GOULDS PUMPS

# Installation, Operation and Maintenance Instructions

## Model 3500 Medium Consistency Pump System

ITT

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# 1 Safety

## 1.1 Important Safety Notice

To: Our Valued Customers:

User safety is a major focus in the design of our products. Following the precautions outlined in this manual will minimize your risk of injury.

ITT Goulds pumps will provide safe, trouble-free service when properly installed, maintained, and operated.

Safe installation, operation, and maintenance of ITT Goulds Pumps equipment are an essential end user responsibility. This Pump Safety Manual identifies specific safety risks that must be considered at all times during product life. Understanding and adhering to these safety warnings is mandatory to ensure personnel, property, and/or the environment will not be harmed. Adherence to these warnings alone, however, is not sufficient — it is anticipated that the end user will also comply with industry and corporate safety standards. Identifying and eliminating unsafe installation, operating and maintenance practices is the responsibility of all individuals involved in the installation, operation, and maintenance of industrial equipment.

Please take the time to review and understand the safe installation, operation, and maintenance guidelines outlined in this Pump Safety Manual and the Instruction, Operation, and Maintenance (IOM) manual. Current manuals are available at https://www.gouldspumps.com/en-US/Tools-and-Resources/Literature/ or by contacting your nearest Goulds Pumps sales representative.

These manuals must be read and understood before installation and start-up.

For additional information, contact your nearest Goulds Pumps sales representative or visit our Web site at https://www.gouldspumps.com

## 1.2 Safety Warnings

Specific to pumping equipment, significant risks bear reinforcement above and beyond normal safety precautions.

**WARNING:**
A pump is a pressure vessel with rotating parts that can be hazardous. Any pressure vessel can explode, rupture, or discharge its contents if sufficiently over pressurized causing death, personal injury, property damage, and/or damage to the environment. All necessary measures must be taken to ensure over pressurization does not occur.

**WARNING:**
Operation of any pumping system with a blocked suction and discharge must be avoided in all cases. Operation, even for a brief period under these conditions, can cause superheating of enclosed pumpage and result in a violent explosion. All necessary measures must be taken by the end user to ensure this condition is avoided.

**WARNING:**
The pump may handle hazardous and/or toxic fluids. Care must be taken to identify the contents of the pump and eliminate the possibility of exposure, particularly if hazardous and/or toxic. Potential hazards include, but are not limited to, high temperature, flammable, acidic, caustic, explosive, and other risks.

**WARNING:**
Pumping equipment Instruction, Operation, and Maintenance manuals clearly identify accepted methods for disassembling pumping units. These methods must be adhered to. Specifically, applying heat to impellers and/or impeller retaining devices to aid in their removal is strictly forbidden. Trapped liquid can rapidly expand and result in a violent explosion and injury.

ITT Goulds Pumps will not accept responsibility for physical injury, damage, or delays caused by a failure to observe the instructions for installation, operation, and maintenance contained in this Pump Safety Manual or the current IOM available at http://www.gouldspumps.com/literature.

# 1.3 Safety

### Definitions

Throughout this manual the words Warning, Caution, Electrical, and ATEX are used to indicate where special operator attention is required.

Observe all Cautions and Warnings highlighted in the Pump Safety Manual and the IOM provided with your equipment.

**WARNING:**
Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
Example: Pump shall never be operated without coupling guard installed correctly.

**CAUTION:**
Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
Example: Throttling flow from the suction side may cause cavitation and pump damage.

**Electrical Hazard:**

**WARNING:**
Indicates the possibility of electrical risks if directions are not followed.
Example: Lock out driver power to prevent electric shock, accidental start-up, and physical injury.

**ATEX:**

**WARNING:**
When installed in potentially explosive atmospheres, the instructions that follow the Ex symbol must be followed. Personal injury and/or equipment damage may occur if these instructions are not followed. If there is any question regarding these requirements or if the equipment is to be modified, please contact an ITT Goulds Pumps representative before proceeding.
Example: Improper impeller adjustment could cause contact between the rotating and stationary parts, resulting in a spark and heat generation.

# 1.4 General precautions

**WARNING:**
A pump is a pressure vessel with rotating parts that can be hazardous. Hazardous fluids may be contained by the pump including high temperature, flammable, acidic, caustic, explosive, and other risks. Operators and maintenance personnel must realize this and follow safety measures. Personal injuries will result if procedures outlined in this manual are not followed. ITT Goulds Pumps will not accept responsibility for physical injury, damage or delays caused by a failure to observe the instructions in this manual and the IOM provided with your equipment.

**Table 1: General Precautions**

| | | |
|---|---|---|
| WARNING | | NEVER APPLY HEAT TO REMOVE IMPELLER. It may explode due to trapped liquid. |
| WARNING | | NEVER use heat to disassemble pump due to risk of explosion from tapped liquid. |
| WARNING | | NEVER operate pump without coupling guard correctly installed. |
| WARNING |  | NEVER run pump below recommended minimum flow when dry, or without prime. |
| WARNING |  | ALWAYS lock out power to the driver before performing pump maintenance. |
| WARNING | | NEVER operate pump without safety devices installed. |
| WARNING |  | NEVER operate pump with discharge valve closed. |
| WARNING |  | NEVER operate pump with suction valve closed. |
| WARNING |  | DO NOT change service application without approval of an authorized ITT Goulds Pumps representative. |
| WARNING | | Safety Apparel:<br>• Insulated work gloves when handling hot bearings or using bearing heater<br>• Heavy work gloves when handling parts with sharp edges, especially impellers<br>• Safety glasses (with side shields) for eye protection<br>• Steel-toed shoes for foot protection when handling parts, heavy tools, etc.<br>• Other personal protective equipment to protect against hazardous/toxic fluids |
| WARNING | | Receiving:<br>Assembled pumping units and their components are heavy. Failure to properly lift and support equipment can result in serious physical injury and/or |

| | | |
|---|---|---|
| | | equipment damage. Lift equipment only at specifically identified lifting points or as instructed in the current IOM. Current manuals are available at www.gouldspumps.com/literature_ioms.html or from your local ITT Goulds Pumps sales representative. Note: Lifting devices (eyebolts, slings, spreaders, etc.) must be rated, selected, and used for the entire load being lifted. |
| WARNING |  | Alignment:<br>Shaft alignment procedures must be followed to prevent catastrophic failure of drive components or unintended contact of rotating parts. Follow coupling manufacturer's coupling installation and operation procedures. |
| WARNING |  | Before beginning any alignment procedure, make sure driver power is locked out. Failure to lock out driver power will result in serious physical injury. |
| CAUTION |  | Piping:<br>Never draw piping into place by forcing at the flanged connections of the pump. This may impose dangerous strains on the unit and cause misalignment between pump and driver. Pipe strain will adversely effect the operation of the pump resulting in physical injury and damage to the equipment. |
| WARNING | | Flanged Connections:<br>Use only fasteners of the proper size and material. |
| WARNING | | Replace all corroded fasteners. |
| WARNING | | Ensure all fasteners are properly tightened and there are no missing fasteners. |
| WARNING |  | Startup and Operation:<br>When installing in a potentially explosive environment, please ensure that the motor is properly certified. |
| WARNING |  | Operating pump in reverse rotation may result in contact of metal parts, heat generation, and breach of containment. |
| WARNING |  | Lock out driver power to prevent accidental start-up and physical injury. |
| WARNING |  | The impeller clearance setting procedure must be followed. Improperly setting the clearance or not following any of the proper procedures can result in sparks, unexpected heat generation and equipment damage. |
| WARNING |  | If using a cartridge mechanical seal, the centering clips must be installed and set screws loosened prior to setting impeller clearance. Failure to do so could result in sparks, heat generation, and mechanical seal damage. |
| WARNING |  | The coupling used in an ATEX classified environment must be properly certified and must be constructed from a non-sparking material. |
| WARNING | | Never operate a pump without coupling guard properly installed. Personal injury will occur if pump is run without coupling guard. |

| | | |
|---|---|---|
| WARNING |  | Make sure to properly lubricate the bearings. Failure to do so may result in excess heat generation, sparks, and / or premature failure. |
| CAUTION |  | The mechanical seal used in an ATEX classified environment must be properly certified. Prior to start up, ensure all points of potential leakage of process fluid to the work environment are closed. |
| CAUTION |  | Never operate the pump without liquid supplied to mechanical seal. Running a mechanical seal dry, even for a few seconds, can cause seal damage and must be avoided. Physical injury can occur if mechanical seal fails. |
| WARNING | | Never attempt to replace packing until the driver is properly locked out and the coupling spacer is removed. |
| WARNING |  | Dynamic seals are not allowed in an ATEX classified environment. |
| WARNING |  | DO NOT operate pump below minimum rated flows or with suction and/or discharge valve closed. These conditions may create an explosive hazard due to vaporization of pumpage and can quickly lead to pump failure and physical injury. |
| WARNING | | Ensure pump is isolated from system and pressure is relieved before disassembling pump, removing plugs, opening vent or drain valves, or disconnecting piping. |
| WARNING | | Shutdown, Disassembly, and Reassembly:<br>Pump components can be heavy. Proper methods of lifting must be employed to avoid physical injury and/or equipment damage. Steel toed shoes must be worn at all times. |
| WARNING | | The pump may handle hazardous and/or toxic fluids. Observe proper decontamination procedures. Proper personal protective equipment should be worn. Precautions must be taken to prevent physical injury. Pumpage must be handled and disposed of in conformance with applicable environmental regulations. |
| WARNING | | Operator must be aware of pumpage and safety precautions to prevent physical injury. |
| WARNING |  | Lock out driver power to prevent accidental startup and physical injury. |
| CAUTION | | Allow all system and pump components to cool before handling them to prevent physical injury. |
| CAUTION |  | If pump is a Model NM3171, NM3196, 3198, 3298, V3298, SP3298, 4150, 4550, or 3107, there may be a risk of static electric discharge from plastic parts that are not properly grounded. If pumped fluid is non-conductive, pump should be drained and flushed with a conductive fluid under conditions that will not allow for a spark to be released to the atmosphere. |
| WARNING | | Never apply heat to remove an impeller. The use of heat may cause an explosion due to trapped fluid, resulting in severe physical injury and property damage. |
| CAUTION | | Wear heavy work gloves when handling impellers as sharp edges may cause physical injury. |
| CAUTION | | Wear insulated gloves when using a bearing heater. Bearings will get hot and can cause physical injury. |

| | | |
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| WARNING | | Noise:<br><br>Sound pressure levels may exceed 80 dbA in operating process plants. Clear visual warnings or other indicators should be available to those entering an area with unsafe noise levels. Personnel should wear appropriate hearing protection when working on or around any equipment, including pumps. Consider limiting personnel's exposure time to noise or, where possible, enclosing equipment to reduce noise. Local law may provide specific guidance regarding exposure of personnel to noise and when noise exposure reduction is required. |
| WARNING | | Temperature:<br><br>Equipment and piping surfaces may exceed 130ºF (54ºC) in operating process plants. Clear visual warnings or other indicators should alert personnel to surfaces that may reach a potentially unsafe temperature. Do not touch hot surfaces. Allow pumps operating at a high temperature to cool sufficiently before performing maintenance. If touching a hot surface cannot be avoided, personnel should wear appropriate gloves, clothing, and other protective gear as necessary. Local law may provide specific guidance regarding exposure of personnel to unsafe temperatures. |
| WARNING | | This product contains Carbon Black a chemical known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov |

## 1.5 

Special care must be taken in potentially explosive environments to ensure that the equipment is properly maintained. This includes but is not limited to:

### Description of Ex-Directives

The Ex-directives are a specification enforced in Europe and the United Kingdom for electrical and non-electrical equipment installed in those locations. Ex-directives deal with the control of potentially explosive atmospheres and the standards of equipment and protective systems used within these atmospheres. The relevance of the Ex-requirements is not limited to Europe or the UK. You can apply these guidelines to equipment installed in any potentially explosive atmosphere.

### Guidelines for compliance

Compliance is fulfilled only when you operate the unit within its intended use. Do not change the conditions of the service without the approval of an ITT representative. When you install or maintain explosion proof products, always comply with the directive and applicable standards (for example, IEC/EN 60079-14).

1. Monitoring the liquid end temperature.
2. Maintaining proper bearing lubrication.
3. Ensuring that the pump is operated in the intended hydraulic range.

The Ex conformance is only applicable when the pump unit is operated within its intended use. Operating, installing or maintaining the pump unit in any way that is not covered in the Instruction, Operation, and Maintenance manual (IOM) can cause serious personal injury or damage to the equipment. This includes any modification to the equipment or use of parts not provided by ITT Goulds Pumps. If there is any question regarding the intended use of the equipment, please contact an ITT Goulds representative before proceeding.

Current IOMs are available at https://www.gouldspumps.com/en-US/Tools-and-Resources/Literature/IOMs/ or from your local ITT Goulds Pumps Sales representative.

All pumping unit (pump, seal, coupling, motor and pump accessories) certified for use in an Ex classified environment, are identified by an Ex tag secured to the pump or the baseplate on which it is mounted. A typical tag would look like this:

If applicable, your pump may have either a CE Ex (ATEX) tag or UKCA Ex tag affixed to the pump. See the Safety section for a description of the symbols and codes. Typical nameplate only shown below, the actual area classification may be different.


**Figure 1: Typical Ex pump nameplate**

**Table 2: Temperature class definitions**

| Code | Maximum permissible pumpage temperature in °C \| °F | Minimum permissible pumpage temperature in °C \| °F |
|---|---|---|
| T1 | 450 \| 842 | 372 \| 700 |
| T2 | 300 \| 572 | 277 \| 530 |
| T3 | 200 \| 392 | 177 \| 350 |
| T4 | 135 \| 275 | 113 \| 235 |
| T5 | 100 \| 212 | Option not available |
| T6 | 85 \| 185 | Option not available |

The code classification marked on the equipment must be in accordance with the specified area where the equipment will be installed. If it is not, do not operate the equipment and contact your ITT Goulds Pumps sales representative before proceeding.

The code classification marked on the equipment must be in accordance with the specified area where the equipment will be installed. If it is not, do not operate the equipment and contact your ITT Goulds Pumps sales representative before proceeding.

## 1.6 Parts

The use of genuine Goulds parts will provide the safest and most reliable operation of your pump. ITT Goulds Pumps ISO certification and quality control procedures ensure the parts are manufactured to the highest quality and safety levels.

Please contact your local Goulds representative for details on genuine Goulds parts.

# 2 Pump Description

## 2.1 Introduction

The ITT Goulds Model 3500 heavy duty stock pump is a centrifugal pump designed to handle paper stock up to approximately 16% O.D. consistency. The pump design incorporates special features to induce flow into the pump suction and to remove air that is present in stock at higher consistencies.

## 2.2 Design concept

There are two major obstacles in pumping paper stock at consistencies above 8% with a centrifugal pump: the formation of a fiber network that will not readily flow, and high air content which can cause air binding of a standard centrifugal pump.

The Model 3500 pump is normally attached to a suction vessel or standpipe, and a constant level is maintained above the suction centerline. An inducer mounted on the end of the pump shaft creates turbulence in the suction standpipe (Fig. 2, Zone 1), breaking up the fiber network and separating air from the pulp. The pulp is then induced to flow into the pump suction by the static head in the standpipe and the pumping action of the inducer. The amount of turbulence required (minimum pump speed) as well as the minimum standpipe level are a function of the stock type, quality, consistency and temperature of each specific application.

Further air separation occurs due to the action of a centrifuge in Zone 2. The air collects in an annulus around the shaft and then passes through balance holes in the impeller shroud. Any remaining paper stock is separated from the air behind the impeller via a patented secondary separation device (U.S. Patent #5,087,171). The paper stock is pumped to the casing volute via large back pump-out vanes (Zone 3), and the air flows to atmosphere or to a vacuum source depending on operating conditions (Zone 5).

Pressure generation takes place in the impeller and casing volute in the normal manner once the air has been removed (Zone 4).

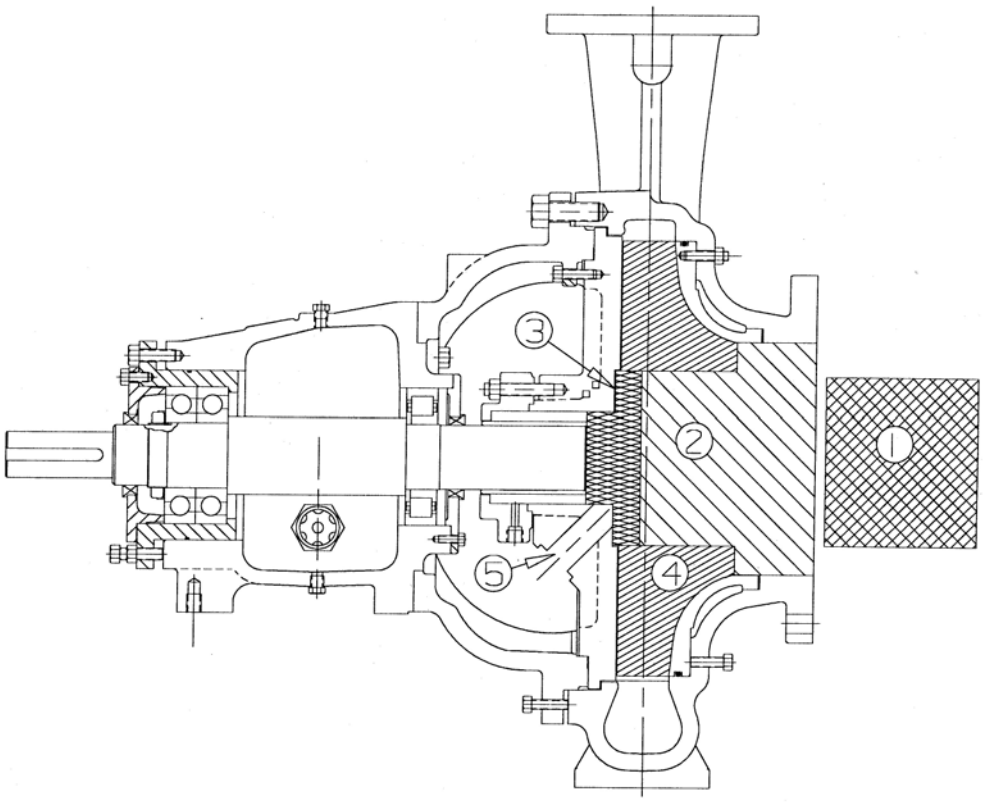



**Figure 2: Suction standpipe zones**

# 2.3 Construction details

Casing - The casing is vertically split, top centerline discharge, providing a back pullout design for ease of maintenance. A renewable sideplate is incorporated into the design to reduce maintenance costs. The sideplate is sealed with an O-ring and gasket.

Impeller - The impeller is an open design with a full back shroud. It is designed for a matched close clearance with the suction sideplate to provide optimum efficiency. The impeller has balance holes to allow air to pass through the back shroud. Remaining paper stock is returned to the casing volute via large pump-out vanes.

The impeller is keyed to the shaft and sealed with PTFE O-rings.

Inducer - A rugged cast inducer breaks up the fiber network to promote entry of the stock into the pump suction. The inducer threads onto the end of the pump shaft and is sealed with a PTFE O-ring.

Centrifuge - A centrifuge between the inducer and the impeller provides superior secondary air separation. The centrifuge is keyed to the shaft and sealed with PTFE O-rings.

Repeller - A patented (U.S. Patent # 5,087,171) repeller behind the impeller provides superior secondary air separation. The repeller is keyed to the shaft and sealed with PTFE O-rings.

Stuffing Box Cover - The stuffing box cover contains a de-gasification nozzle through which excess air is removed. Shaft sealing is accomplished with a mechanical seal as standard.

Shaft/Shaft Sleeve - The shaft is designed to minimize deflection in the seal area and at the impeller. It is protected from the pumpage by a replaceable sleeve sealed with a PTFE O-ring.

Power End - A heavy duty power end is provided for maximum reliability. It includes a duplex angular contact thrust bearing and a cylindrical roller radial bearing for maximum load carrying ability. The bearings are sized for a two year minimum $L_{10}$ (14 year average) life under the worst operating conditions. Oil lubrication is standard and the frame is sealed at both ends with labyrinth oil seals. An external axial adjustment is provided to maintain the proper impeller clearance for optimum efficiency.

# 3 Installation

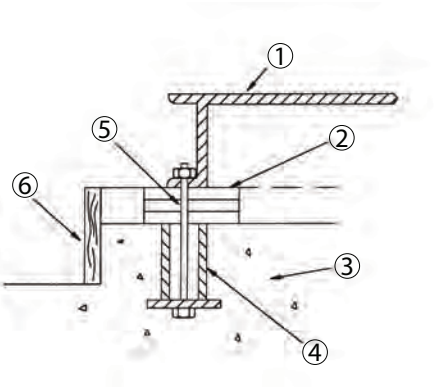
## 3.1 Site / foundation

A pump should be located near the supply of liquid and have adequate space for operation, maintenance, and inspection.

Baseplate mounted pumps are normally grouted on a concrete foundation, which has been poured on a solid footing. The foundation must be able to absorb any vibration and to form a permanent, rigid support for the pumping unit.

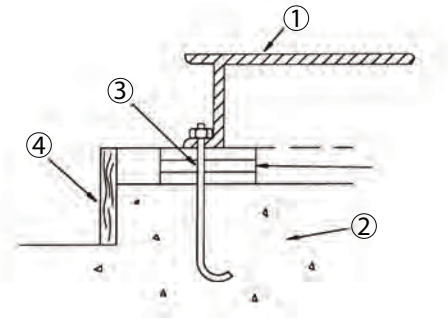
The location and size of the foundation bolts are shown on the outline assembly drawing, provided with the pump data package.

Foundation bolts commonly used are sleeve type (Fig. 3) and J Type (Fig. 4). Both designs permit movement for final bolt adjustment.




1. Baseplate
2. Shims
3. Foundation
4. Sleeve
5. Bolt
6. Dam

**Figure 3: Sleeve type foundation bolts**

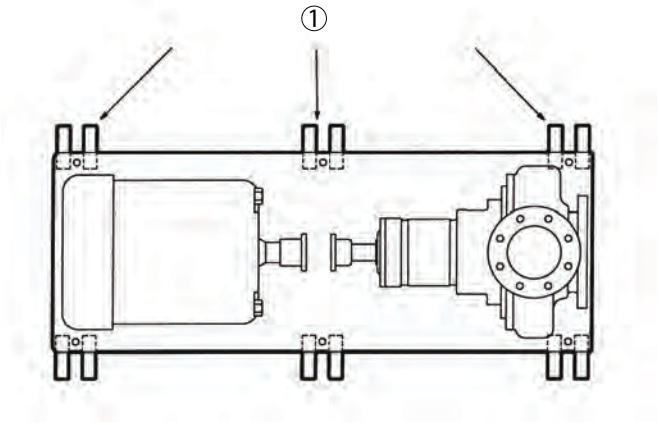



1. Baseplate
2. Foundation
3. J bolt
4. Dam

**Figure 4: J type foundation bolts**

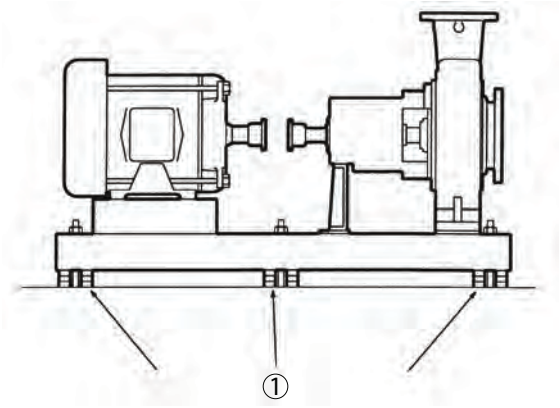
# 3.2 Level baseplate

1. Place two sets of wedges or shims on the foundation, one set on each side of every foundation bolt. The wedges should extend 20 mm (.75 in) to 40 mm (1.5 in) above foundation, to allow for adequate grouting. This will provide even support for the baseplate once it is grouted.
2. Remove water and/or debris from anchor bolt holes/sleeves prior to grouting. It the sleeve type bolts are being used, fill the sleeves with rags to prevent grout from entering.




1. Shims or wedges

3. Carefully lower baseplate onto foundation bolts.
4. Level baseplate to within 3.2 mm (.125 in) over length of the baseplate and to within 1.5 mm (0.875 in) over the width of the base by adjusting wedges.
5. Hand tighten bolts.




1. Shims or wedges

# 3.3 Alignment and alignment procedure

The points at which alignment is checked and adjusted are:

- Initial Alignment is done prior to operation when the pump and the driver are at ambient temperature.
- Final Alignment is done after operation when the pump and driver are at operating temperature.

Alignment is achieved by adding or removing shims from under the feet of the driver and shifting equipment horizontally as needed.

Accurate alignment of the equipment must be attained. Trouble-free operation can be accomplished by following these procedures.

## 3.3.1 Alignment checks

**Initial Alignment (Cold Alignment)**

- Before Grouting Baseplate - To ensure alignment can be obtained.
- After Grouting Baseplate - To ensure no changes have occurred during grouting process.
- After Connecting Piping - To ensure pipe strains haven't altered alignment. If changes have occurred, alter piping to remove pipe strains on pump flanges.

**Final Alignment (Hot Alignment)**

- After First Run - To obtain correct alignment when both pump and driver are at operating temperature. Thereafter, alignment should be checked periodically in accordance with plant operating procedures.

## 3.3.2 Alignment criteria

Good alignment is achieved when the dial indicator readings as specified in the alignment procedure are .05 mm (.002 in.) Total Indicated Reading (T.I.R.) or less when the pump and driver are at operating temperature (Final Alignment).

During the installation phase, however, it is necessary to set the parallel alignment in the vertical direction to a different criteria due to the differences in expansion rates of the pump and driver. Table 2 shows recommended preliminary (cold) settings for electrical motor driven pumps based on different pumpage

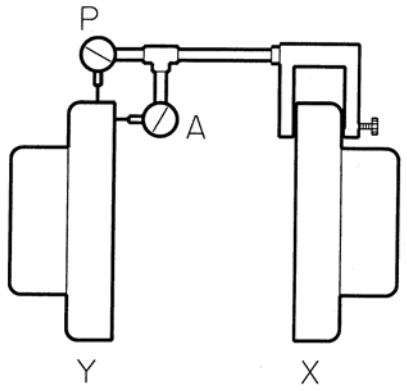
temperatures. Driver manufacturers should be consulted for recommended cold settings for other types of drivers (steam turbines, engines, etc.)

**Table 3: Cold setting of parallel vertical alignment**

| Pumpage Temperature | Set Driver Shaft |
|---|---|
| 10° C (50° F) | .05 mm (.002 in.) LOW |
| 65° C (150° F) | .03 mm (.001 in.) High |
| 120° C (250° F) | .12 mm (.005 in.) High |

# 3.4 Set up

1. Mount two dial indicators on one of the coupling halves (X) so they contact the other coupling half (Y) (Fig. 7).




Y - Motor end

X - Pump end

**Figure 5: Dial indicator mounting**

2. Check setting of indicators by rotating coupling half X to ensure indicators stay in contact with coupling half Y but do not bottom out. Adjust indicators accordingly.

# 3.5 Measurement

1. To ensure accuracy of indicator readings, always rotate both coupling halves together so indicators contact the same point on coupling half Y. This will eliminate any measurement problems due to runout on coupling half Y.
2. Take indicator measurements with driver feet hold-down bolts tightened. Loosen hold down bolts prior to making alignment corrections.
3. Take care not to damage indicators when moving driver during alignment corrections.

## 3.5.1 Angular alignment

A unit is in angular alignment when indicator A (Angular indicator) does not vary by more than .05 mm (.002 in.) as measured at four points 90° apart.

**Vertical Correction (Top-to-Bottom)**

1. Zero indicator A at top dead center (12 o’clock) of coupling half Y.
2. Rotate indicators to bottom dead center (6 o’clock). Observe needle and record reading.

3. Negative Reading - The coupling halves are further apart at the bottom than at the top. Correct by either raising the driver feet at the shaft end (add shims) or lowering feet at the other end (remove shims) (Fig. 8).

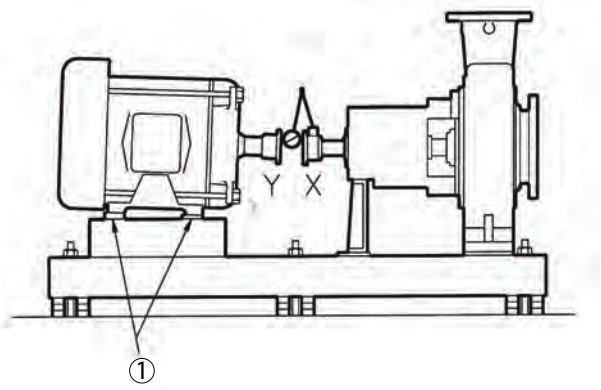



**Figure 6:**

Positive Reading - The coupling halves are closer at the bottom than at the top. Correct by either lowering the driver feet at the shaft end (remove shims) or raising the driver feet at the other end (add shims).

4. Repeat steps 1-3 until indicator A reads .05 mm (.002 in) or less.

**Horizontal Correction (Side-to-Side)**

1. Zero indicator A on left side of coupling half Y, 90° from top dead center (9 o'clock).
2. Rotate indicators through top dead center to the right side, 180° from the start (3 o'clock). Observe needle and record reading.
3. Negative Reading - The coupling halves are further apart on the right side than the left. Correct by either sliding the shaft end of the driver to the left or the other end to the right.

   Positive Reading - The coupling halves are closer together on the right side than the left. Correct by either sliding the shaft end of the driver to the right or the other end to the left (Fig. 9).

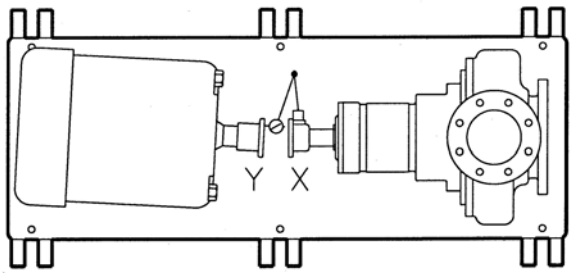



**Figure 7:**

4. Repeat steps 1 through 3 until indicator A reads .005 mm (.002 in.) or less.
5. Re-check both horizontal and vertical readings to ensure adjustment of one did not disturb the other. Correct as necessary.

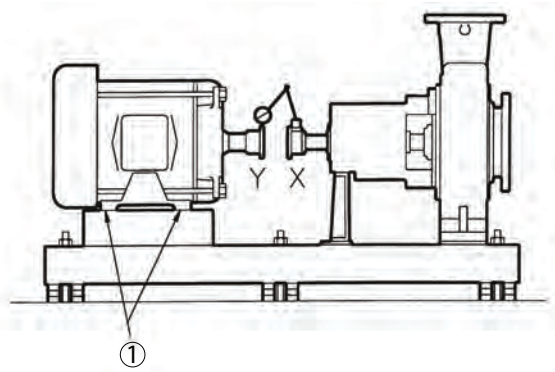
## 3.5.2 Parallel alignment

A unit is in parallel alignment when indicator P (parallel indicator) does not vary by more than .005 mm (.002 in.) as measured at four points 90° apart at operating temperature. Note the preliminary vertical cold setting criteria, refer to Table 3: Cold setting of parallel vertical alignment on page 16.

**Vertical Correction (Top-to-Bottom)**

1. Zero indicator P at top dead center of coupling (12 o'clock) half Y, see Figure 5: Dial indicator mounting on page 16.
2. Rotate indicator to bottom dead center (6 o'clock). Observe needle and record reading.
3. Negative Reading - Coupling half X is lower than coupling half Y. Correct by removing shims of thickness equal to half of the indicator reading under each driver foot.

   Positive Reading - Coupling half X is higher than coupling half Y. Correct by adding shims of thickness equal to half of the indicator reading from each driver foot (Fig. 10).




1. Shims

**Figure 8:**

**NOTICE:**
Equal amounts of shims must be added to or removed from each driver foot. Otherwise the vertical angular alignment will be affected.

4. Repeat steps 1 through 3 until indicator reads within .05 mm (.002 in.) or less when hot, or per Figure 5: Dial indicator mounting on page 16 when cold.

**Horizontal Correction (Side-to-Side)**

1. Zero indicator P on the left side of coupling half Y, 90° from top dead center (9 o'clock).
2. Rotate indicators through top dead center to the right side, 180° from the start (3 o'clock). Observe needle and record reading.

   Negative Reading - Coupling half Y is to the left of coupling half X. Correct by sliding driver evenly in the appropriate direction (Fig. 11).

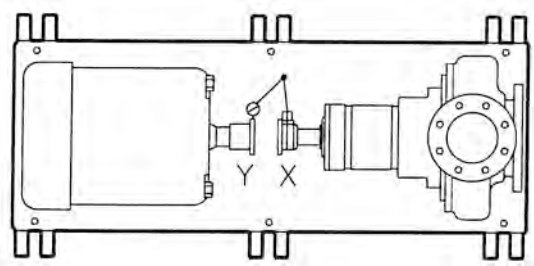



**Figure 9:**

Positive Reading - Coupling half Y is to the right of coupling half X. Correct by sliding driver evenly in the appropriate direction.

**NOTICE:**
Failure to slide motor evenly will affect horizontal angular correction.

3. Repeat steps 1 through 3 until indicator P reads .05 mm (.002 in.) or less.
4. Re-check both horizontal and vertical readings to ensure adjustment of one did not disturb the other. Correct as necessary.

## 3.5.3 Complete alignment

A unit is in complete alignment when both indicators A (angular) and P (parallel) do not vary by more than .05 mm (.002 in.) as measure at four points 90° apart.

**Vertical Correction (Top-to-Bottom)**

1. Zero indicators A and P at top dead center (12 o'clock) of coupling half Y.
2. Rotate indicator to bottom dead center (6 o'clock). Observe the needles and record the readings.
3. Make corrections as outlined previously.

**Horizontal Correction (Side-to-Side)**

1. Zero indicators A and P on the left side of coupling half Y, 90° from top dead center (9 o'clock).
2. Rotate indicators through top dead center to the right side, 180° from the start (3 o'clock). Observe the needle, measure and record the reading.
3. Make corrections as outlined previously.
4. Recheck both vertical and horizontal readings to ensure adjustment of one did not disturb the other. Correct as necessary.

**NOTICE:**
With experience, the installer will understand the interaction between angular and parallel and will make corrections appropriately.

**Table 4: Troubleshooting**

| Problem | Probable Cause | Remedy |
|---|---|---|
| Cannot obtain horizontal (Side-to-Side alignment, angular or parallel) | Driver feet bolt bound. | Loosen pump hold down bolts and slide pump and driver until horizontal alignment is achieved. |
| | Baseplate not leveled properly, probably twisted. | Determine which corner(s) of the baseplate are high or low and remove or add shims at the appropriate corner(s) and realign. |
| Cannot obtain vertical (Top-to-Bottom) alignment, angular or parallel | Baseplate not leveled properly, probably bowed. | Determine if center of baseplate should be raised or lowered and correct by evenly adding or removing shims at the center of the baseplate. |

# 3.6 Grout baseplate

1. Clean areas of baseplate that will contact grout. Do not use oil-based cleaners because grout will not bond to it. Refer to grout manufacturer's instructions.
2. Build dam around foundation. Thoroughly wet foundation (Fig. 12).

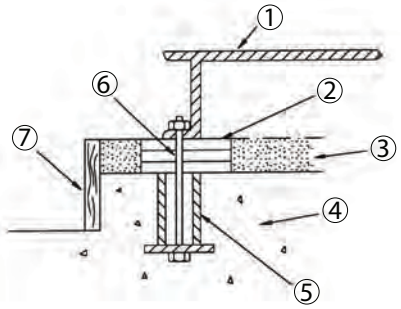



**Figure 10:**

3. Pour grout through grout hold in baseplate, up to level of dam. Remove air bubbles from grout as it is poured into place. Non-shrink grout is recommended (Fig. 12).
4. Allow grout to set.
5. Fill remainder of baseplate with grout. Remove air as before (Fig. 13).

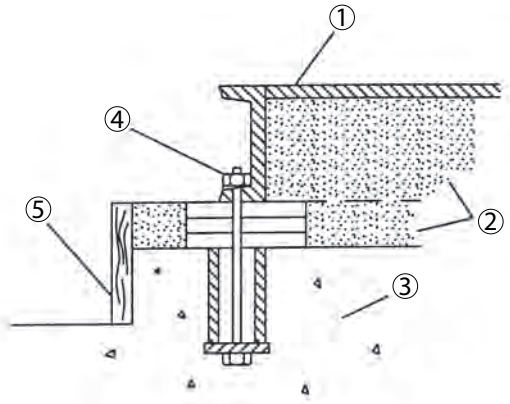



**Figure 11:**

6. Allow grout to set at least 48 hours.
7. Tighten foundation bolts.

## 3.6.1 Alignment check

Re-check alignment before continuing, using methods previously described.

# 3.7 PIPING

## 3.7.1 General

1. All piping must be supported independently of, and line up naturally with, the pump flanges.
2. Piping runs should be as short as possible to minimize friction losses.
3. Do not connect piping to pump until grout has hardened and pump and driver hold-down bolts have been tightened.

# 4 Preparation for Startup

## 4.1 Check rotation

1. Lock out power to driver.
2. Make sure coupling hubs are securely fastened to shafts.
3. Unlock driver power.
4. Make sure everyone is clear. Jog driver just long enough to determine direction of rotation. Rotation must correspond to arrow on bearing housing.
5. Lock out power to driver.

### 4.1.1 Check impeller axial clearance

The proper impeller axial clearance is required for proper air removal and efficient pump operation. See the maintenance section of this manual for the correct clearance and method of setting.

## 4.2 Couple pump and driver

1. Install and lubricate coupling per manufacturer’s instructions.
2. Install coupling guard (Fig. 14).

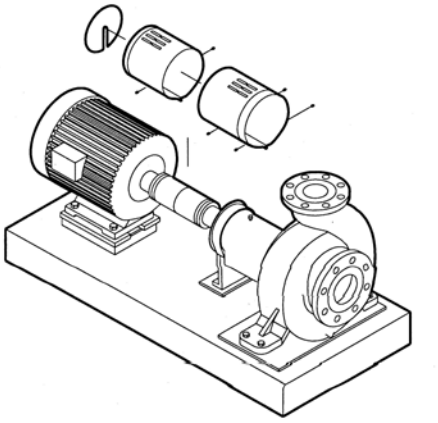


**Figure 12:**

### 4.2.1 Lubricating bearings

Oil Lubrication: Pumps are shipped without oil. Fill the bearing frame with oil, through the filler connection (located on top of bearing frame), until the level reaches the mark in the middle of the oil level sight-glass. A high quality turbine type oil, with rust and oxidation inhibitors should be used.

Refer to the Maintenance Section of this manual for further details on lubrication.

### 4.2.2 Shaft sealing

The Model 3500 pump is supplied with a cartridge mechanical seal as standard. Cartridge seals are pre-set at the factory and require no field settings. Remove the holding clips prior to operation to correctly set the seal. Refer to the manufacturer’s outline drawing and instruction manual for further information.

A fresh water flush is required to lubricate and cool the seal faces. Refer to the Operation section of this manual for details on the seal flush system supplied with the pump.

# 5 Operation and Controls

## 5.1 Air removal system (Refer to Figure 14)

See Figure 13:  on page 23.

The air removal system consists of an on/off control valve (ARV), a vacuum relief valve (VR), a compound pressure gauge (PI), a vacuum pump and piping from the Model 3500 to the vacuum pump.

The vacuum pump pumps the air from the Model 3500, via the degas piping. The vacuum pump is a Nash Model AHF75 liquid ring pump operating at 1150 RPM. The vacuum pump requires about 2 to 4 GPM service liquid flow (operating and maintenance instructions for the Nash vacuum pump are included in the Appendix).

Vacuum pump control is on/auto/off through a switch in the control room.

In the on mode, the vacuum pump is running. In the auto mode, the vacuum pump starts when the model 3500 is started, and stops when the Model 3500 is shutdown.

If the vacuum pump stops during operation, an alarm must warn the operator.

The air removal valve (ARV) prevents stock from entering the air removal piping when the Model 3500 is not running, or the stock consistency is low.

The air removal valve is equipped with a pneumatic actuator and solenoid valve, with the choice of operation auto/on/off through a switch in the control room. In the on mode, the ARV is 100% open, in the off mode, the ARV is closed. In the auto mode, the ARV will be open when the level control valve (LCV) is open and closed when the LCV is closed.

The vacuum relief valve (VR) is used to control the pressure in the air removal system at a constant setting. The pressure in the air removal piping is indicated on the compound gauge (PI).

Before start up, the pressure in the degas system should be set at -5 inches Hg (mercury) gauge. This operation is carried out by starting the vacuum pump with the ARV closed, and adjusting the VR until a reading of 5 in Hg vacuum shows on the compound gauge (PI).

During operation, if fiber is being drawn into the air removal system, the vacuum level should be reduced by opening the VR valve. If discharge pressure or pump operation is erratic, the vacuum level should be increased by closing the VR valve.

## 5.2 Level control - typical

Refer to IOM Appendix for specific description for each unit. Reference Figure 15.

A level must be maintained in the suction standpipe for proper pump operation and air removal. A level transmitter (LT) must be installed to measure standpipe level and provide a signal to a level controller in the control room.

The level measurement range is 0-100%, with the zero point 2' above the pump centerline, and 100% level approximately 1' below the top of the standpipe.

Standpipe level is set on the level controller in the control room. Output from the controller is the input to the level control valve (LCV) on the discharge of the Model 3500 pump.

High and low alarms in the control room should be set at 85% and 10% respectively. Neither alarm should be interlocked to shut down the Model 3500. The Model 3500 will not start if the standpipe level is less than 10%.

The exact operating level for the standpipe must be set for each specific application to obtain optimum air removal and pump performance. With stock temperatures up to 170° F, a level of 3' to 5' above the

pump centerline is typical. Above 170° F, the level must be increased to account for the increased vapor pressure of the stock. At the 195° F, a level of 13' to 14' above the pump centerline will be required.

If the unit is equipped with a variable speed drive, output from the level controller would control the pump speed rather than the LCV position.

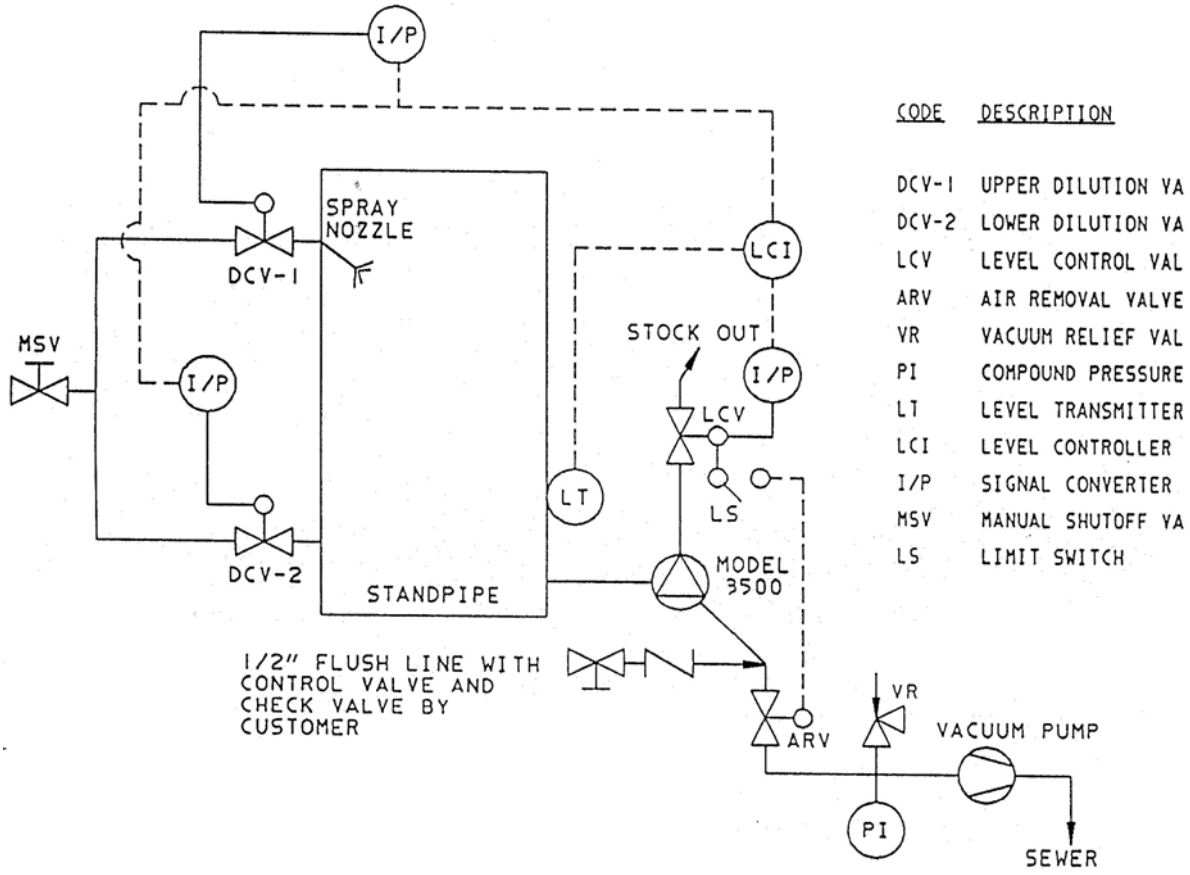



**Figure 13:**

# 5.3 Dilution system – typical

Refer to IOM Appendix for specific description for each unit. Reference Figure 14.

An automatic standpipe dilution system is recommended so the highest possible average consistency for which the discharge piping is designed can be continuously delivered by the pump. The consistency of the stock being pumped is the major contributor to friction head loss in the discharge piping, followed by pH and temperature (this is true only if the same fiber type is being pumped). The higher the consistency, the greater the friction head loss. Usually the only parameter or variable that can be adjusted in the standpipe is stock consistency, which can be controlled by the dilution system.

The dilution system normally consists of an upper spray nozzle with a control valve (DCV-1) and a lower dilution header with a control valve (DCV-2)

In the auto mode, the upper dilution valve (DCV-1) will open to assist pumping when the standpipe level exceeds its setpoint by 10%. A maximum signal selector is also used to allow DCV-1 and DCV-2 to be open a preset amount, while still maintaining the automatic function on an increase in level.

The normal setpoint of the standpipe level controller (LCI) is approximately 25%. When the level exceeds 25%, the level control valve opens to bring the level back to its set-point. When the level exceeds 35%, the dilution controller (DCI) will signal the dilution valve (DCV-1) to start to open. It will open gradually

with level and be 100% open at 85% level. DCV-1 will gradually close as the level decreases back to its set-point.

The lower dilution valve (DCV-2) should be programmed to begin opening when DCV-1 is greater than 50% open, and should be 100% open, when DCV-1 is 100% open.

If the Model 3500 is running and the standpipe level is less than 10%, the upper and lower dilution valves will open 100%. The valves will close when one of the above conditions change.

# 5.4 Seal/vacuum flush

Seal and flush water is manually controlled with a Safematic seal water monitoring unit. The seal water flow to the bearing frame cooling coil and then to the mechanical seal is monitored with a 0-2 GPM flow meter. The seal water from the mechanical seal outlet is directed to the gland flush connection. Seal water required is 1-1½ GPM. A second 0-2 GPM flow meter is supplied to provide 1-2 GPM directly to the Model 3500 vacuum chamber. A third flow meter (0-4 GPM) provides approximately 2 GPM of make-up water directly to the vacuum pump.

Check valves are provided to prevent stock from flowing back into the seal and flush water control unit.

The water supply to the seal and flush water monitoring equipment should be clean filtered water with a maximum particle size of 50 microns and supplied at minimum pressure of 45 PSIG. The seal water flow indicators for the mechanical seal and the vacuum pump are equipped with flow switches, which are set to give an alarm if the flow falls below 50% of the set point. The Model 3500 pump will not start unless the seal water flow is above the minimum.

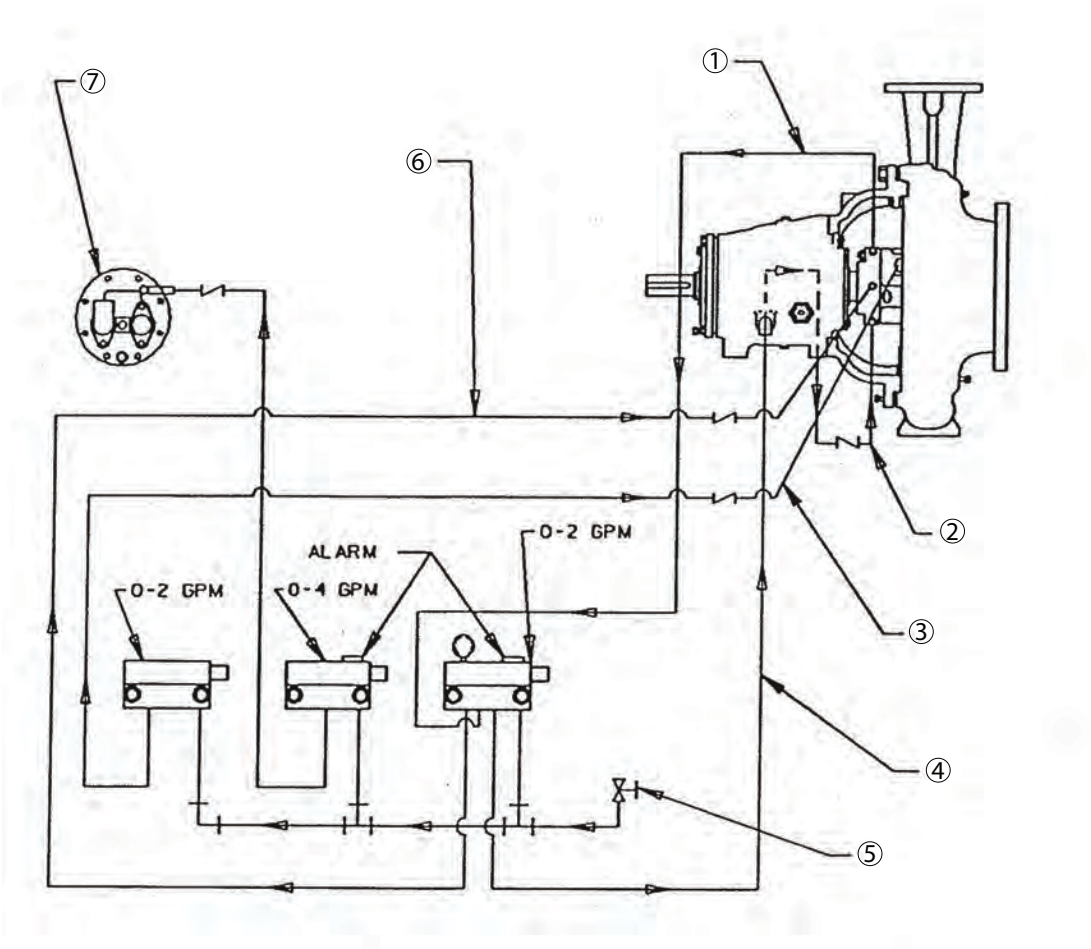



**Figure 14:**

## 5.5 Standpipe steam heating

Detailed operating instructions for optional standpipe steam heating are included in the appendix to this manual.

## 5.6 Pumping water or low consistency stock

The Model 3500 pump system should be checked out with water to make sure everything is operating in accordance with all alarms and interlocks. When running with water the air removal valve is closed, otherwise the system will operate the same as if pumping stock.

## 5.7 Pumping with stock - start up procedure

Turn the seal water on to the mechanical seal (1 - 1½ GPM), the vacuum pump (2 GPM), and to the vacuum chamber (1-2 GPM).

The control switches for the vacuum pump and the air removal valve are in the automatic mode.

Fill the standpipe with water to a minimum level of 35% with DCV-1 and DCV-2.

With the level control in the auto mode, set the level at 35%, start the Model 3500, and open the dilution valves DCV-1 and DCV-2 to 100%.

The vacuum pump starts.

Begin adding stock to the standpipe. When the stock flow to the standpipe is at normal production, slowly close the dilution valves and switch the dilution controller to auto.

Slowly lower the level set value to 20 to 25% leaving the level controller on automatic. If the pump discharge pressure drops or pumping becomes erratic, slowly increase the level until pumping is normal.

## 5.8 Shutdown procedure

During brief shutdowns (approximately four hours or less), it is usually sufficient to flush and drain the standpipe, pump and control valve without displacing the stock in the entire discharge line. During extended shutdowns (over four hours), it is recommended to also flush and drain the discharge line.

Shut off steam, if being used for heating in standpipe.

Stop the pulp flow to the standpipe. After the pulp is pumped from the standpipe and the discharge piping has been cleared of stock, the Model 3500 can be shut down.

During the shutdown sequence, the dilution system, air removal valve and vacuum pump should be in the auto mode. After the Model 3500 is shut down, the air removal valve and the vacuum pump switch should be changed to the off mode.

The seal water to the mechanical seal and the vacuum pump can be shut off. If the seal water to this mechanical seal is left on, the standpipe can gradually fill up with water.

## 5.9 Operation without a vacuum pump

If, for some reason, maintenance is required on the vacuum pump and an interruption in production is not wanted, it may be possible to change out the vacuum pump by the following procedure.

Raise the set value of the level controller 70 to 75% and open the dilution valves 75%. This should dilute the stock to the point where operation without a vacuum pump can be achieved.

Reduce the vacuum in the air removal system, watching to make sure the level in the standpipe does not increase. If the level increases excessively or does not stop, increase the amount of dilution until the pump will operate without air removal system.

Stop the vacuum pump. If the standpipe level remains at its set valve, the vacuum pump can be removed from the system and repaired or replaced.

## 5.10 Monitoring during operation

The pump operation is monitored in the control room with:

- Standpipe level indication
- Discharge control valve position
- Pump speed, if variable speed drive
- Upper dilution valve position
- Lower dilution valve position
- Amp meter for Model 3500 drive motor
- Signal lights showing Model 3500 running, vacuum pump running, and air removal valve position
- Alarms for vacuum pump not running, Model 3500 shutdown, seal water flow, and standpipe high and low level

Monitors at the pump location include:

- Seal water flow to the Model 3500, vacuum pump, and vacuum chamber
- Vacuum/Pressure in the air removal system

The actual value of the level control (LCI) should be within the range of ± 5% of the set value. The normal output signal should be 20-30%. If it is continuously lower than the set value, the regulation of the level control valve may be disturbed.

If the pressure indicator (PI) in the air removal system varies ± 1 ft., the set value of the standpipe level is too low, the pulp in the standpipe contains large amounts of air, or the level control is not working properly.

The Model 3500 motor load should be relatively stable, although consistent variations would be considered normal. Sudden changes in motor load usually indicate that more air is entering the pump from the standpipe, which can be corrected by increasing the standpipe level set point.

Usually the main cause for pumping problems is that the stock in the standpipe contains large void areas, the stock is bridging in the standpipe, the stock consistency is too high, or because changes in consistency, pH or temperature have caused a significant increase in the discharge piping head loss. The above causes can be remedied by increasing the dilution water flow.

**Table 5: Troubleshooting model 3500 standpipe installation**

| PROBLEM | SYMPTOMS | POSSIBLE CAUSE | SOLUTIONS |
|---|---|---|---|
| Pump will not start pumping | Amps to drive motor normal | Control valve LCV does not open | Check that the supply air pressure to the actuator is sufficient |
| | | Discharge pipe plugged | Open by flushing, check that any manual valves in the discharge pipe are open |
| | Amps to drive motor below normal | ARV has not opened | Open manually and check setting on LCV limit switch |
| | | Pressure in air removal piping too high | Check that the vacuum pump is running and the setting of the vacuum relief valve |
| | | Air removal pipe plugged with stock | Flush air removal piping |
| Pump discharge flow too low | Level control valve 100% open | Standpipe dilution valve not operating, or dilution water pressure too low | Check that dilution valve is operating, check dilution water pressure |
| | | Flow too high compared to pump capacity | Check pump and motor speed, check V belts if V belt driven |
| | Pump power consumption and air removal pressure unstable | Level in standpipe too low, or air removal pressure too high | Raise the level set point in the standpipe, or reduce pressure in air removal piping |
| Stock discharge pipe vibrates | Power consumption and air removal pipe pressure stable | Discharge piping inadequately supported | Improve discharge pipe supports and anchors |
| | Power consumption and air removal vacuum unstable | Stock in the standpipe has large voids, or the consistency is too high | Make sure that stock delivered to the standpipe is well shredded. Dilute if necessary by adding dilution at the shredder screw and to the upper part of standpipe. |
| | | The signal to the level control valve is unstable | Check the valve movement, delay the input from the level transmitter if necessary |
| | | Level measurement is too sensitive | Add filtering, or delay the input to the LIC |

| PROBLEM | SYMPTOMS | POSSIBLE CAUSE | SOLUTIONS |
|---|---|---|---|
| Motor overloaded | Motor overloaded | Volume flow above normal | Consistency is too low, switch to manual control |
| Flow unstable | Power consumption normal | Flow transmitter is too sensitive | Increase transmitter response time |
| | Power consumption normal but changes with the level control valve opening | Control not working properly | Recalibrate or adjust controller |

# 6 Maintenance

## 6.1 Lubrication

Oil lubricated bearings must be lubricated at the job site. Remove fill plug and add oil until level is at the center of the sight glass. Replace fill plug.

Change the oil after 2000 hours for new bearings, thereafter every 2000 operating hours or 3 months (whichever comes first). Change more often if oil becomes contaminated with dirt or water.

A high quality turbine oil with runs and oxidation inhibitors should be used. For the majority of operational conditions, bearing temperatures will run between 60° C (140° F) and 82° C (180° F). In this range, an oil of ISO viscosity grade 68 at 40° C (105° F) is recommended. If bearing temperatures exceed 82° C (180° F), use of ISO viscosity grade 100 is recommended.

**Table 6: Lubricating Oil Requirements**

| | **Bearing temperature below 82° C (180° F)** | **Bearing temperature above 82° C (180° F)** |
|---|---|---|
| ISO Grade | VG 68 | VG 100 |
| Approx. SSU at 38° C (100° F) | 300 | 470 |
| DIN 51517 | C68 | C100 |
| Kinem. viscosity at 40° C (105° F) $mm^2/sec$ | 68 | 100 |

**Acceptable Oils**

Exxon: Teresstic EP 68

Chevron: GTS Oil 68

Mobil: Mobil DTE 26 300 SSU @ 38° C (100° F)

Gulf: Gulf Harmony 68

Phillips: Magnus Oil Grade 315

Phillips: MM motor oil SAE 20-20W

Phillips: HDS motor oil SAE 20-20W

## 6.2 Impeller clearance adjustment

If a gradual loss of head and/or capacity occurs, performance can be restored by adjusting the impeller. If performance cannot be restored by adjusting the impeller, the pump should be disassembled and the impeller, suction sideplate, and casing inspected for wear.

The proper impeller clearance setting provides for equal clearance on both the front side (impeller to suction sideplate) and the back side (repeller to stuffing box cover). Prior to setting the impeller clearance, it is first necessary to measure the total impeller travel (normally in the range of 0.090" to 0.140"). Half of the total travel value then becomes the proper clearance to set the impeller off the suction sideplate.

**NOTICE:**
If pump is equipped with a cartridge mechanical seal, the centering tabs must be in place and tightened, and the set screw collar loosened. Failure to take these steps prior to adjusting the impeller clearance can damage the mechanical seal.

To adjust clearance, proceed as follows:

1. Loosen adjustment bolts and nuts (D).
2. Tighten each bolt (C) evenly while slowly rotating shaft, until impeller just starts to rub against suction sideplate.
3. Clamp a dial indicator to the power frame, with the button resting on the end of the shaft or against the face of the coupling hub. Set indicator at 0.
4. Loosen bolts (C).
5. Be sure jam nuts on bolts (D) are loose. Tighten bolts (D) evenly while slowly rotating shaft, until impeller/repeller just starts to rub on the stuffing box cover.
6. The dial indicator will now show the total travel of the impeller. Divide the total travel by two to determine the proper front and back clearance; i.e. if total travel is 0.120", set clearance at 0.060".
7. Loosen bolts (D).
8. Tighten bolts (C) evenly until dial indicator reads the proper clearance (½ the total travel).

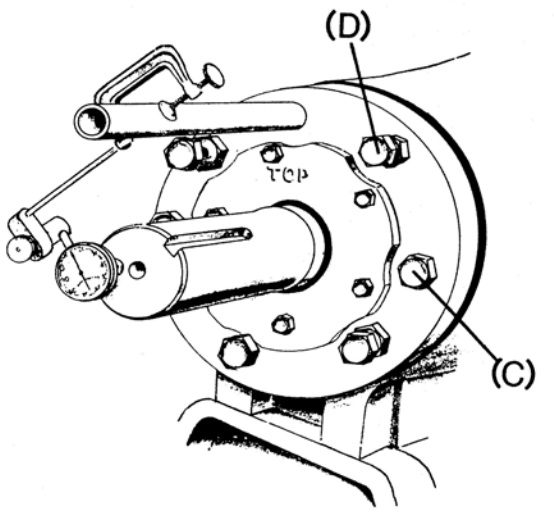



**Figure 15:**

9. Tighten bolts (D) evenly. Check to make sure all bolts (C) are tight. Finally, tighten jam nuts on bolts (D).

   The impeller is now set with equal clearance on the front and back sides. Rotate shaft several times to check for free turning.

> **NOTICE:**
> For pumps equipped with cartridge seals, the following steps must be taken after impeller adjustment to properly set the seal prior to start-up.

10. Tighten drive collar set screws.
11. Loosen and back off centering tabs.

# 6.3 Disassembly

The back pullout feature of this pump allows the complete back pullout assembly (bearing frame and rotating element) to be removed without disturbing suction or discharge piping or driver.

The sectional and parts list contains a complete sectional view of the pump and parts list with the proper identification numbers. Refer to this section as required during maintenance procedures and when ordering spare or repair parts.

To prepare for disassembly, proceed as follows:

1. Lock out power supply to motor.
2. Shut off all valves controlling flow to and from the pump.

3. Remove all auxiliary tubing and piping.
4. Flush the pump to remove corrosive or toxic pumpage if required.
5. Drain liquid from standpipe.
6. Disconnect coupling and remove coupling spacer (refer to coupling instructions).
7. Drain oil.
8. If unit has stuffing box packing, remove the gland stud nuts. The gland is in two halves and can be removed.

To remove the back pullout assembly, proceed as follows:

9. Place chain or sling from crane or hoist through frame adapter (108).
10. Remove frame foot hold-down bolts.
11. Remove bolts (370) which hold frame adapter to casing.
12. Adjust sling tension to support back pullout assembly.
13. Slide the back pullout assembly from the casing. The Model 3500 has jacking bolts (418) to assist disassembly. Screw the jacking bolts into the tapped holes in the frame adapter. Tighten bolts evenly, a flat at a time, to jack back pullout assembly from casing.

    If working space is available to the side of the baseplate, the "pullout assembly" can be turned perpendicular to the baseplate. Replace one pedestal hold-down bold in baseplate and support the bearing frame flange with blocks. Complete disassembly of the “pullout assembly” can be accomplished on the job site. If preferred, it can be removed to an available work area.
14. Remove casing gasket (351).
15. Secure shaft from rotating at the coupling end and loosen and remove inducer (274) by placing a lever between the inducer (274) vanes.

    Slide the centrifuge (275A) off the shaft. Careful prying may be necessary. Remove key (178B).

    Remove the impeller (101) by carefully prying at the back side at 2 points 180 degrees apart.
16. Remove impeller key (178) from the shaft.

    Do not lose or damage the shaft o-rings (496B and 496C).
17. If unit has a mechanical seal, remove gland stud nuts. The gland is a solid ring and cannot be removed after unbolting. Carefully slide the gland off the gland studs and move back on shaft and shaft sleeve. Avoid contact with exposed lapped seal faces and keep them clean.
18. Remove repeller (262) and key from shaft.
19. Remove the adapter to bearing frame bolts (370B) and pull the adapter and stuffing box cover as an assembly. Do not allow the stuffing box cover to strike the shaft, shaft sleeve, or any mechanical seal part.
20. A cartridge mechanical seal is standard. Position and tighten the centering tabs and loosen the drive collar set screws. The cartridge seal can then be removed as a unit.
21. Scribe shaft at coupling hub for proper positioning of hub during reassembly and remove hub.

To disassemble remainder of the liquid end, casing and suction sideplate, proceed as follows:

22. Disconnect suction and discharge flanges.
23. Remove casing hold-down bolts and move casing toward driver. If preferred, casing can be removed from baseplate for further disassembly.
24. Remove suction sideplates nuts (423A).
25. Remove suction sideplate (176) by tightening the three jacking screws (370L). Be careful not to damage the suction sideplate o-ring (412C).

To complete disassembly of power end proceed as follows:

26. Remove the bolts (370B) which hold the frame adapter to the bearing frame. Remove the frame adapter (108).
27. Remove the bolts (360) which hold the inboard bearing end cover to the frame. Remove the end cover (119A) and labyrinth seal (125).
28. Remove bearing housing bolts (370C). Impeller adjustment bolts with jam nuts (370D) can be used to assist in the removal of the shaft and bearing assembly from the bearing frame.

29. Slide the complete shaft assembly from back end of bearing frame. (See Fig. 18) This includes the shaft, both bearings (radial and thrust), and bearing housing. Do not lose or damage bearing housing o-ring.

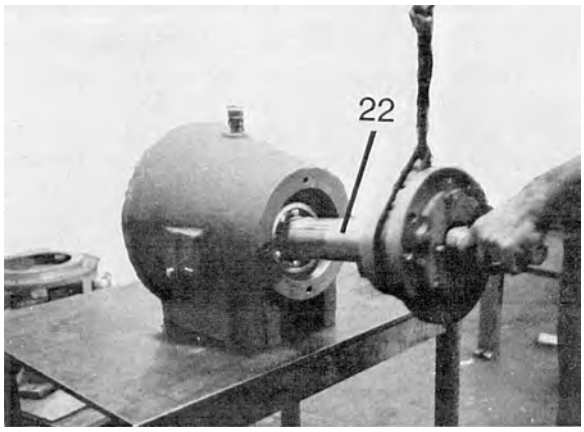



**Figure 16:**

30. Using a bearing puller or a press, remove the inboard cylindrical roller bearing (409). Be sure to apply the removing force to the inner race of the bearing to prevent damage to the races.
31. Be sure shaft and keyway are free of burrs and sharp edges so labyrinth seal o-ring will not be damaged and remove bearing end cover (109A).
32. Slide the bearing housing (134A) off shaft.
33. Straighten "tang" in lock washer (382) and remove bearing lock nut and washer.
34. Remove coupling end bearing using a bearing puller. Care must be taken to prevent damage to bearings. Never use a hammer to drive shaft through bearing. Protect bearing from contamination.
35. 27. The "L" group shaft is equipped with two oil flingers (236). If the shaft is being re-used, the flingers should not be removed, as they may be deformed during removal. If the shaft is being replaced, new flingers should be used.

**Table 7: List of components**

| Item No. | No. Req'd | Part Name | Material | ASTM No. |
|---|---|---|---|---|
| 100 | 1 | CASING | 317SS | A743 GR CG-8M |
| 101 | 1 | IMPELLER | 317SS | A743 GR CG-8M |
| 108 | 1 | ADAPTER, FRAME | CAST IRON | A48 CLASS 25B |
| 109A | 1 | COVER, BRG, END (THRUST) | CAST IRON | A48 CLASS 20 |
| 112A | 2 | BALL BEARING (THRUST) | STEEL | -- |
| 119A | 1 | COVER, BRG, END (RADIAL) | CAST IRON | A48 CLASS 20 |
| 122 | 1 | SHAFT | 4140 AISI | A434 GR 4140 |
| 126 | 1 | SLEEVE, SHAFT | 317SS | A743 GR CG-8M |
| 134A | 1 | HOUSING, BEARING | CAST IRON | A48 CLASS 20 |
| 136 | 1 | LOCKNUT, BEARING | STEEL | -- |
| 176 | 1 | SIDEPLATE, SUCTION | 317SS | A743 GR CG-8M |
| 178 | 1 | KEY, IMPELLER | AISI 303 | A582 TYPE 303 |
| 178B | 1 | KEY, CENTRIFUGE | AISI 303 | A582 TYPE 303 |
| 184 | 1 | COVER, STUFFING BOX ASSY | 317SS | A743 GR CG-8M |
| 228A | 1 | FRAME, BEARING | CAST IRON | A48 CLASS 258 |
| 236 | 2* | FLINGER | STEEL | A569 |
| 241 | 1 | FOOT, FRAME | CAST IRON | A48 CLASS 20 |

| Item No. | No. Req'd | Part Name | Material | ASTM No. |
|---|---|---|---|---|
| 251 | 1 | SIGHT GAGE | STEEL AND GLASS | -- |
| 262 | 1 | REPELLER | 317SS | A743 GR CG-8M |
| 265 | 4 | STUD (GLAND) | AISI 303 | A582 TYPE 303 |
| 265A | 4 | STUD (SIDEPLATE) | AISI 303 | A582 TYPE 303 |
| 274 | 1 | INDUCER | 317SS | A743 GR CG-8M |
| 275A | 1 | CENTRIFUGE | 317SS | A276 TYPE 317 |
| 332A | 1 | SEAL, OIL (THRUST) | NON-METALLIC | -- |
| 333A | 1 | SEAL, OIL (RADIAL) | NON-METALLIC | -- |
| 351 | 1 | GASKET, S.B. COVER TO CASING | NON-ASBESTOS | -- |
| 358N | 1 | GLAND, STUFF, BOX | 317SS | A743 GR CG-8M |
| 360 | 1 | GASKET, BRG, END COVER (RADIAL) | VELLUMOID | -- |
| 360A | 3 | GASKET, BRG, END COVER (THRUST) | VELLUMOID | -- |
| 360P | 1 | GASKET, (SIDEPLATE) | NON-ASBESTOS | -- |
| 370 | 12 | H.C. SCREW (ADAPT. TO CASING) | STEEL | A193 8-7 |
| 370A | 6 | H.C. SCREW (END COVER - THRUST) | STEEL | A307 GR 8 |
| 370B | 4 | H.C. SCREW (ADAPT TO FRAME) | STEEL | A307 GR 8 |
| 370C | 4 | H.C. SCREW (BRG. HSG) | STEEL | A307 GR 8 |
| 370D | 4 | HEX TAP BOLD (ADJ.) | STEEL | A307 GR 8 |
| 370F | 2 | H.C. SCREW (FOOT TO FRAME) | STEEL | A307 GR 8 |
| 370H | 1 | H.C. SCREW (ADAPT. TO BOX) | STEEL | A307 GR 8 |
| 370L | 3 | HEX TAP BOLT (JACKING) | AISI 303 | A582 TYPE 303 |
| 370P | 6 | H.C. SCREW (END COVER - RADIAL) | STEEL | A307 GR 8 |
| 382A | 1 | LOCKWASHER, BRG. | STEEL | -- |
| 400 | 1 | KEY, COUPLING | CARBON STEEL | A108 GR 1018 |
| 408 | 1 | PLUG (BRG, FRAME - VENT) | STEEL | -- |
| 408A | 1 | PLUG (BRG, FRAME - DRAIN) | STEEL | -- |
| 408B | 1 | PLUG (S.B. COVER - VENT) | 316SS | A276 TYPE 316 |
| 409 | 1 | BRG., CYLINDRICAL ROLLER (RADIAL) | STEEL | -- |
| 412C | 1 | O-RING (SUCTION SIDEPLATE) | VITON | -- |
| 412F | 2 | O-RING (SHAFT SLEEVE & REPELLER) | PTFE | -- |
| 423 | 4 | HEX NUT (GLAND) | AISI 304 | A276 TYPE 304 |
| 423A | 4 | HEX NUT (SIDEPLATE) | AISI 304 | A276 TYPE 304 |
| 423B | 4 | HEX NUT (ADJ.) | STEEL | A563 |
| 437 | 2 | LOCKWASHER (FRAME TO FOOT) | STEEL | -- |
| 494 | 2** | COOLER (BRG. HSG.) | 304SS/COPPER | -- |

| Item No. | No. Req'd | Part Name | Material | ASTM No. |
|---|---|---|---|---|
| 496 | 1 | O-RING (BRG. HSG.) | BUNA | -- |
| 496C | 2 | O-RING (INDUCER & CENTRI-FUGE) | PTFE | -- |

* "L" Group only

** Only one cooler on "S" & "M" Group

**Table 8: Bearing designation vs pump size and group**

| Pump Size | Group | Thrust Bearing | Radial Bearing |
|---|---|---|---|
| 3x6-14 | S | SKF BA2B459313 | SKF NUP-313ECP |
| 4x8-18H | M | SKF 8317 | SKF NUP-317ECP |
| 6x10-18 | M | SKF 8317 | SKF NUP-317ECP |
| 6x10-22H | M | SKF 8317 | SKF NUP-317ECP |
| 4x8-24 | L | SKF BA24B459422 | SKF NUP-222ECP |

# 6.4 Inspection and overhaul

### Impeller and Repeller

Replace if impeller or repeller show excessive erosion, corrosion, extreme wear or vane breakage. O-ring grooves must be in good condition. Check condition of bores, as fit on shaft is critical (0.0010 to 0.0025" clearance standard). Check impeller balance if possible (max. unbalance of 3.6 in-oz. standard).

### Inducer and Centrifuge

Replace if they show excessive erosion, corrosion, or bent/broken vanes. Check condition of o-ring grooves.

### Suction Sideplate

Replace if sideplate shows excessive metal loss due to corrosion, erosion or wear.

### Shaft

Check for runout to see that the shaft is not bent. Bearing seats and labyrinth seal areas must be in perfect condition and free of scratches and grooves. O.D. and finish in these areas must be within bearing manufacturer’s specifications. Check that the keyway is free of corrosion. Replace shaft if necessary.

### Shaft Sleeve

The shaft sleeve is a push fit and is bored 0.001" to 0.003" larger than the shaft and should tap easily on the shaft. If the sleeve does not tap on easily, the bore and shaft should be inspected to see that they are free from foreign matter or burrs. The fit of the key in the keyway should also be checked to see that it is not causing binding. The key should have a sliding fit on the sides and should have clearance at the top. Sleeve surface in stuffing box must be smooth and free of grooves. If grooved, replace. O-ring groove must be in good condition. The original diametrical clearance between shaft sleeve and stuffing box bore is 0.025" to 0.032". If this clearance has increased to more than 0.050", the shaft sleeve, and at times the stuffing box, should be replaced.

### Mechanical Seal

Lapped seal faces, gaskets, and shaft sealing members must be in perfect condition or excessive leakage may result. Replace worn or damaged parts.

**Ball Bearings**

Replace if worn, loose, rough or noisy when rotated. Replacement bearings must be of the proper size and type as specified in the construction details (Figure 20).

**Labyrinth Oil Seals**

Inspect and replace if o-rings are torn or otherwise damaged.

**General**

All parts should be clean before assembly. This is especially important at o-ring grooves, threads, lock fits, gasket surfaces and bearing areas. Any burrs should be removed with crocus cloth.

# 6.5 Reassembly of pump

This procedure covers reassembly of the pump after complete disassembly. Be sure all directions in the Inspection and Overhaul section have been followed.

Installation of Thrust Bearings

The Model 3500 utilizes a thrust bearing on the coupling end of the shaft designed for high unidirectional thrust loads. It is thus critical that the thrust bearing be installed in the proper orientation. The "S" and "L" group pumps utilize a four point contact bearing paired with a standard

angular contact bearing. The "M" group pump utilizes a Pumpac pair of bearings. Refer to bearing chart in Figure 19 for detailed bearing designations.

Both types of thrust bearings consist of a matched pair of bearings with an arrow scribed on the outer races (see Figures 21 & 22). The arrow must point in the direction of axial thrust (i.e. towards the coupling end of the shaft). An arrow attached to the top of the bearing frame (Figures 21 & 22) shows the correct thrust direction.

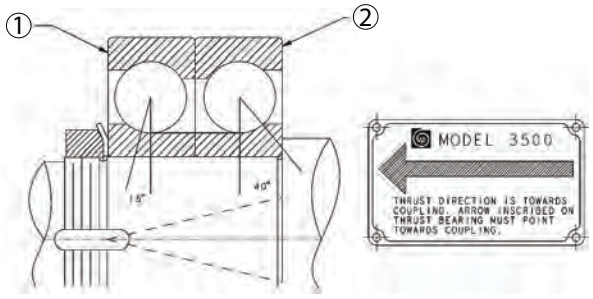
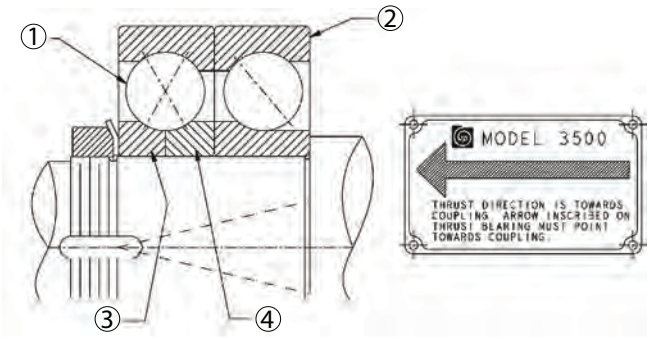



**Figure 17:**




1. Inner ring, inside
2. Outer ring, balls and cage
3. Inner ring, outside
4. Angular contact, ball bearing assembly

**Figure 18:**

1. Install shaft flingers. Note: flingers are required on "L" group pumps only. Prop shaft upright and apply a light coat of oil to the shaft turn for the flinger. Place flinger on shaft and push on by hand as far as possible. Use a block of wood and a hammer to seat the flinger in place against the shaft shoulder. The block should be set against the thin wall of the flinger that forms the cylindrical mounting surface (see Figure 22). Flip the shaft to place the other end up and install the second flinger in the same manner.

   "S" and "L" Group
2. Refer to Figure 22 for installation of the four point thrust bearing. Remove bearings from boxes and orient as shown in Figure 22. Note: Items 1 and 3 are not interchangeable. Heat and mount item 1 against shaft shoulder. Lubricate and install item 2. Heat and install item 3. Heat and install item 4.

   "M" Group

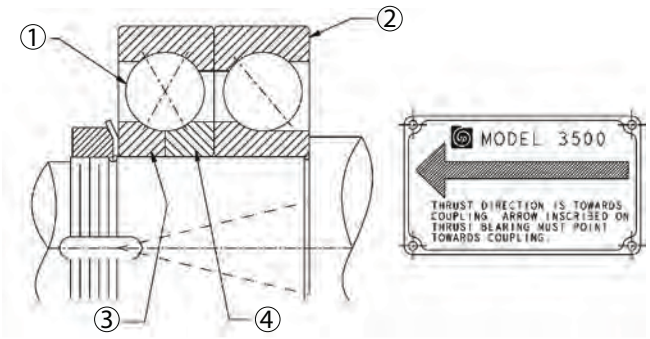
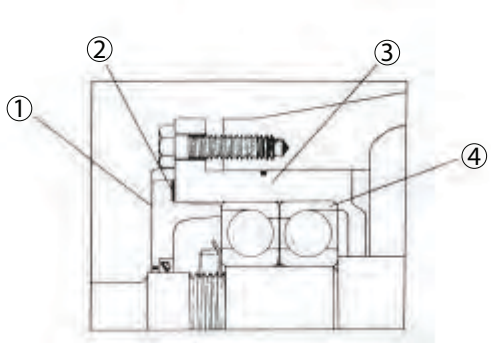



**Figure 19:**

3. Install Pumpac thrust bearing as follows. Removed bearings from boxes and orient as shown in Figure 21. Oil bearing seat on shaft. Slide both bearings onto shaft as far as possible by hand. Place pipe or driving sleeve over shaft making sure it rests against inner race only. Make sure bearing is square on shaft. Tap or press evenly until bearing is seated firmly against the shaft shoulder. Do not mar shaft, especially where it contacts the labyrinth seal.
4. Insert the bearing lock washer (382A), pressing tang into shaft keyway until it is firmly against the bearing.
5. Oil shaft threads lightly and snug the bearing locknut (136) against the lock washer. Tighten firmly with a spanner wrench. Seat tang securely into slot in locknut with drift pin. If necessary, tighten locknut slightly to match tang with slot. Do not loosen locknut to position.

6. Slide bearing housing (134A) with o-ring in place, over impeller end of shaft and over outboard bearing.
7. Install labyrinth seal stator into thrust end cover with o-ring lubricant applied to o-ring.
8. Place bearing end cover and .006" white manilla gasket over coupling end of shaft and fit into bearing housing. If oil seal is dry, oil lightly before sliding over shaft. Be sure to position TOP (cast on cover) in line with TOP on housing. Bolt end cover firmly to housing. Install labyrinth seal rotor on shaft with o-ring lubricant.
9. Oil inboard bearing seat on shaft. Slide inboard roller bearing on shaft as far as possible by hand. Place driving sleeve of sufficient length over the shaft. The sleeve should contact the inside race of the bearing. Be sure the bearing is square on shaft then press or tap the bearing firmly against the shaft shoulder. Take care not to mar shaft.
10. Place a small amount of o-ring lubricant on inside of bearing frame at oil seal. Slide shaft assembly into the bearing frame as far as possible. When the bearing housing is properly installed (oil return hole at the bottom), the word TOP located on the flange of the bearing housing will line up with the top of bearing frame. Be sure bearing housing o-ring (496) is in place in groove on housing. Insert bearing housing bolts into bearing housing and screw about ½" into frame to hold shaft during further assembly.
11. Install labyrinth seal stator into the bearing end cover (inboard) with o-ring lubricant.
12. Slide gasket and inboard bearing end cover over shaft and bolt to bearing frame.
13. Install labyrinth seal rotor on shaft with o-ring lubricant.
14. Bearing end play may be determined at this point as follows:

    Clamp dial indicator to the pump so that the button rests against the end of the shaft. Push the shaft back and forth as far as possible. Total end play must be at least 0.001" and not more than 0.008". If end play is less than 0.001" add coupling and bearing end cover gaskets made form 0.006" thick manilla paper. Because of machining tolerances, duplex thrust bearings may vary in which by up to 0.030". A correctly assembled pump may require as few as one or as many as three 0.006" thick gaskets. See to Figure 24.




15. Install and position coupling hub at scribe mark on shaft.
16. Slide shaft sleeve with cartridge mechanical seal in place on the shaft.
17. Assemble stuffing box cover to frame adapter before attaching frame adapter to bearing frame.
18. Bolt frame adapter and stuffing box cover assembly to bearing frame with (370B).
19. Install repeller (262) on shaft. Insure shaft sleeve and repeller o-rings (412F) are in place.
20. Place stuffing box cover-to-casing gasket against shoulder of stuffing box cover. Small amounts of o-ring lube may be used on both sides of gasket to seal and secure gasket in place.
21. Lubricate shaft with never seize or similar substance and install impeller key (178). Be sure shaft sleeve o-ring (496B) is in place. Slide impeller on shaft. Install centrifuge key (178B) and slide centrifuge (275A) with o-ring (496C) in place on shaft until it contact impeller. With inducer o-ring (496C) in place, screw inducer (274) into end of shaft. Prevent shaft from rotating and use a lever approximately 4 ft. in length to firmly tighten.

**NOTICE:**
Insufficient tightening of inducer may result in loosening during operation which may damage pump.

22. Lubricate suction liner o-ring (496A) with a silicone based o-ring lubricant and install in suction liner o-ring groove. Also, lubricate the bore in the casing which will contact with this o-ring. Carefully guide the suction liner into casing. To facilitate installation, liner should be placed with the large diameter held off the floor and the casing lowered over the line. Install and evenly tighten suction liner nuts (423A). Be sure the jacking bolts (370L) have been backed off.
23. Tighten casing hold-down bolts.
24. Connect suction and discharge flanges. Care should be taken to prevent excessive pump flange loading.
25. Slide the completely assembled "back pullout" unit into the casing. Tighten the frame adapter-to-casing bolts evenly to assure that the gap between adapter and casing is even. Check with a feeler gauge at 4 points 90 degrees apart around the adapter.
26. Install pedestal hold-down bolts. Frame pedestal (241) is not to be flush with baseplate. Clearance of ¼" is normal. Install shims under pedestal before tightening.
27. Set impeller clearance as outlined in this section. Overall travel should be .090" to .140" depending on tolerances. If not, check casing gasket to be sure it is 1/16" thick. If total travel is greater than .250" due to impeller wear, then impeller should be replaced.
28. Tighten drive collar set screws on cartridge mechanical seal. Loosen and remove centering tabs.
29. Replace auxiliary piping.
30. Follow procedures outlined in Section 4 - Preparation for Start-up.

**NOTICE:**
Pay particular attention to instructions concerning alignment and lubrication.

## 6.6 How to order

When ordering parts call 1-800-446-8537 or your local ITT Goulds Representative.

## 6.7 Emergency service

Emergency parts service is available

24 hours/day, 365 days/year

Call 1-800-446-8537

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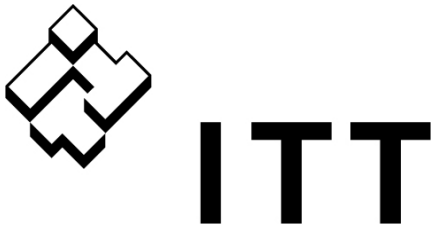

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3951 Capitol Avenue
City of Industry, CA 90601-1734
USA

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