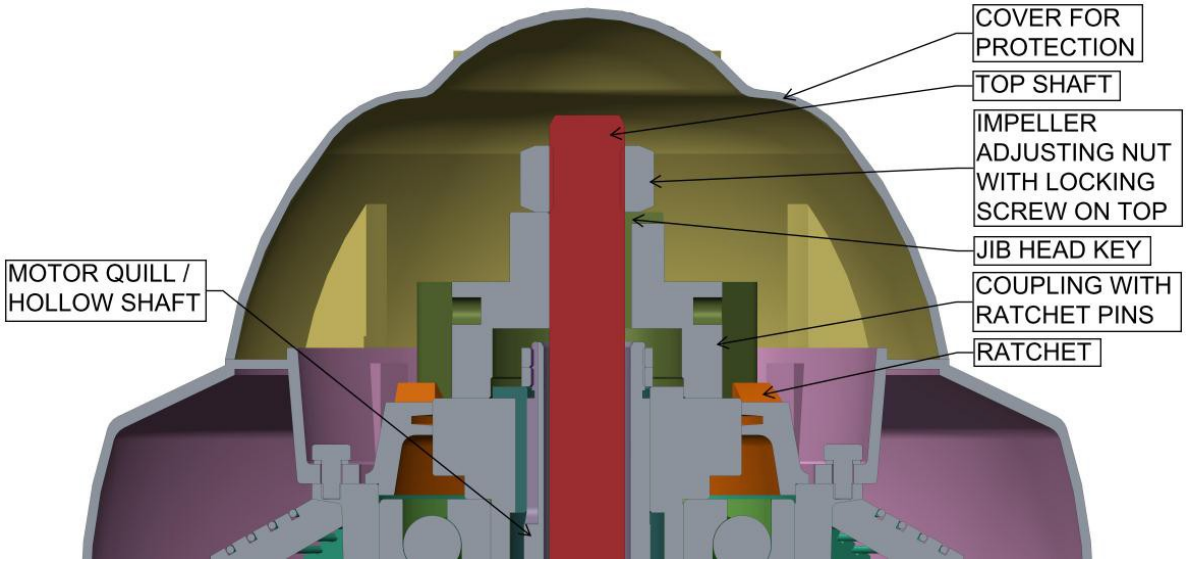


Figure 31 – Impeller Adjustment in Hollow Shaft Motor

The Top Shaft has threads at its non-driving end that engages at the top of Hollow Shaft Motor. Once the Hollow Shaft Motor is installed along with the Ratchet and Coupling with Ratchet Pins, Impeller Adjustment Nut can be rotated such that the whole Rotating Assembly can just rotate freely along its axis without any problem.

7. Pump Disassembly Procedure for Maintenance / Repairs :

Pump Disassembly procedure has quite the reverse of the steps as described in the former topics. Proper Disassembly procedure is very important for better performance and life of pump after restoration. Disassembly of pump is carried out only in two cases: 1) for regular scheduled maintenance and 2) if there is any kind of malfunctioning of the equipment.

7.1 General Considerations / Checks before starting Disassembly :

At every stage of disassembly procedure, respective components must be checked for all types of non-uniformities in the components, like any wear and tear in the shaft sleeve and / or bearings affecting the running clearances, all wearing rings, all gaskets, o-rings, seals must be checked, preferably replaced every time the main assembly is dismantled to prevent any types of leakages in the assembly.

7.2 Carrying out the Disassembly of Pump :

The Disassembly process of Pump must be carried out in a very systematic way, just like the assembly / installation process. Below steps can be noted down when carrying out the disassembly procedure of pump.

- Overhead crane of suitable capacity is always required for disassembly of pump just the way it's required in the Installation process.
- The motor must be disassembled first. It must be checked for rotation, condition of bearings and seals.
- Check the pins and bushes of Couplings, any misalignment between the driving and driven half, ratchet and ratchet pins. If there is a crack in ratchet, immediately replace it with another one.
- Disassemble the Bearing Unit Assembly, check the oil level and condition of oil. If need be, change the oil or top-up accordingly. If Bearings have completed their working hours, it is highly recommended to change the bearings for longer enhanced life of pump.
- Remove the Stuffing Box and replace the gland packing rings. Check for the condition of Stuffing Box Bearing. If need be, replace the Stuffing Box Bearing as well. Also shaft sleeve must be checked for wear and tear and condition of its surface.
- Then remove discharge head very carefully so as not to damage the top shaft due to any impact.
- Hold the top shat at the top as shown in Figure 22 first and then uncouple it to remove it very carefully. All the shafts must be disassembled in this way only to avoid any damage to them and check / inspect for their respective straightness.
- Same process as shown in Figure 20 must be carried out to lift the column pipes and then the Bowl Assembly.
- DO NOT pile up the disassembled components on each other. This may damage the components and ultimately the whole pump performance.
- Replace all the gaskets and other rubber parts.
- Check the condition of all the fasteners. Immediately replace the damaged fastener if there.
- Check the condition of Bowls, Bowl Bearings, all wearing rings, Impeller and Suction Bell. Replace the wearing rings if clearances between them have increased beyond permissible limit.
- Follow the installation procedure mentioned above to reassemble the pump.

8. Technical Data:

8.1 Direction of rotation :

Direction of Rotation is always specified / indicated on the motor skirt and/or Bearing Unit Assembly of the Pump unit. Usually, the equipment is designed to rotate Anti-clockwise when viewed from top.

8.2 Details of bearings used in Bearing Unit Assembly :

Both, Anti-friction as well as Tilting Pad Type Bearings are available in Bearing Unit Assembly based on the requirements /demand of Customer.

Application of Anti-friction Bearings is found in the Bearing Unit Assembly above the Discharge Pipe. Two types of bearings are used in Bearing Unit Assembly, i.e. one is a Spherical Roller Thrust Bearing (292XX, 293XX or 294XX – series) to take care of all the axial thrusts incurred while pump in operation and usually a Deep Groove Ball Bearing (60XX, 62XX, 63XX or 64XX – series) to take care of residual radial loads respectively. Bearings of 'SKF' make or equivalent are used in the Bearing Unit Assembly.

Tilting Pad Bearings are usually used where speed is low and Axial Thrust is relatively high. Tilting Pad Bearing consists of combination of Thrust Pads at the bottom of Thrust Collar and Guide Pads around the Guide Bearing Collar.

8.3 Details Of Bearings Used In Bowl & Column Assembly :

The Bearings used in Bowl Assembly as well as Column Assembly are journal bearings with different materials. Usually such bearings used in Bowl assembly can be metallic (like Bronze) or of composite materials (like Thordon). In Column Assembly, bearings with composite materials like 'Cutless' Rubber or Thordon are used.

8.4 Gasket Details :

Until otherwise specified, all the gaskets are cut from Compressed Asbestos Fibre (CAF) jointing sheets about 1.5mm thick following IS:2712 standard.

8.5 Oils And Their Respective Grades :

For Pumps with Antifriction Bearing Unit Assemblies and/or Oil Lubricated Column Pipe Bearings, SAE-30 Grade oils are used.

For Tilting Pad Type Bearing Unit Assemblies, ISO VG-46 Grade oils are used.

These respective grades of Oils must not be changed without consultation of the OEM manufacturer (in case of these pumps – 'Jyoti Ltd.').

9. Pump Start-up, Operation and Shut-Down :

9.1 Pump Pre-Start Procedure :

Please read carefully the instructions provided by manufacturer for detailed information for the prime mover (electric motor, engine, or steam turbine), coupling, drive shaft, gear-head or mechanical seal. When applicable to the pump and prior to start-up & check the following:

Ensure that, all the procedures described in the Installation Manual of various components, sub-assemblies & other equipment in the system are performed & defined checks are performed.

Check for the following:

1) All safety devices and controls are installed and operating properly.
2) Motor connections are tight & cabling is properly routed and connected.
3) Direction of rotation is checked before motor is coupled with the pump & it is in matching to the requirement.
4) Pump & Motor alignment.
5) Lubrication & cooling to motor & pump bearings.
6) Lubrication & cooling to stuffing box.
7) Impeller lift is adjusted as per manufacturer's recommendations.
8) Pump rotating assembly is freely rotating after adjusting the impeller lift.
9) Delivery piping mating flanges are firmly bolted between joints to avoid leakage & firmly supported.
10) After connecting piping to the pump, rotate the shaft several times by hand to ensure there is no binding and all parts are free. Recheck the coupling alignment, as previously described, to ensure no pipe strain. If pipe strain exists, correct piping
11) Calibrated pressure gauges are connected.
12) Maximum liquid level / minimum liquid level must be maintained in the sump as mentioned in the general arrangement drawing or as specified in the order.
13) Adequate Oil Level must be checked in the Bearing Unit Assembly before starting the Pump to prevent dry run of bearings.
14) To prevent premature pump failure at initial start-up due to dirt or debris in the pipe system, ensure the system has been adequately cleaned and flushed.
15) In case of Forced Water lubrication system, ensure adequate flow of lubricant before starting the pump.
16) Pump must not run dry as the rotating parts inside the pump may gall and seize to the stationary parts. The parts must be lubricated / rinsed by the liquid being pumped.
17) Ensure that minimum submergence is available as per pump design.
18) Ensure that pump is not experiencing starvation on the suction side by allowing suction strainer to become clogged.

The pump must be properly vented through the discharge head vent connections. This is especially important for fluids with suction pressures close to their vapor pressures. Vent Piping must be continuously rising back to source so fluid cannot collect in the vent line.

9.2 Starting the Pump :

1. Partially close valve in discharge line.
2. Pre-lubricate the column pipe bearings through the arrangement provided at top of discharge head below the motor skirt.
3. Open the air release valve provided at the discharge head, so that, the air trapped in the column can be vented out. **DO NOT** forget to close the air release valve after the pressure at discharge head has reached at the required value.
4. Start the pump. **Immediately observe pressure gauges. If discharge pressure is not quickly attained, immediately inspect the water level at the sump level. The water level must be higher than or at least the minimum recommended water level in the General Assembly Drawing provided along with the pump.**
5. Open the Discharge Valve gradually once the pump has attained the rated speed. If driver overheats or there is excessive vibration, stop the pump.

Observe pump for vibration levels, bearing temperature and excessive noise. If normal levels are exceeded, shut down and resolve.

Improper impeller adjustment can result for rubbing between the rotating and stationary parts, resulting in a noise, vibrations and heat generation / temperature rise.

Do not operate the pump outside the preferred operating range except during startup.

9.3 Pump in Operation :

With the pump in operation, there should be some leakage at the stuffing box packing. The correct leakage is a rate which keeps the shaft and stuffing box cool (approximately one drop per second). Check the temperature of the leakage as well as the discharge head. If the pump runs hot and the leakage begins to choke off, stop the pump and allow it to cool down. A few light taps with a hammer on the gland will upset the packing sufficiently to resume leakage. After pump has cooled, restart pump and follow preceding procedure. Run pump 15 minutes, check leakage, if it exceeds two drops per second, adjust packing to keep the leakage rate within specified limits. If leakage rate is not getting within limits, replace the gland packing.

9.4 Shut-Down Procedure :

1. Slowly close discharge valve.
2. Shut down and lock all the electrical connections to prevent accidental rotation.
3. Ensure the reverse rotation lock (Ratchet and Ratchet pin below the pump half coupling) has been engaged to prevent reverse rotation.

10. Maintenance, Inspection and Spares :

10.1 Daily Checks :

1. Pressure gauge readings
2. Voltage and current
3. Vibration readings

10.2 Periodical Checks :

1. Check for Vibration, unwanted noise
2. Calibration of measuring instruments
3. All the controls and its effective operation with precision
4. Liquid content, cleaning of the tank, piping and auxiliary systems

10.3 Overhauling :

1. After about 4000 hours of continuous working, it is required that pump overhauling should be carried out.
2. It is recommended that overhauling should be carried out by specialized and experienced persons.
3. Oils in Bearing Unit Assemblies must be checked for viscosity before topping up. Manufacturer recommends filling fresh oil in the Bearing Unit Assemblies in intervals of 6 months or 3000 working hours whichever is earlier.
4. Guidelines for assembly / disassembly of the pump are as mentioned in this book.
5. While ordering spare parts, details of the pump model, order no., etc. as mentioned in the name plate must be specified.
6. Name and quantity of the parts required as spare, has to be mentioned clearly while quoting spare order.

Keep the sufficient stock of the spares, in case of emergency.

10.4 List of Recommended Essential Spares :

A few points must be kept in mind before ordering the spare parts:

- Entire Rotating assembly can be ordered as essential set of spare parts.
- While ordering spares for shafts, the manufacturer highly recommends ordering “set of shaft with respective sleeve”, as the sleeve and shaft are shrink fitted because of the need of the application.
- Type of Lubrication ‘must’ be mentioned while ordering the set of spare parts.
- It is highly recommended to have at least one set of spares between 3 identical pumps for one plant.

Below mentioned table enlists the recommended spare parts for Vertical Turbine Type of Pumps. Still, if there is any query regarding the list of spare parts, our Customer Service Executive can be contacted anytime.

Table 2 – List of Recommended Spare parts for Vertical Pumps:

Sr. No.	ITEM DESCRIPTION	LUBRICATION TYPE
1	SUCTION BELL WEARING RING	SELF / FORCED / OIL
2	IMPELLER WEARING RING	SELF / FORCED / OIL
3	IMPELLER	SELF / FORCED / OIL
4	IMPELLER SHAFT	SELF / FORCED / OIL
5	IMPELLER SHAFT SLEEVES	SELF / FORCED / OIL
6	IMPELLER LOCKING NUT	SELF / FORCED / OIL
7	IMPELLER BACK SEAL RING	SELF / FORCED / OIL
8	BOWL SEAL RING	SELF / FORCED / OIL
9	BOWL BEARING	SELF / FORCED / OIL
10	SHAFT COUPLINGS	SELF / FORCED / OIL
11	LINE SHAFT	SELF / FORCED / OIL
12	LINE SHAFT SLEEVE	SELF / FORCED / OIL
13	LINE SHAFT BEARING	SELF / FORCED / OIL
14	STUFFING BOX BEARING	SELF / FORCED / OIL
15	GLAND PACKING	SELF / FORCED / OIL
16	LANTERN RING	SELF / FORCED / OIL
17	GLAND	SELF / FORCED / OIL
18	TOP LINE SHAFT (HEAD SHAFT)	SELF / FORCED / OIL
19	BEARING UNIT ASSEMBLY	SELF / FORCED / OIL
20	O-RING SEALS	FORCED / OIL
21	MECHANICAL SEALS	SELF / FORCED / OIL
22	RATCHET PINS	SELF / FORCED / OIL
23	COUPLING PINS WITH BUSHES	SELF / FORCED / OIL
24	SHAFT AND COUPLING KEYS	SELF / FORCED / OIL
25	SUITABLE OILS FOR LUBRICATION	SELF / FORCED / OIL

11. System and Installation Inspection Checklist :

Use these checklists in conjunction with the standard instruction manual provided with the equipment.
After completing these checklists, please forward a copy to head office for registering into Quality Assurance-Customer Support records. Please process set of separate checklists for each individual pump being installed.

Table 3 – System and Installation Checklist

Check Point	Confirmation	Deviation observed	
Pump foundation level is within 0.4 mm per meter	Yes	No	
Foundation is adequately designed to handle the weight and loading of the pump. Jyoti Limited does not design foundations and is not responsible for foundation inadequacies.	Yes	No	
Discharge head, sole plate, base plate, etc., is properly grouted using high quality non-shrink grout. To be verified by "sounding" the foundation.	Yes	No	
All foundation bolts / anchor bolts are adequately tightened.	Yes	No	
All discharge piping is properly supported and that there is no excessive nozzle loading on the discharge flange. Verify this by loosening and then checking freedom of the flange bolting.	Yes	No	
Flexible or expansion joints are properly fitted to pump discharge & all tie rods are in place and properly installed & uniformly tightened.	Yes	No	
All valves are operating freely and are properly installed for the direction of flow. Installed valves do have the proper pressure rating.	Yes	No	
Delivery system is properly "lined up" for the test with all necessary indicating & recording instrumentation duly calibrated.	Yes	No	
Rotating assembly is free for rotation.	Yes	No	
Ensure that for initial run of system for 10 minutes which is required to flush the entire system, sufficient water is available at intake.	Yes	No	
Ensure that before engaging the motor with pump, the direction of rotation is checked.	Yes	No	
For external or forced water lubrication to pump or motor, necessary arrangements are completed.	Yes	No	
Pump & Motor alignment is correct.	Yes	No	
Ensure that desired submergence is available.	Yes	No	
Impeller lift is checked. (Please provide measured value)	Yes	No	
Have operating and maintenance procedures been reviewed and discussed with customer?	Yes	No	
Have customer received test certificates & Installation, Operation and Maintenance Manual?	Yes	No	
Overall appearance & quality of material received at site. (Customer's feedback is required)			Please attach additional sheet if required.
Customer does have adequate mandatory spares parts in stock.	Yes	No	If yes, please give list & visual inspection report.

Installation and Start-up Checklists:

Customer:		**Customer's Order Reference & Date:**	
Consultant:		**Project / Site Location:**	
Contact Person & Contact Details from Customer end:		**Contact Person & Contact Details from site:**	
Sale Note No. & Date:		**Pump Model & Number of Stages:**	
Pump Approval: Yes / No	**Pump Inspection: Yes / No**	**Insp. Agency :**	**Inspection date:**
Motor Approval: Yes / No	**Motor Inspection: Yes / No**	**Insp. Agency :**	**Inspection date:**
Date of dispatch from works:		**Erection by & Date of completion:**	
Installation inspected by & date:			

Pump-Motor Technical Parameters:

Head : Mtrs.	**Rate of flow: m^3/hr**	**Efficiency: %**	**Speed: RPM**
Pump Input: kW	**Motor Rating: kW**	**Voltage: V.**	**No. of poles:**
Motor Make:	**Motor Frame Size:**	**Efficiency: %**	**Power Factor:**
Motor Enclosure:	**Motor Amps. FLC:**	**Pump Lubrication: Oil Lubricated / Self Water Lubricated / Forced Water Lubricated.**	

Motor Bearings cooling & Lubrication:	**Type of coupling:**	**Type of sealing: 1) Mechanical Seal 2) Gland Packing**	**Pump Impeller Diameter:**
Pump Material of Construction			
Strainer:		**Suction bell:**	
Impeller:		**Bowl:**	
Impeller shaft:		**Intermediate shaft:**	
Top shaft:		**Bearings:**	
Column Pipe:		**Discharge Head:**	

12. Trouble Shooting Tips with Probable Causes :

12.1 Trouble Indicators and Possible Causes :

Insufficient Pressure 1. Speed too slow (check voltage) 2. Improper impeller diameter or adjustment 3. Impeller loose 4. Impeller plugged 5. Wear rings worn 6. Entrained air in pump 7. Leaking column joints or bowl castings 8. Wrong rotation	**No Liquid Delivered** 1. Pump suction broken (water level below bell inlet) 2. Suction valve closed 3. Impeller plugged 4. Strainer clogged 5. Wrong rotation 6. Shaft broken or unscrewed 7. Impeller loose
Vibration 1. Motor imbalance - electrical 2. Motor bearings not properly seated 3. Motor drive coupling out of balance 4. Misalignment of pump, castings, discharge head, column or bowls 5. Discharge head misaligned by improper mounting or pipe strain 6. Bent shafting 7. Worn pump bearings 8. Clogged impeller or foreign material in pump 9. Improper impeller adjustment 10. Vortex problems in sump 11. Resonance - system frequency at or near pump speed	**Insufficient Capacity** 1. Speed too slow 2. Improper impeller trim 3. Impeller loose 4. Impeller or bowl partially plugged 5. Leaking joints 6. Strainer partially clogged 7. Suction valve throttled 8. Low water level 9. Wrong rotation
Pump Drawing Too Much Power 1. Speed too high 2. Improper impeller adjustment 3. Improper impeller trim 4. Pump out of alignment or shaft bent 5. Lubricating oil too heavy 6. Pumping sand, silt or foreign material	**Abnormal Noise** 1. Motor noise 2. Pump bearings running dry 3. Broken column bearing retainers 4. Broken shaft or shaft enclosing tube 5. Impellers dragging on bowl case 6. Cavitation due to low submergence or operation beyond maximum capacity rating 7. Foreign material in pump
Gland Packing Failure 1. Improper finishes 2. Incorrect clearances 3. Wrong selection of packing 4. Faulty installation and maintenance 5. Abrasive or corrosive conditions 6. Insufficient lubrication 7. Leakage 8. Shaft run-out 9. Misalignment 10. Unbalanced motor coupling 11. Worn out bearings	

12.2 Trouble Shooting Tips :

Trouble Source	Probable Cause	Remedy
Uneven wear on bearings, uniform wear on shafts.	Pump non-rotating parts misaligned.	Check mounting and discharge pipe connection and check for dirt between column joints. Correct misalignment, replace bearings, and repair or replace shaft.
Uniform wear on bearings and shafts.	Abrasive action.	Replace parts. Consider changing materials or means of lubrication.
Uniform wear on bearings, uneven wear on shafts.	Shaft run out caused by bent shafts, shafts not butted in coupling, dirt or grease between shafts.	1. Straighten shaft or replace, clean and assemble correctly. 2. Face parallel and concentric.
Wear on impeller skirts and/or bowl seal ring.	1. Abrasive action or excess bearing wear allowing impeller skirts to function as bearing journal. 2. Impellers set too high.	1. Install new bearings and wear rings. Upgrade material if abrasion occurring. 2. Re-ring and adjust impellers correctly.
Impeller end seal wear.	Improper impeller adjustment. Impeller running on bottom.	Install "L"-shaped bowl wear rings. Adjust impeller setting per pump manufacturer's recommendations
Wear on bowl vanes.	Abrasive action.	Coat bowls; upgrade material, or rubber line.
Wear on suction bell vanes.	Cavitation due to recirculation.	Correct condition or upgrade materials to extend life.
Impeller Wear: Exit vanes and shrouds.	Abrasive action.	Replace impeller if excessive. Consider coating or upgrading material.
Pitting on entrance vanes of impeller.	Cavitation.	Correct condition or upgrade materials to extend life. Remove the cause of cavitation. Cavitation can be avoided by providing sufficient net positive suction head (NPSH) for the pump. However, this may be an expensive correction at site. An alternate solution is to reduce the NPSH requirement of the pump by one of the following methods: Evaluate system head condition, 1) NPSH available, and, if possible, reduce pump capacity. 2) Change impellers to obtain low NPSH design. 3) Replace the pump assembly with a different model capable of operating with the system NPSH available.

Trouble Source	Probable Cause	Remedy
Pitting on impellers and bowl casing.	Corrosion, erosion, or recirculation.	When metallic corrosion alone is adversely affecting pump performance, the solution is to select material that will corrode very slowly when in contact with the fluid being pumped. Investigate cost of different materials versus frequency of replacements. Protective coatings can also reduce corrosion in some applications.
Bearing Failures: Bearing Wear	Abrasive action.	Convert to fresh water flushing on bearings, or use pressure-grease or oil lubrication; or use bearings made of harder material.
Bearing seized or galling on shaft.	Running dry without lubrication.	Check lubrication; look for plugged suction or evidence of flashing.
Bearing failure or bearing seized.	High temperature failure.	Check with pump manufacturer for bearing temperature limits. Generally, *Bronze* - 175° F maximum in water. *Synthetics* - 125° F. *Carbon* - 300° F. *Rubber* - 125° F.
Excessive shaft wear.	Rubber bearings will swell in hydrocarbon, H2S, and high temperature.	Change bearing material.

Trouble Source	Probable Cause	Remedy
Shaft and Couplings: Bent shaft.	Mishandling in transit or assembly.	Check straightness. Correct to 0.0005 in. /ft. run out or replace.
Shaft coupling unscrewed	Pump started in reverse rotation.	Shaft may be bent. Check shafts and couplings. Correct the direction rotation.
Shaft coupling elongated. (Necked down).	1. Motor started while pump is running in reverse. 2. Corrosion. 3. Pipe wrench fatigue on reused couplings. 4. Power being applied to shafts that are not butted in coupling.	1. Look for faulty check valve. Could also be momentary power failure or improper starting cycles. 2. Replace couplings. 3. Replace couplings. 4. Check for galling on shaft ends.
Broken shaft.	1. Can be caused by same reasons for coupling elongation. 2. Can also be caused by bearings seized due to lack of lubrication. 3. Foreign material locking impellers or galling wear rings. 4. Metal fatigue due to vibration. 5. Improper impeller adjustment or continuous up thrust conditions, causing impeller to drag.	1. Look for faulty check valve, momentary power failure or improper starting timers. 2. Same as above for bearing seizure. 3. Add strainers or screens. 4. Check alignment of pump components to eliminate vibration. 5. Consult pump manufacturer for Impeller Adjustment.
Impeller loose on shaft (rarely occurs).	1. Repeated shock load by surge in discharge line (could knock top impeller loose). 2. Foreign material jamming impeller. 3. Differential expansion due to temperature. 4. Improper parts machining and assembly. 5. Torsional loading on submersible pumps.	1. Refit impeller. 2. Usually will break shaft or trip overloads before impeller comes loose. 3. Change to material with the same expansion factor. 4. Repair and refit. 5. Overcome by adding keyway to the collet mounting.

13. Typical Construction and Classification Details of a Vertical Turbine Pump :

This section covers some basic fundamentals of the Types, Classifications and Construction of Vertical Turbine Type of Pumps. This information can help the Customer to decide what type of pump is more suitable for his site / project, on a preliminary basis.

13.1 Classification of Different types of Vertical Pumps:

The Vertical Turbine Pumps classified with respect to the below characteristics:

13.1.1 Classification based on the number of Stages :

- Single Stage where there is only one set of Bowl and Impeller in Bowl Assembly. Refer Figure 32
- Multi Stage where there are multiple Bowls and Impellers in Bowl Assembly. Refer Figure 33

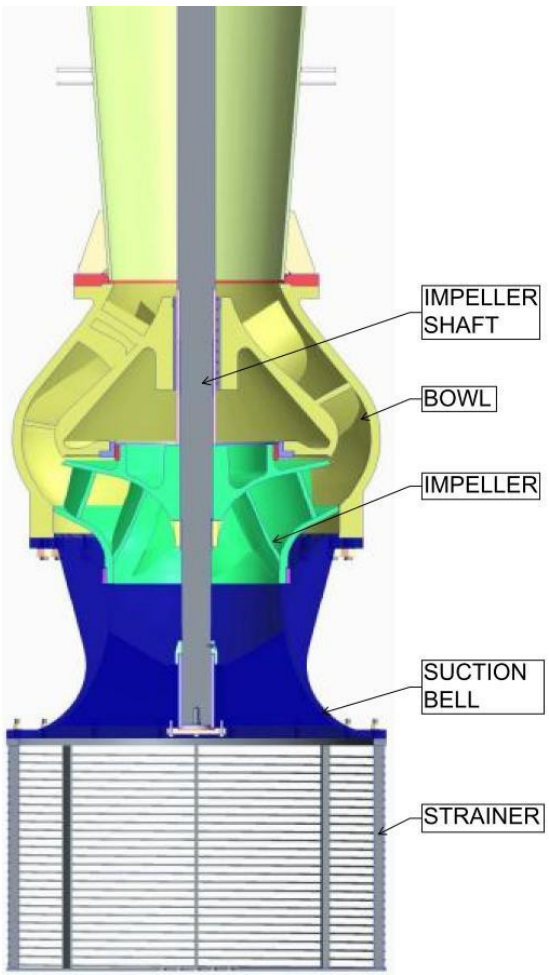


Figure 32 – Single Stage Bowl Assembly

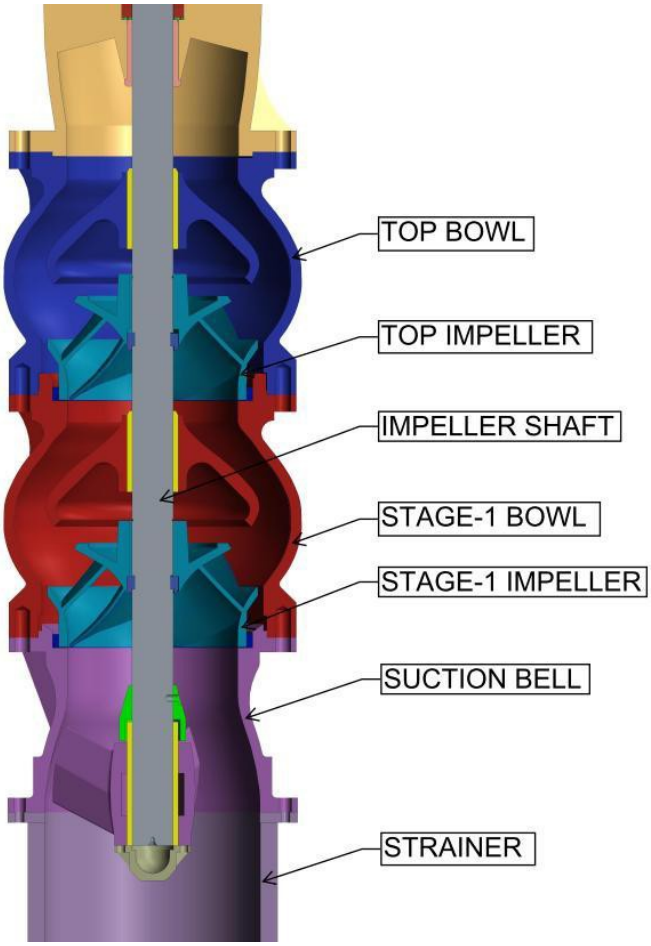


Figure 33 – Multi Stage Bowl Assembly

13.1.2 Classification based on the types of Impellers :

- **Radial Flow Impeller or Turbine Type Impeller (VT):**

  Vertical Turbine Pumps with Radial Flow Impellers are used where the requirement is for High Head Low Discharge of Fluid. In this type of Impeller, the fluid enters axially and is discharged in radial direction as shown in the figure below:

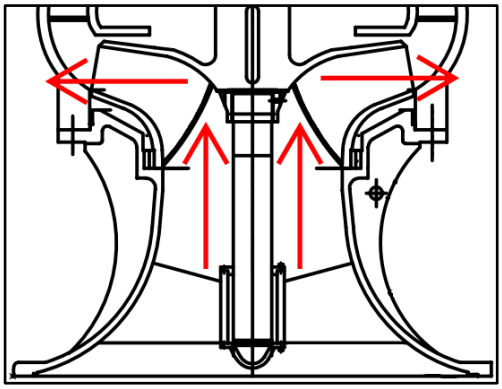


Figure 34 – Typical Radial Flow Impeller in operation

- **Mixed Flow Impeller (VM):**

  Vertical Turbine Pumps with Mixed Flow Impellers are used where the requirement of Head and Discharge is not very high. In this type of Impeller, the fluid enters axially, but the discharge is not in radial direction but at an angle. This particular type of Impeller is a compromise between a Radial Flow Impeller and an Axial Flow Impeller, which delivers Head and Discharge in between the ranges of other two types of Impellers.

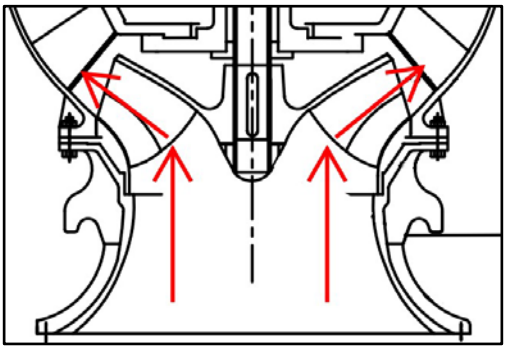


Figure 35 – Typical Mixed Flow Impeller in operation

- **Axial Flow Impeller or Propeller Type Impeller (VP):**

  Vertical Turbine Pumps with Axial Flow are used where the requirement of Discharge is high and Head is Low. These pumps are also called Propeller Pumps due the propeller type of shape of its impeller. In these types of Impellers, the fluid enters the impeller axially and is delivered in axial direction only.

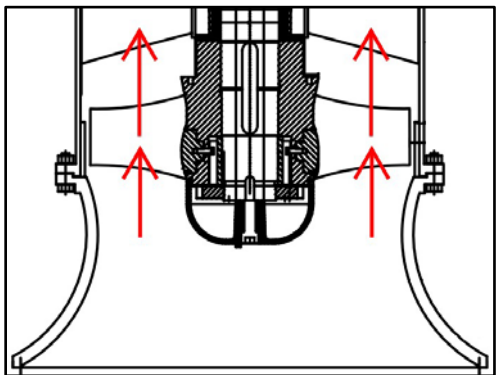


Figure 36 – Typical Axial Flow Impeller in operation

Below table shows the selection criteria for the type of Impellers to be used in different requirements:

Table 4 – Types of Impellers with respective characteristics

Sr. No.	Type of Flow in Impeller	Specific Speed (NSq)	Remarks
1.	Radial Flow (VT or T)	2000 to 4000	High Head Low Discharge
2.	Mixed Flow (VM)	4000 to 9000	Med. Head Med. Discharge
3.	Axial Flow (VP)	Above 9000	Low Head High Discharge

13.1.3 Classification based on Delivery Location :

- **Delivery Location Above Floor (Single Floor System)**

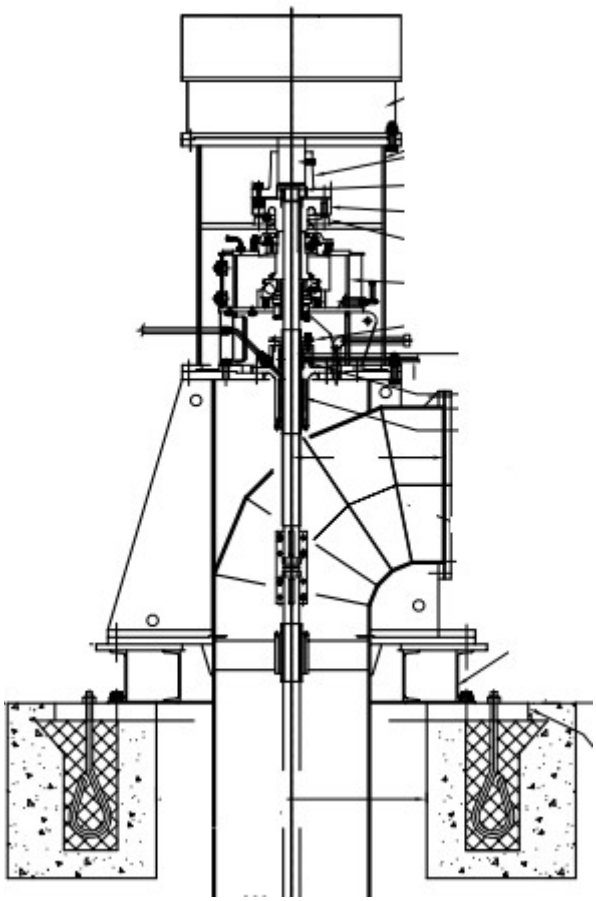


Figure 37 – Discharge Head above Floor

- **Delivery Location Below Floor (Two Floor System)**

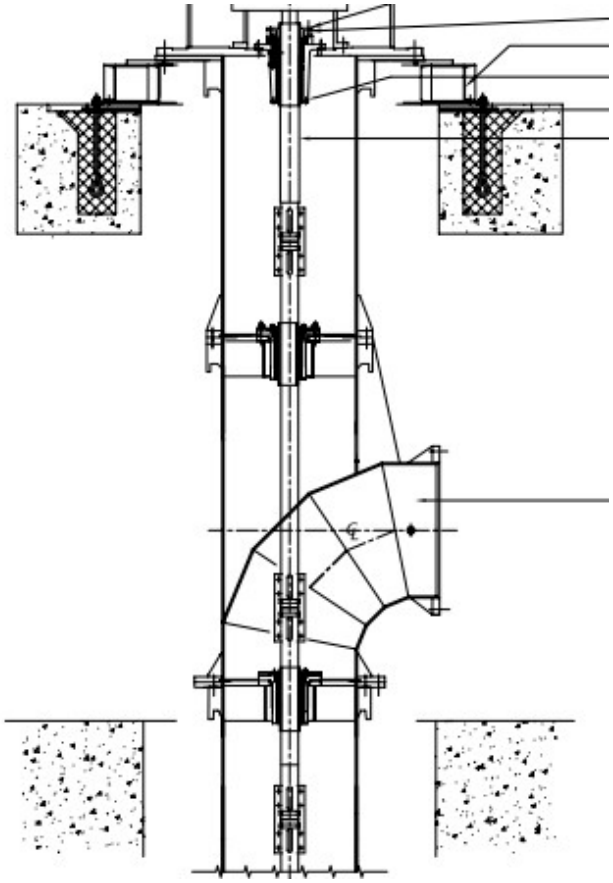


Figure 38 – Discharge Head Below Floor

Delivery Location Above Floor – The Discharge Head and the Motor are located at the same floor level. Refer Figure 37.

Delivery Location Below Floor – The Discharge Head and the Motor are located on two different Levels. Here, the discharge pipe lines are laid below the main floor level. Refer Figure 38.

13.1.3 Classification based on the Lubrication System of Bearings :

- **Self Water Lubrication**

  The bearings in this type of lubrication system are provided with adequate lubrication with the water that is delivered by the pump itself. No additional arrangement is required for the lubrication of such bearings. Such type of lubrication is applied where liquid to be handle is clear and does not contains suspended solid particles. The water to be pumped has very less amount of abrasive elements (typical example: used for the pumping of drinking water)

  Refer Figure 39 for further details.

- **Forced Water Lubrication**

  In this type of lubrication system, water with very less or no abrasive elements is circulated in the shaft enclosing tubes of the column assembly for adequate lubrication of bearings. Life span of bearings with such arrangements is increased due to the absence of abrasive materials in the lubricating water. Such arrangement is used for large sized pumps for irrigation or raw water pumping applications where the water to be pumped has very high amount of abrasive elements present in it.

  Refer Figure 40 for further details.

- **Oil Lubrication**

  This type of lubrication system is similar to the forced water lubrication arrangement. But extra care has to be taken care for avoiding the leakage of oil into the pumped water. Such arrangement is used in some pumps of smaller sizes where constant running of the pumps is necessary.

  Refer Figure 40 for further details.

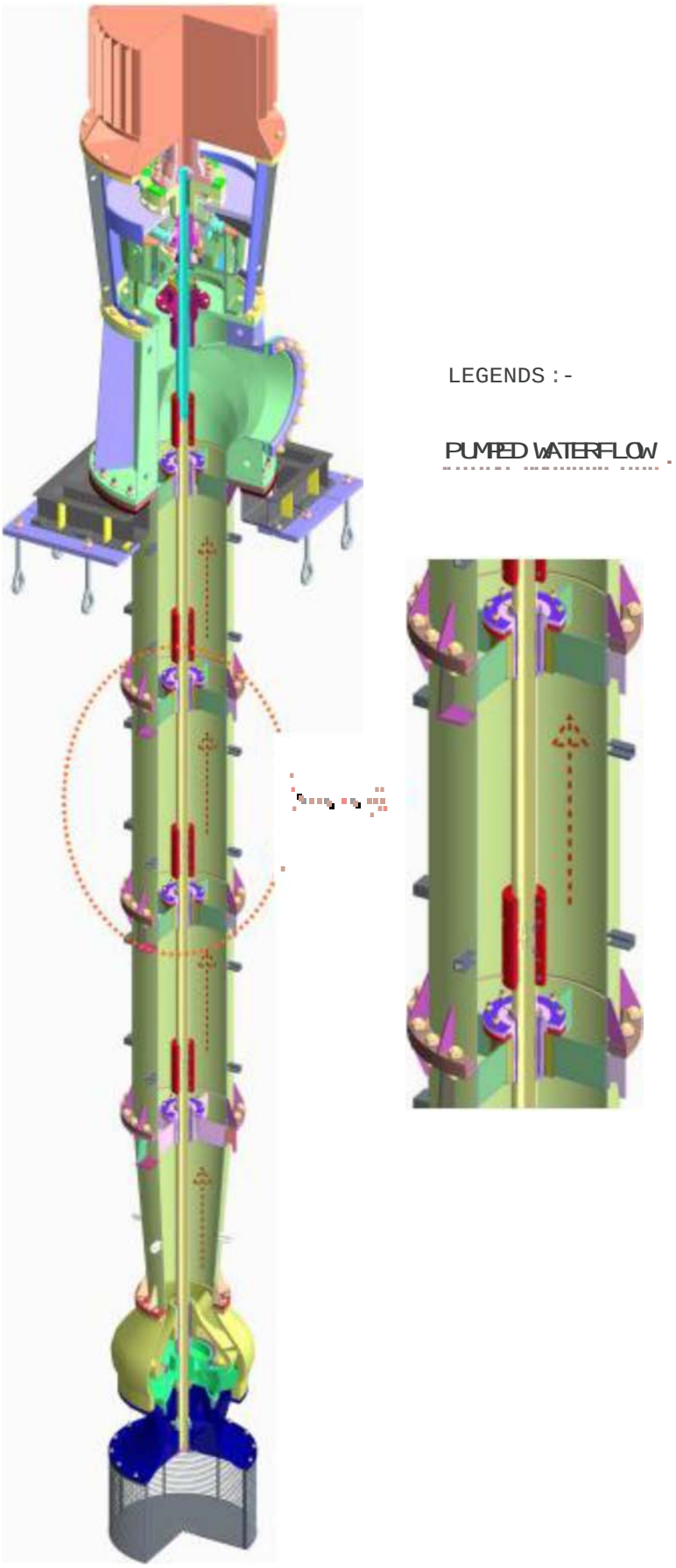


Figure 39 - Vertical Pump with Self Water Lubrication

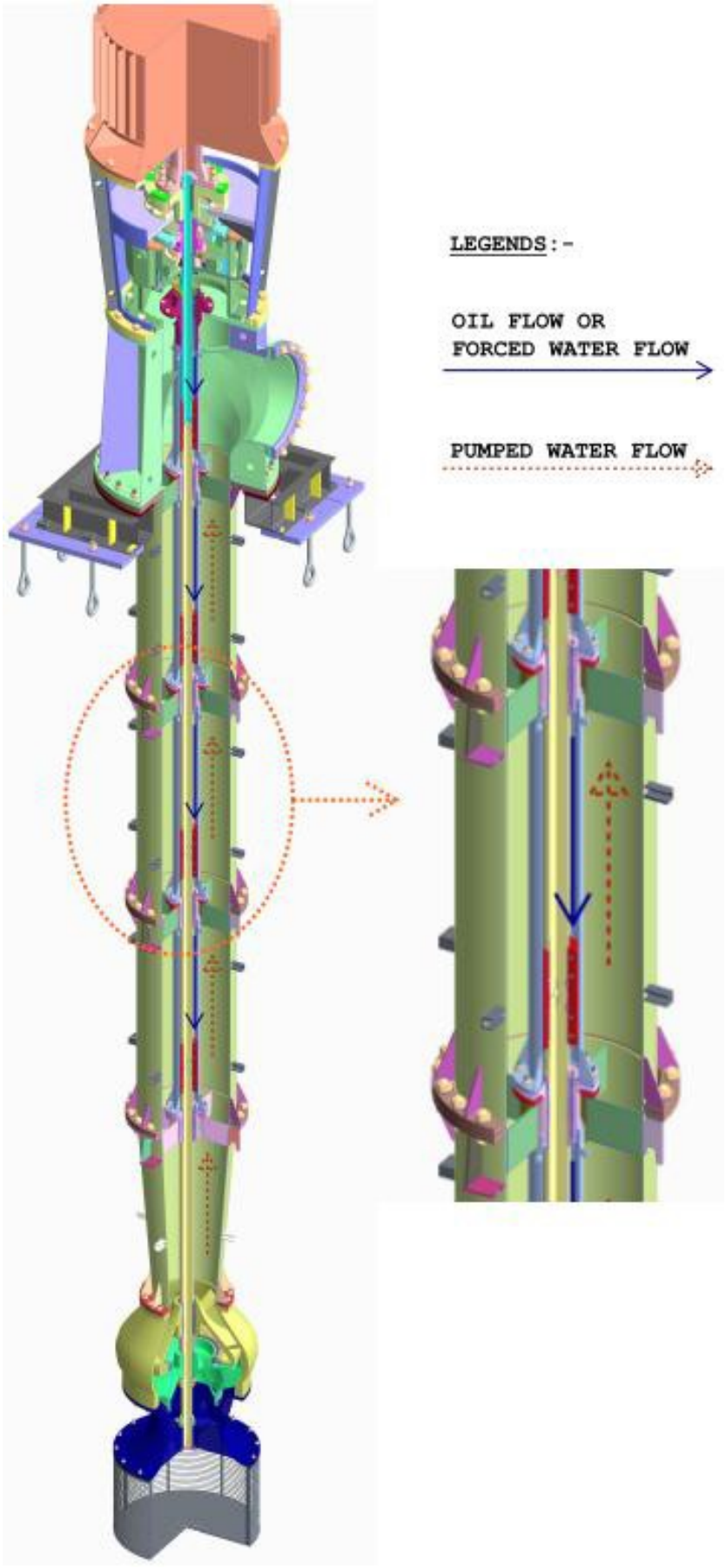


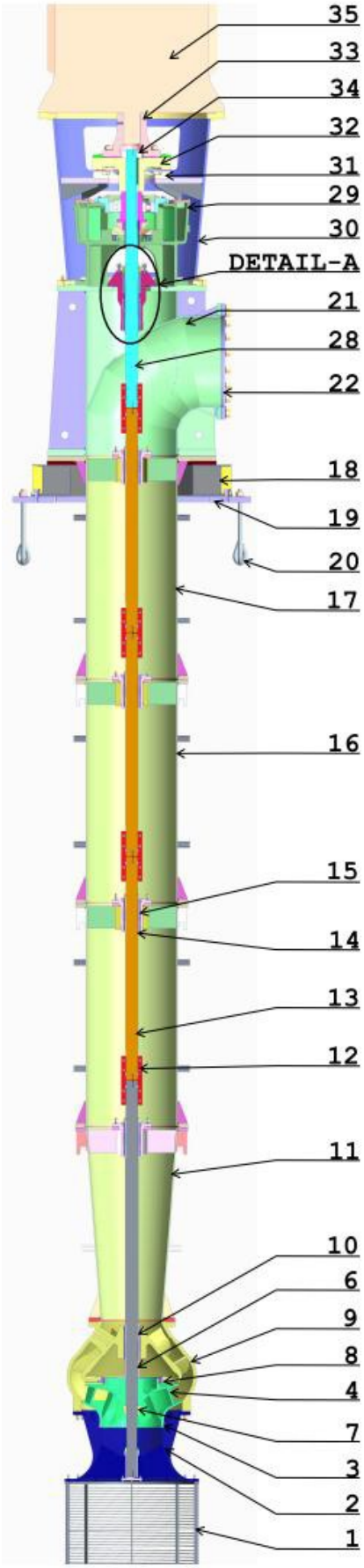
Figure 40 – Vertical Pump with Forced Lubrication (Forced Water or Oil)

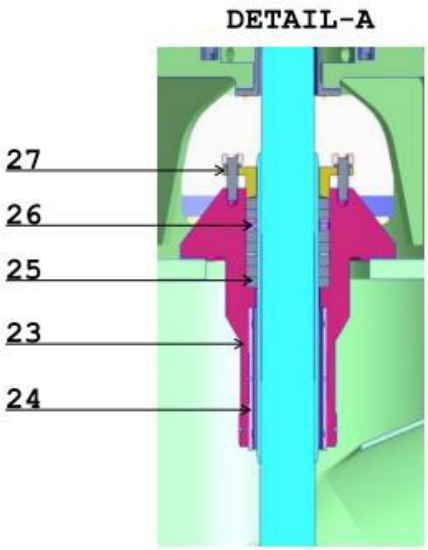
13.2 Components in Different types of classified pumps :

Typically a Vertical Turbine Pump has following major sub-assemblies. Some set of components vary in the below mentioned assemblies based on the different classifications of Pumps.

1. **Bowl Assembly** – that contains a Suction Bell, Impeller mounted on Impeller Shaft, Bowl (called Diffuser also) and a Tapered Column Pipe. In addition to these components, a Suction Strainer is also assembled at the mouth of Suction Bell to prevent any debris or chunks from going inside
2. **Column Pipe Assembly** – mainly constitute for the stem region of a Vertical Pump. All the water from Bowl Assembly is carried by the Column Pipes in the Column Assembly. The Column Pipe Bearings (journal bearing application) support the series of Line Shafts coupled together with the help of muff couplings or screw couplings. This series of Line Shafts is responsible for transferring the rotary motion from Motor to Impeller.
3. **Discharge Assembly** – that consists of the Discharge Head which connects to the main delivery pipe line. It also contains a Bearing Unit that houses Thrust Bearing to absorb axial load of the pump while in rotation. The Motor is mounted on this assembly. The Discharge Assembly also governs the type of Installation, i.e. above floor or below floor. This depends on the requirement of discharge location at site.

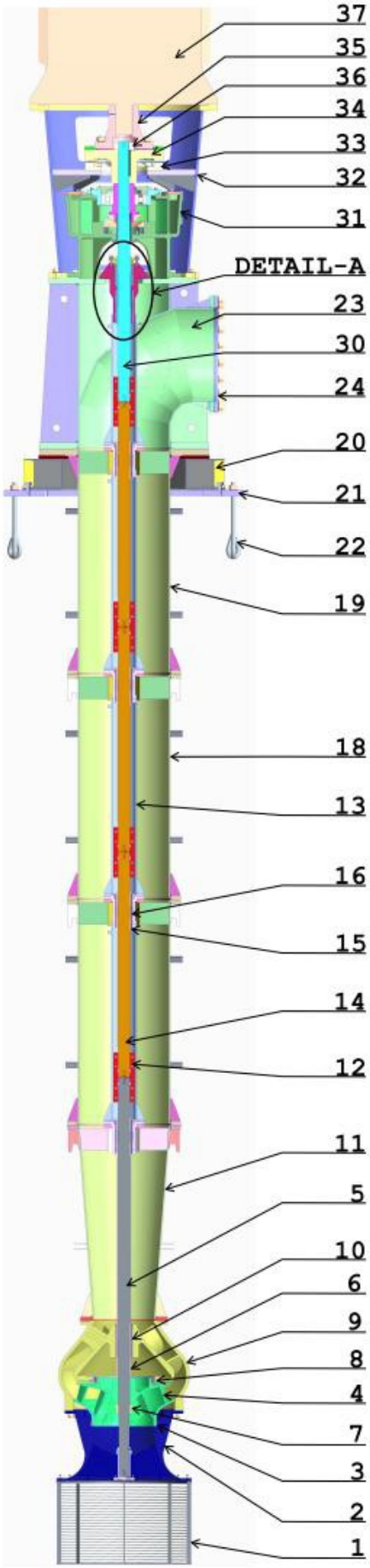
   Figure 41 and Figure 42 show cross section of **Typical Vertical Turbine Pump** along with its major components. Please note that the below figure is for graphical representation purpose only, and must not be considered as final layout of the supplied Pump Assembly.

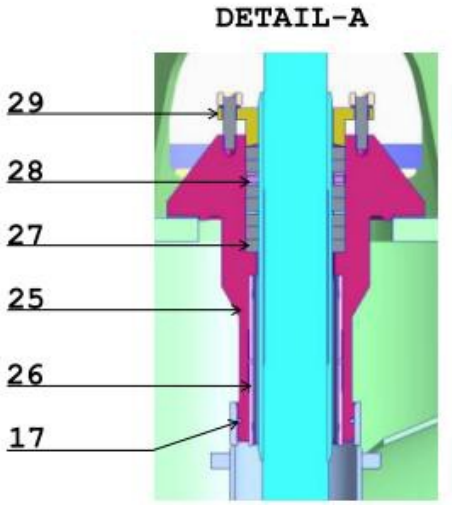




Sr. No.	Description
35	MOTOR
34	IMPELLER ADJUSTING NUT
33	MOTOR HALF COUPLING
32	PUMP HALF COUPLING
31	RATCHET
30	MOTOR SKIRT
29	BEARING UNIT ASSEMBLY
28	TOP LINE SHAFT (HEAD SHAFT)
27	GLAND
26	LANTERN RING
25	GLAND PACKING
24	STUFFING BOX BEARING
23	STUFFING BOX
22	COMPANION FLANGE
21	DISCHARGE HEAD
20	FOUNDATION BOLT
19	SOLE PLATE
18	PUMP BASE
17	TOP COLUMN PIPE
16	COLUMN PIPE
15	LINE SHAFT BEARING
14	LINE SHAFT SLEEVE
13	LINE SHAFT
12	COUPLING
11	TAPER COLUMN PIPE (DIFFUSER)
10	BOWL BEARING
9	BOWL
8	BOWL SEAL RING
7	IMPELLER LOCKING NUT
6	IMPELLER SHAFT SLEEVE
5	IMPELLER SHAFT
4	IMPELLER
3	SUCTION BELL RING
2	SUCTION BELL
1	STRAINER

Figure 41 – Typical Single Stage Vertical Pump (Self Water Lubricated) with Major Components





Sr. No.	Description
37	MOTOR
36	IMPELLER ADJUSTING NUT
35	MOTOR HALF COUPLING
34	PUMP HALF COUPLING
33	RATCHET
32	MOTOR SKIRT
31	BEARING UNIT ASSEMBLY
30	TOP LINE SHAFT (HEAD SHAFT)
29	GLAND
28	LANTERN RING
27	GLAND PACKING
26	STUFFING BOX BEARING
25	STUFFING BOX
24	COMPANION FLANGE
23	DISCHARGE HEAD
22	FOUNDATION BOLT
21	SOLE PLATE
20	PUMP BASE
19	TOP COLUMN PIPE
18	COLUMN PIPE
17	O-RING
16	LINE SHAFT BEARING
15	LINE SHAFT SLEEVE
14	LINE SHAFT
13	SHAFT ENCLOSING TUBE
12	COUPLING
11	TAPER COLUMN PIPE (DIFFUSER)
10	BOWL BEARING
9	BOWL
8	BOWL SEAL RING
7	IMPELLER LOCKING NUT
6	IMPELLER SHAFT SLEEVE
5	IMPELLER SHAFT
4	IMPELLER
3	SUCTION BELL RING
2	SUCTION BELL
1	STRAINER

Figure 42 – Typical Single Stage Vertical Pump (Forced Lubricated) with Major Components

13.2.1 **Bowl Assembly :**

This assembly forms the major functional assembly for the pump. The fluid gets its energy for discharge at the specified Head in this assembly. The suction bell ensures a smooth flow of the fluid into the impeller. Impeller rotates and transfers its rotational energy in the form of Head into the fluid. Bowl ensures a smooth flow of the fluid without much energy loss. Taper Column Pipe works as a diffuser between Bowl Assembly and Column Assembly.

Below is the list of major components of Bowl Assembly:

a. Impeller
b. Impeller shaft with sleeve
c. Suction Bell
d. Suction Strainer (*optional*)
e. Bowl
f. Bowl Bearing
g. Bowl Bearing Sleeve (*in multistage pumps*)
h. Bowl Bearing Housing
i. Taper Column Pipe
j. Impeller Shaft Coupling

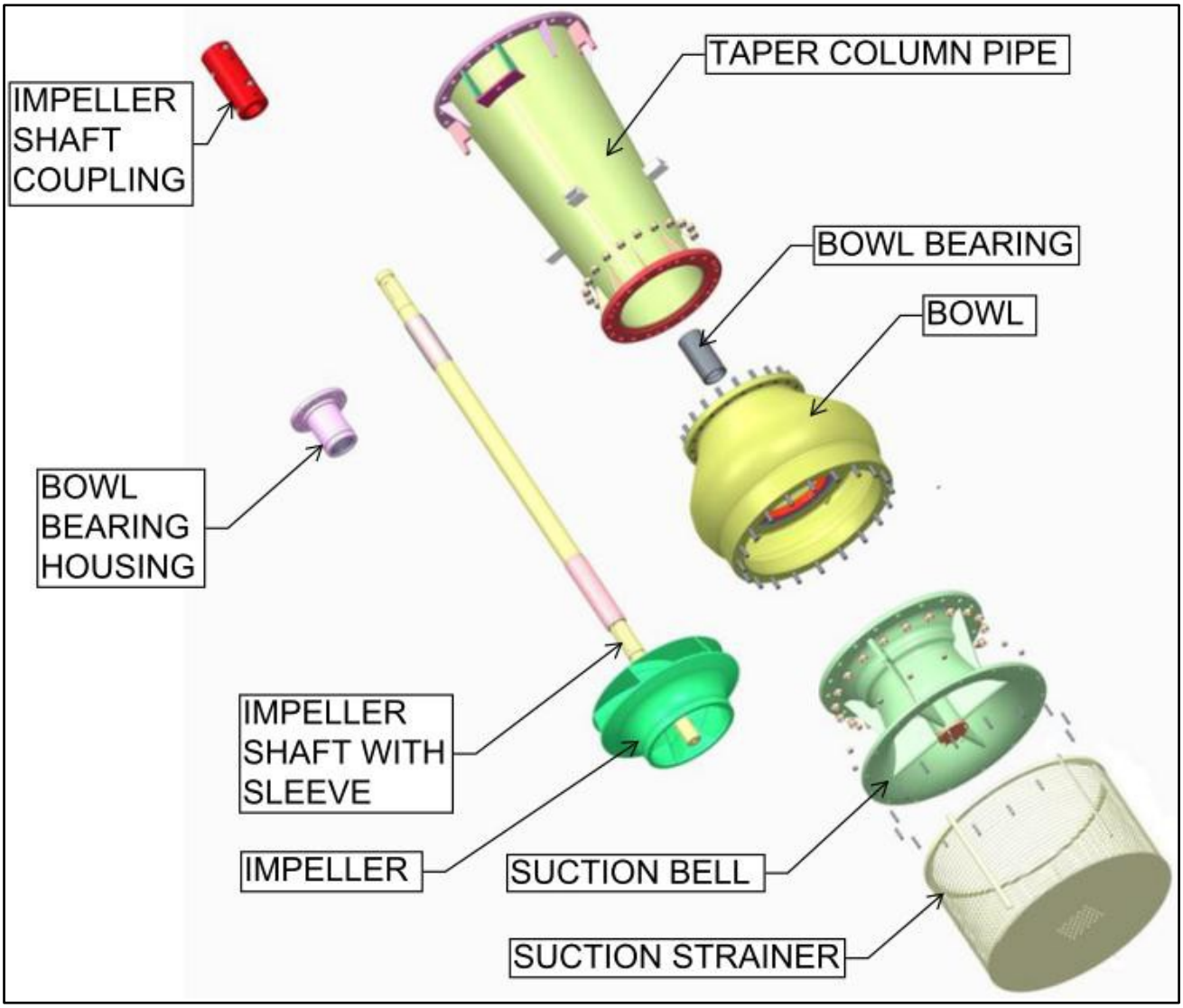


Figure 43 – Exploded View of Bowl Assembly

13.2.2 **Column Pipe Assembly :**

Column Assembly forms the stem of complete pump assembly. Column Assembly acts as a bridge between the Bowl Assembly and Discharge Assembly for delivery of the pumped fluid. Below is the list of major components of The Column Pipe Assembly:

a. Series of Column Pipes
b. Line Shafts
c. Line Shaft Bearings
d. Bearing Housings (*or bearing holders in case of small sized pumps*)
e. Line Shaft Couplings
f. Shaft Enclosing Tubes (*oil lubricated or forced water lubricated pumps*)

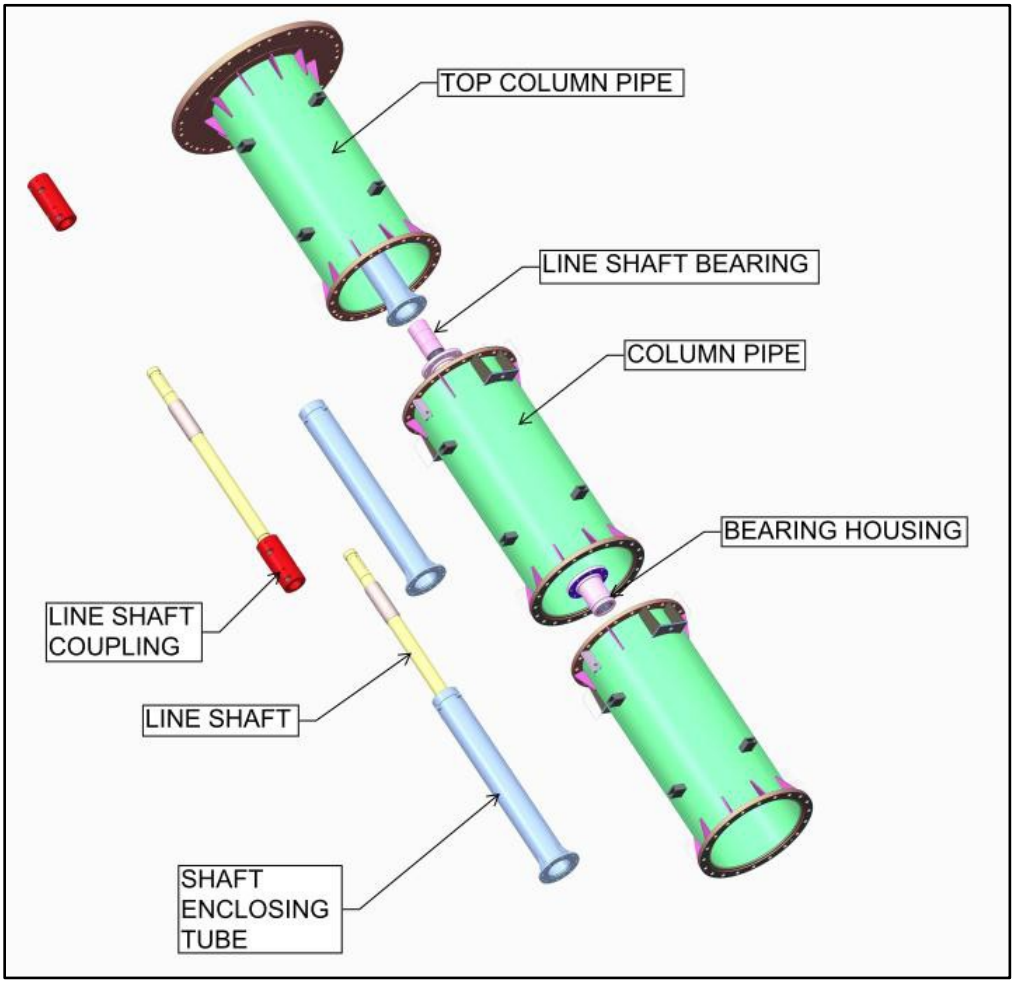


Figure 44 – Exploded View of Column Pipe Assembly

13.2.3 **Discharge Head Assembly :**

Discharge Head provides the drive arrangement to the shafts, Impeller adjustment and most importantly, the outlet arrangement for the pumped fluid and foundation base for the complete pump system using base plate and sole plate. The Discharge Head Assembly consists of the following major components:

a. Motor
b. Motor Skirt
c. Pump Half Coupling
d. Motor Half Coupling
e. Bearing Housing (*Or bearing Unit*)
f. Stuffing Box Assembly
g. Discharge Head
h. Head Shaft or Pump Shaft
i. Line Shaft Bearing
j. Shaft Enclosing Tube (*oil lubricated or forced water lubricated pumps*)
k. Base Plate + Sole Plate

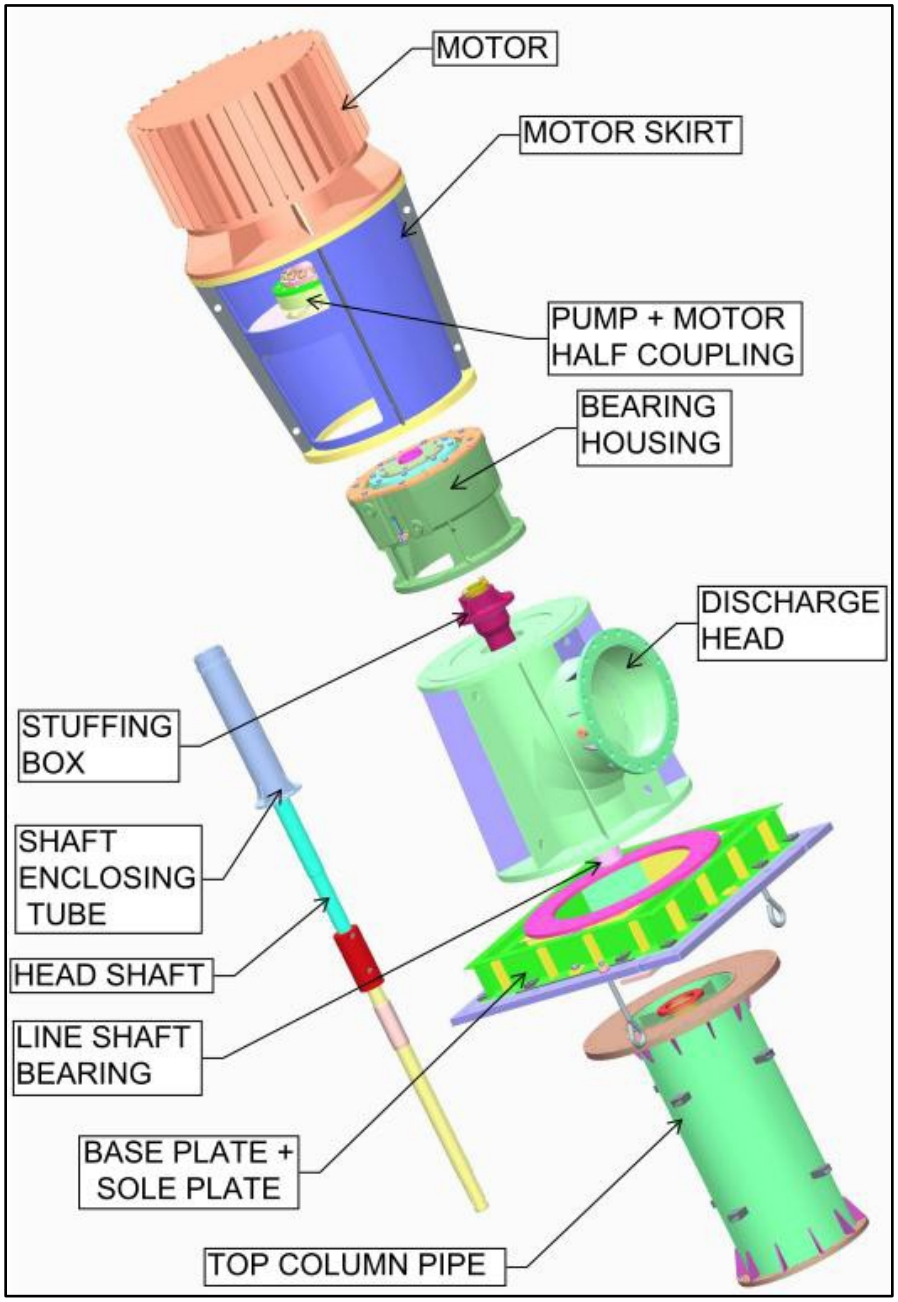


Figure 45 – Exploded View of Discharge Head Assembly

14. Table of Figures and Illustrations :

FIGURE 1 – CROSS SECTION OF TYPICAL FOUNDATION FOR PUMP 12
FIGURE 2 – RESTING THE BOWL ASSEMBLY 14
FIGURE 3 – LIFTING THE BOWL ASSEMBLY 14
FIGURE 4 – ASSEMBLING THE SUCTION STRAINER 14
FIGURE 5 – BOWL RESTING ON SUPPORT BEAMS 14
FIGURE 6 – APPLYING ANTI-SEIZE PASTE ON THE THREADED END OF IMPELLER SHAFT 15
FIGURE 7 – MOUNTING THREADED COUPLING ON SHAFT AND APPLYING GREASE OVER FLANGE FACES 15
FIGURE 8 – RESTING COLUMN PIPE ON WOODEN PLANKS 16
FIGURE 9 – MOUNTING EYE-BOLTS, CHAIN & SHACKLES ON TOP FLANGE FACE 16
FIGURE 10 – LIFTING THE COLUMN PIPE 16
FIGURE 11 – ASSEMBLY OF LINE SHAFT IN BOWL ASSEMBLY 16
FIGURE 12 – ASSEMBLING THE COLUMN PIPE WITH BOWL ASSEMBLY 17
FIGURE 13 – TIGHTENING THE FASTENERS IN DIAMETRICAL FASHION IN THE ASSEMBLY 17
FIGURE 14 – LOWERING THE ENTIRE ASSEMBLY 17
FIGURE 15 – BEARING RETAINER 18
FIGURE 16 – ASSEMBLING BEARING RETAINER AND LINE SHAFT COUPLING 18
FIGURE 17 – ASSEMBLING ADDITIONAL LINE SHAFT 18
FIGURE 18 – ASSEMBLING ADDITIONAL COLUMN PIPE 18
FIGURE 19 – LIFTING THE BOWL ASSEMBLY OF LARGE SIZED PUMPS 19
FIGURE 20 – LOWERING DOWN THE BOWL ASSEMBLY INTO THE SUMP 20
FIGURE 21 – BOWL ASSEMBLY RESTING ON GIRDER / CHANNEL 20
FIGURE 22 – LINE SHAFT INSTALLATION 21
FIGURE 23 – LOWERING THE COLUMN ASSEMBLY 21
FIGURE 24 – ASSEMBLY OF TOP SHAFT 22
FIGURE 25 – LIFTING THE DISCHARGE HEAD 22
FIGURE 26 – GENERAL CROSS SECTION OF STUFFING BOX AND GLAND ASSEMBLY 23
FIGURE 27 – PREPARING GLAND PACKING RINGS FOR STUFFING BOX 24
FIGURE 28 – INSTALLING HOLLOW SHAFT MOTOR 26
FIGURE 29 – IMPELLER ADJUSTMENT MECHANISM TYPE 1 27
FIGURE 30 – IMPELLER ADJUSTMENT MECHANISM TYPE 2 27
FIGURE 31 – IMPELLER ADJUSTMENT IN HOLLOW SHAFT MOTOR 28
FIGURE 32 – SINGLE STAGE BOWL ASSEMBLY 41
FIGURE 33 – MULTI STAGE BOWL ASSEMBLY 41
FIGURE 34 – TYPICAL RADIAL FLOW IMPELLER IN OPERATION 42
FIGURE 35 – TYPICAL MIXED FLOW IMPELLER IN OPERATION 42
FIGURE 36 – TYPICAL AXIAL FLOW IMPELLER IN OPERATION 42
FIGURE 37 – DISCHARGE HEAD ABOVE FLOOR 43
FIGURE 38 – DISCHARGE HEAD BELOW FLOOR 43
FIGURE 39 – VERTICAL PUMP WITH SELF WATER LUBRICATION 45
FIGURE 40 – VERTICAL PUMP WITH FORCED LUBRICATION (FORCED WATER OR OIL) 46
FIGURE 41 – TYPICAL SINGLE STAGE VERTICAL PUMP (SELF WATER LUBRICATED) WITH MAJOR COMPONENTS 48
FIGURE 42 – TYPICAL SINGLE STAGE VERTICAL PUMP (FORCED LUBRICATED) WITH MAJOR COMPONENTS 49
FIGURE 43 – EXPLODED VIEW OF BOWL ASSEMBLY 50
FIGURE 44 – EXPLODED VIEW OF COLUMN PIPE ASSEMBLY 51
FIGURE 45 – EXPLODED VIEW OF DISCHARGE HEAD ASSEMBLY 52

15. Declarations and Disclaimer :

NOTE:

Materials of construction, specifications, dimensions, design features, and application information, where shown in these modules, are subject to change and/or modification without notice by JYOTI LIMITED at their option.

WARRANTY:

New equipment manufactured by Jyoti Limited, Vadodara is warranted to be free from defects in material and workmanship under normal use and service for a period of one year from date of shipment; Jyoti Limited's obligation under this warranty being limited to repairing or replacing at its option any part found to its satisfaction to be so defective provided that such part is, upon request, returned to Jyoti Limited, Vadodara factory from which it was shipped, transportation prepaid. This warranty does not cover parts damaged by decomposition from chemical action or wear caused by abrasive materials, nor does it cover damage resulting from misuse, accident, neglect, or from improper operations, maintenance, installation, modification or adjustment. This warranty does not cover parts repaired outside Jyoti Limited, Vadodara factory without prior written approval. Jyoti Limited, Vadodara makes no warranty as to starting equipment, electrical apparatus or other material not of its manufacture, since the same are usually covered by warranties of the respective manufacturers thereof.

Expressed warranty has been given by Jyoti Limited, Vadodara to Purchaser with respect to the head, capacity or other like performance characteristics or as per purchase order mutually agreed performance parameters of the equipment.

CELEBRATING 70 YEARS OF ENGINEERING EXCELLENCE