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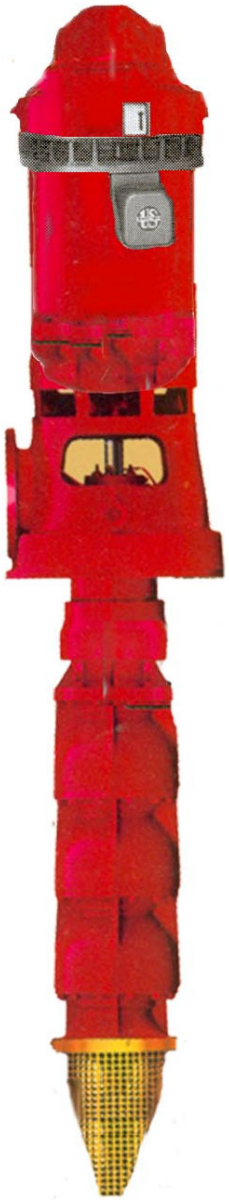
INSTALLATION INSTRUCTIONS FOR SHORT-COUPLED LINESHAFT TURBINE PUMP



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INTRODUCTION

An Armstrong Turbine Pump is a precision machine and satisfactory operation is dependent to a great extent upon careful and correct installation. Good, sound, practical judgment must be used by the installer to adapt these instructions to the particular installation. Read the instructions through carefully before starting installation. Always keep in mind that axial alignment is extremely important in a line shaft turbine and that turbine pumps are designed to move clean, solids-free fluids.

The purpose of this manual is to explain how to install a short-coupled turbine pump that is to be set shallow enough to have the bowl, column, and head shipped together as an assembled unit. Many applications for vertical turbines fit into this category, from cooling towers to golf course irrigation to municipal drinking water. Therefore, an entire manual was dedicated to the factory pre-assembled units.

I. PRE-INSTALLATION PROCESSES

A. Checking the Sump Conditions

Before any attempt is made to install the pump, the sump should be checked carefully to make sure of the depth and cleanliness of the receptacle. The sump depth should be measured to make sure that it will receive the total pump length. The water level in the sump should be measured prior to installation of the pump to make sure the pump will have proper submergence. The pump bowl should be submerged at all times, when the pump is operating.

Check the sump for any debris that may have fallen into during the construction or alteration of the system. Nails, welding slag, pieces of metal, and excessive sand are all examples of foreign matter that can be found at a location and that can destroy a pump.

B. Checking the Hoisting Equipment

Contact the factory for the approximate total weight of the pumping unit. This weight can be confirmed by checking it against freight bills, if available. All components of the pulling unit should be rated for no less than twice the total weight of the pump.

The lifting equipment must also allow the pumping unit to be lowered at a controlled rate of speed. The shock resulting from any of the suspended equipment hitting the foundation with any speed may cause damage to the pumping unit. Personal injury, as well as, the mechanical damage could result from unsafe handling.

C. Gathering the Required Equipment and Supplies

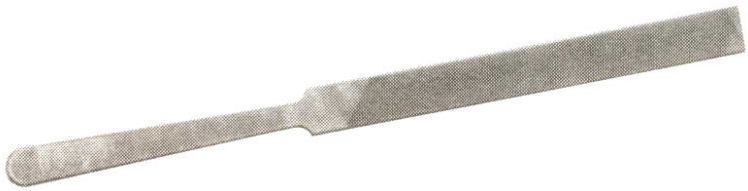
Minimum Selection of Tools Required for Installing the Pump

Qty	Description
1	cable sling or chain of sufficient strength and length to lift the entire pump for discharge head installation.

2	pipe wrenches to thread together the shafting.

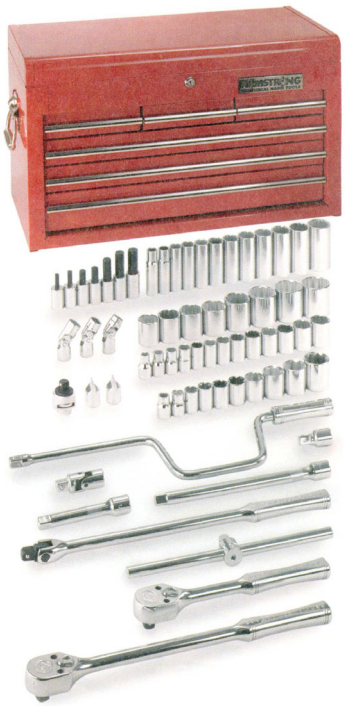
2	14" adjustable crescent wrenches.

1	flat file.



1	wire brush.

1 assortment of sockets, ratchet, and open/closed end wrenches.

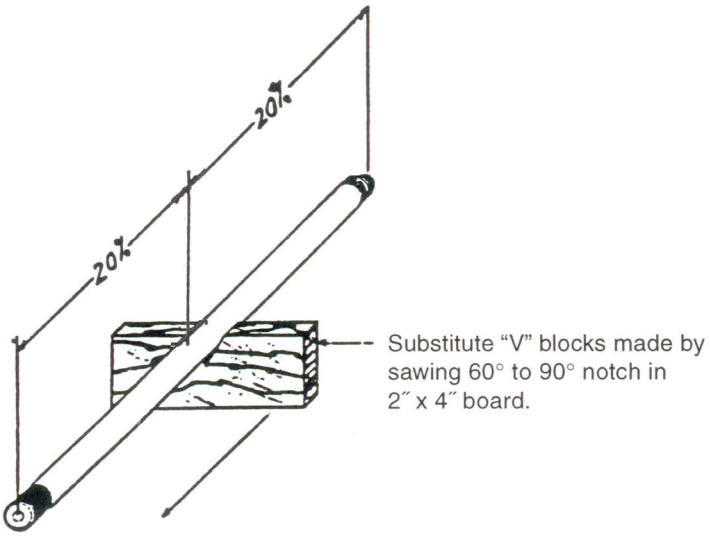


1 assortment of flat and "Phillips" type screw drivers.

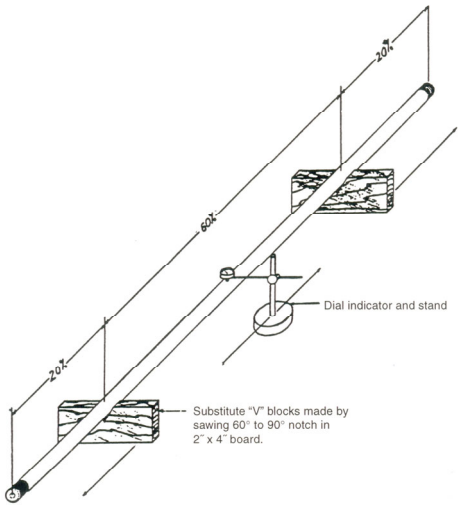
1 small paint brush for cleaning threads.

1 50’ rope.

2 "V" blocks or shaft rollers to support shafting for checking straightness.



1 dial indicator and stand calibrated in .001" divisions for checking shaft straightness.



An assortment of cleaning rags, two sheets of fine Emery cloth and three cornered files large enough to fix small thread defects are also required. A supply of distillate or coal oil should be available for cleaning purposes. If gasoline must be used, add turbine oil as a lubricant to keep the shafting from seizing in the shaft coupling.

The turbine oil used should meet the following specifications:

1. Food grade
2. Non-detergent
3. Viscosity: 95 to 105 secs., Saybolt universal at 100° F 35 secs., Saybolt universal at 210° F 4.Cold pour point: -20° F. 5.A.P.I. gravity: 28 to 29.5 6.Open cup flash point: 340 to 350° F

The local oil distributor will recommend and provide a specific brand of oil to meet these specifications. One example of a food grade turbine oil is Arco Prime 2000.

D. Checking the Foundation

It should be remembered that a short-coupled turbine pump can be a heavy piece of machinery and the weight is concentrated in a small area. The foundation must be suitable to support the entire weight including the driver.

II. RECEIVING AND INSPECTION PROCESSES

A. Unloading and Receiving the Unit

The number of boxes and pieces should be checked against the freight bills. Report any shortages to the transportation company immediately. Material too heavy to lift from the freight conveyance should be skidded off. Check all parts for damage. Report any damage to the transportation company and the factory immediately. Confirm all verbal conversations by letter. Uncrate and check all parts against the packing list.

B. Cleaning and Inspecting the Parts

Inspection prior to leaving the factory ensures that all items are sound at the time of shipment; however, all faces should be rechecked for hidden damage occurring during transportation or unloading. Handle all shafting with extreme care to prevent springing or bending. All threaded parts must be cleaned and checked for burrs or imperfect threads before any lubricating compound is applied. No foreign particles should remain on the threads or faces of any part. MISALIGNMENT DUE TO FOREIGN PARTICLES ON THREADED PARTS OR BUTTED FACES WILL CAUSE UNDUE WEAR AND MAY RESULT IN A FAILURE THAT IS NOT WARRANTABLE.

III. INSTALLING THE PUMPING UNIT

A. Installing the Baseplate

If the pump is equipped with a separate baseplate, place it on the foundation first over the anchor bolts.

The anchor bolts will not be grouted into position until the discharge flange is bolted to the discharge piping. Once the baseplate is aligned, it should not be disturbed. When the pump is eventually pulled for service, it will be pulled and installed through the baseplate and it should not be necessary to realign the baseplate unless it's foundation has settled. Clean off any dirt or debris from the top of the baseplate.

B. Installing the short-coupled pump

(See APPENDIX E if the unit has a below-ground discharge)

The short-coupled pump assembly should be carefully inspected before placing it in the sump. If the total pump length from the bottom of the head to the bottom of the strainer is over 15', do not detach it from the crate until it is in a vertical position. Remove the basket strainer and the grease plug in the bottom of the suction. If there is no grease contact the factory for instructions. If it has already been greased replace the grease plug and the strainer.

Insert the cable sling through the windows in the discharge head. Do not attach it to or bind the shaft in any way. Attach a second line around the middle of the bowl assembly. Lift the entire unit without letting the weight of the unit rest on the suction case or strainer. Use a rope to "tail in" the bottom end of the bowl or suction assembly. Once the pump is completely off the ground, the line around the bowl assembly can be removed. Do not allow the equipment to hit against anything.

Lower the short-coupled pump into the sump through the baseplate. Keep the head approximately 1/4" above the baseplate. Start all 4 cap screws through washers and the anchor holes in the head base and into the baseplate. Now lower the head completely onto the baseplate and tighten the head-to-baseplate cap screws. If the discharge flange is not in line with the discharge piping, lift up on the entire unit and rotate it slightly as necessary, within the limits of the anchor bolts. If the baseplate will be grouted into place, slip a 1" per 12" tapered wedges under each side. Lower the weight of the unit on the wedges or foundation. Grout the baseplate in, if necessary.

NOTE
DO NOT USE SHIMS UNDERNEATH A CAST IRON DISCHARGE HEAD. THE BASE OF THE HEAD CAN BE CRACKED AS THE BOLTS IN THE HEAD BASE ARE TIGHTENED.

C. Connecting the Discharge Piping

If the pump is to be connected to a main, a Dresser type coupling should be used. The Dresser type coupling will prevent any strain from being transmitted to the pump if alignment is other than perfect between the main and the pump head. Bolt up the discharge flange to the adjacent piping.

NOTE
NEVER FORCE THE HEAD AND ADJACENT PIPING INTO ALIGNMENT TO ANY DEGREE. THEY SHOULD ATTACH TOGETHER FREELY WITHOUT THE FLANGES BEING PULLED TOGETHER BY THE BOLTING. THE WEIGHT OF THE DISCHARGE PIPING SHOULD ALSO BE HELD UP BY PIPE STANDS. THE WEIGHT OF THE PIPE SHOULD NOT BE HELD BY THE DISCHARGE HEAD. IF ANY OF THESE FORCES ARE IMPOSED ON THE DISCHARGE HEAD CAUSING MISALIGNMENT, UNDUE VIBRATION AND WEAR MAY RESULT AND THE WARRANTY WILL BE VOIDED. **DO NOT MATE A FLAT-FACED CAST IRON FLANGE WITH A RAISED FACE FLANGE. THE CAST IRON FLANGE CAN BE EASILY OVERSTRESSED AND CRACKED WHEN THE FLANGES ARE BOLTED TOGETHER.**

D. Checking the Stuffing Box Ports

(see APPENDIX A if a mechanical seal is used or skip this section if the unit is oil lubricated)

At this point check to make sure the pressure relief port and the stuffing box drain are properly piped to their disposal point. The pressure relief port should be piped out through one of the windows in the head and down into one of the through holes in the bottom of the head. A needle valve should be placed somewhere in the piping loop to control the bypass flow. The stuffing box drain will be piped the same way without a valve. It is assumed that the pumped fluid can be returned to the sump without harmful contamination. If there is a concern about contamination both lines can be run to any disposal point necessary. Make sure that the split packing gland nuts are only finger tight. DO NOT TIGHTEN THE NUTS DOWN ON THE SPLIT PACKING GLAND.

E. Checking the Head Shaft

(See APPENDIX B if a vertical solid shaft motor is used.)

Remove the shaft coupling from the top shaft and clean the shaft and coupling threads. Also, check the shaft face for scars or burrs. Check the driver shaft in the same manner and also check for straightness per Fig. 4. Once the head shaft threads are cleaned try the coupling on the end with no key way and make sure it threads on easily. If everything is clean and fits together properly, replace the coupling on the top shaft threading it down only half way.

NOTE
DO NOT THREAD THE COUPLING ALL THE WAY DOWN. SHAFT THREADS WILL TAPER AT THE VERY END AND WILL MISALIGN THE ADJOINING SHAFTS.

Stuff a clean rag in the coupling to prevent debris from falling into it.

Now clean off the top of the discharge head of any paint or debris. Also, make sure the top of the head is free of any burrs or other deformities that may cause misalignment.

IV. INSTALLING THE HOLLOW SHAFT DRIVER

NOTE
THE INSTRUCTIONS BELOW ARE INTENDED TO BE A SUPPLEMENT TO THE DRIVER INSTALLATION INSTRUCTIONS AND AN ALIGNMENT GUIDE ONLY. READ AND FOLLOW THE INSTALLATION AND OPERATION INSTRUCTIONS FOR THE SPECIFIC HOLLOW SHAFT DRIVER USED! THE FOLLOWING PROCEDURES ARE NOT MEANT TO TAKE THE PLACE OF INSTRUCTIONS THAT ARE PROVIDED BY THE DRIVER MANUFACTURER.

A. Setting the Driver and Head Shaft

Remove the cover or bonnet from the driver. Remove the motor "BX" coupling using extreme caution. If the driver is equipped with a non-reverse ratchet assembly, make sure that the back stop balls or pins do not fall into the driver. It may become necessary to dismantle a vertical hollow shaft motor to retrieve a back stop ball or pin. Using a cable sling or chain, hoist the driver and clean the bottom mounting surface making sure to remove paint, burrs, or other foreign matter that would misalign the driver.

The following instructions are for a pump with a 2 piece head shaft. See APPENDIX C if the head shaft terminates below the discharge head. Lower the driver onto the discharge head slowly and align the holes in the motor base with those in the top of the discharge head. Install the four driver cap screws loosely. The head shaft may now be lowered through the driver. Do not remove the rag from the shaft coupling until the end of the drive shaft clears the bottom of the driver. If a steady bushing is included with the motor, press it up over the end of the head shaft at this time. Depending on the style, the steady bushing will either set screw to the hollow shaft of the motor or to the head shaft. If it fits on the hollow shaft, tighten the set screws on it now. Slip the rubber water slinger over the bottom end of the head shaft. If the slinger does not stay in place, contact the factory for the proper size. Then remove the rag and clean the face of the driver shaft and the threads with the rag. If any turbine oil is used, apply it sparingly to the male threads of head shaft away from the face. Excessive lubricant between the faces of shafts can cause misalignment. Thread the shaft into the coupling and tighten per the instructions in Fig. 4.

B. Checking the Head Shaft Alignment

If the driver shaft is not in the center of the motor quill, try to bump the motor from one side to the other. If you cannot center the shaft with slight bumping then either one of the faces of the driver shaft or top shaft is not perpendicular to the axis, there is some debris between the faces or in the coupling threads, one of the registers is off between the motor or head, or there is debris between the motor base and head. Check all of these points to try to center the shaft. Once the shaft is

centered, place a wrench on the shaft coupling or the shaft just above the packing box, rotate the shaft a full revolution and observe whether or not the shaft remains in the center of the driver quill. If it does not remain in the center, the shaft may be bent or there may still be debris between the faces. Locate the problem and correct it before continuing the installation. After it is certain that the shaft is centered, tighten down the driver cap screws.

Clean the motor coupling face and the mating area well, making sure that there are no burrs or foreign matter present. Slip the coupling down over the shaft. The coupling should have a snug fit over the shaft, but should not have to be driven onto the shaft. Insert the proper cap screws through the coupling and bolt it down tightly. Check for eccentricity of the clutch bore by rotating the driver by hand and watch for any horizontal movement of the drive shaft during rotation. Perceptible horizontal movement of the drive shaft indicates that the clutch is bored eccentric or that the clutch is not properly mounted. This must be corrected before the installation proceeds.

DO NOT INSTALL THE HEAD NUT OR GIB KEY AT THIS TIME.

V. STARTING UP THE UNIT

A. Inspecting the Driver

The proper direction of rotation MUST be determined before proceeding further. If the driver is a motor, make sure it has the proper lubrication. Grease lubricated bearings are pre-greased, but should be checked. If grease must be added, be sure to remove relief plugs to keep from damaging the grease seals. The oil reservoirs for oil lubricated bearings should be filled. Lubrication instructions are normally furnished with the driver or are on a plate on the driver. Wire up the motor and engage the starter momentarily to obtain rotation. The motor should rotate counterclockwise looking down on it from above. Three phase motors may be reversed in direction of rotation by switching any two of the three leads. Consult the instructions furnished with single phase motors for changing the direction of rotation.

For right angle gear drives, check the rotation of the engine power takeoff. The most common set up requires that the engine rotate counterclockwise, facing the engine from the power takeoff side. Power takeoffs from tractors and some engines require special right angle gear drives and may rotate in a clockwise direction. Quarter turn V-belt or flat belt drives and belt head assemblies require the proper placement of the engine with respect to the gear drive to produce the correct counterclockwise pump rotation. If you are unsure of the proper direction of rotation, contact the factory.

Install the gib head key in the coupling. It may be necessary to file the key slightly for a proper fit. This should be a snug fit, but the key should not have to be driven in. Make sure that the gib of the key does not extend above the top surface of the coupling.

B. Setting the Impellers

Thread the adjusting nut onto the head shaft until it seats on the motor coupling. Make a mark immediately above the head nut or above the packing pusher to be used as a reference point.

Continue raising the shafting by tightening the head nut, until the impellers are locked against the top of the bowl casings. Do not overtighten the head nut. It is possible to force the impellers loose from the shaft, if the shafting is adjusted too high.

Measure the distance from the head nut or packing pusher to the reference mark that was previously put on the shafting. That measurement should equal the lateral recorded from the factory. Nothing in the design or the construction of the pump will reduce this lateral. If the lateral adjustment checks out less than the measured lateral, check the driver shaft to make sure that the adjusting nut has not run out of threads on the drive shaft and that the key way is long enough. Also, check the shaft coupling to make sure that it is not being pulled up against the bottom of the driver. Determine what the problem is or contact the factory before continuing.

Loosen the adjusting nut until the impellers are resting in the bottom of the bowls again. Now raise the impellers up off of the bottom 1/8 of an inch after the nut seats on the motor coupling. If the pressure encounters exceed 150 psi increase the distance to 1/4". Line up one or all of the holes in the head nut with one in the driver coupling. Insert all the tie down cap screws that are accessible and tighten them to lock the head nut to the motor coupling and prevent it from unscrewing.

If a steady bushing is supplied that set screws to the shaft, tighten it onto the shaft now.

C. Adjusting the Packing Box Leakage

(See APPENDIX A - instruction #4 if a mechanical seal is used or APPENDIX D if the unit is oil lubricated)

Do not tighten the packing gland until the pump is running. FLUID must leak out around the packing gland, WHILE THE PUMP IS OPERATING. The small valve in the pressure relief line will control the amount of fluid bleed-off. Make sure this valve is closed when the pump is first started. This will help establish flow through the packing for cooling. When water begins to flow out of the discharge of the pump, make sure there is water flowing out around the shaft. There should be a fairly uniform flow of water all around the shaft, bubbling up at least 1/8" or more above the packing pusher, but not blowing out in a spray. **IF THERE IS NO LEAKAGE, STOP THE PUMP IMMEDIATELY AND CONSULT THE FACTORY.**

If there is too much leakage, tighten the packing gland in small increments, by hand if possible. Opening the needle valve on the pressure relief line will relieve some of the pressure on the packing and help control the flow. Also, adding more grease to the packing box may reduce the excess leakage. If none of these three methods is successful, consult the factory for assistance.

The leakage should be roughly the temperature of the fluid exiting the discharge of the pump. If it is much hotter than the discharge fluid, more flow is required around the shaft. The packing box and gland should also be cool or of comparable temperature to the pumped fluid. If they are not then more flow is needed through the packing or it may be a sign of shaft misalignment. The packing needs to be broken in slowly, so it is important to watch the packing box leakage for several days. Slight adjustments should be made until the leakage remains consistent.

Normally in short set pumps no additional grease will have to be applied unless it is required to control excessive packing leakage. If grease is applied be sure to apply it while the pump is running. Watch the leakage as each stroke is applied and make certain that the flow is not shut off.

AGAIN, WATER MUST LEAK THROUGH THE PACKING AT ALL TIMES WHILE THE PUMP IS RUNNING.

D. Field Testing the Pump

A valve and pressure gauge should be installed on the discharge piping adjacent to the head. A valve is used to control the amount of flow or pressure discharge from a pump. A flow measuring device in the discharge piping may be necessary for troubleshooting purposes or to accurately control the amount of discharge.

Allow the pump to operate for a short period of time and check for vibration or any other trouble.

NOTE
IN CASE THE PUMP MAY BE OPERATED AGAINST A CLOSED VALVE, MAKE SURE THE MAXIMUM PRESSURE OBTAINABLE DOES NOT EXCEED THE SAFE WORKING PRESSURE OF THE DISCHARGE HEAD.

Start the pump with the valve wide open and then close it until the pressure gauge gives a reading equal to the design pressure that is required. If the pump is not producing the proper flow and head, try adjusting the impellers up or down slightly or check the instrumentation used to measure those values. If the problem is in neither one of these areas, contact the factory.

Turn the pump off and replace the motor bonnet.

VI. MAINTENANCE PROCEDURES

A. General Inspection

The pumps should be visually inspected at least once a day or once every eight hours of operation, whichever is longer. Look for differences in performance (i.e. drop in capacity), a change in amperage draw, or differences in noise levels. Also, see that the motor is not vibrating more and more. Any of these can be an indication of a failed unit or one that is about to fail. Frequent inspections can often save a pump from complete deterioration, so that it can be repaired and remain useful.

B. Checking the Shaft Seal

Always check the shaft seal. Check packing box leakage; **1)** make sure it is leaking sufficiently, **2)** make sure the leakage is not hotter than the fluiding coming out of the discharge, and **3)** make sure the packing is not leaking too much. If the packing is leaking too much or too little it may be signs of the packing breaking in on a new pump. Too much leakage can be slowed by tightening the packing or adding grease. If these do not help, the shaft may be too worn to seal against or the packing may need to be replaced. (See APPENDIX F for instructions on packing replacement) Leakage of fluid hotter than the pumped fluid is a sign of misalignment or insufficient leakage.

NOTE
DO NOT OVER-GREASE A STUFFING BOX ON A CLOSE COUPLED PUMP. EXTRA GREASING IS NOT REQUIRED EXCEPT TO CONTROL EXCESSIVE LEAKAGE.

If a mechanical seal is used, make sure it is not leaking or getting warm. This is also a sign of misalignment or insufficient fluid bypass through the seal.

On an oil-lubricated pump, make sure not water is coming up the oil tubing. Also, check to see that there is sufficient oil in the oil pot and that the dripper is working. If the tension nut is warm, it may caused by misalignment or insufficient oil lubrication.

C. Driver maintenance

See the manual provided for the specific driver used for maintenance instructions.

VII. TROUBLESHOOTING

If the unit and it does not seem to be operating properly, re-read the above instructions double check to see if all the steps have been properly completed. If the problem still cannot be located please contact the factory for assistance. If you are having trouble with the units production capacity please report as detailed information

as possible. The required data would included, but not be limited to the following; 1) actual head and capacity produced over the entire operating range, 2) the rotational speed the driver is actually turning, 3) the voltage and amperage on each leg of the supply cable. If there are problems with noise or vibration, it is helpful to have one of the actual installers and someone familiar with the complete system speak to a factory representative. The accuracy of the measuring devices used, should always be considered when the performance of the unit is compared to its design conditions.

APPENDICIES:

APPENDIX A - INSTALLING A MECHANICAL SEAL

NOTE
SPECIFIC INSTALLATION INSTRUCTIONS FOR THE ACTUAL SEAL PROVIDED ARE FURNISHED BY THE SEAL MANUFACTURER. PLEASE CONTACT THE FACTORY IF YOU DID NOT RECEIVE THEM. THE FOLLOWING INSTRUCTIONS ARE NOT MEANT TO REPLACE THOSE INSTRUCTIONS. THEY ARE GENERAL GUIDELINES FOR TYPICAL CARTRIDGE SEAL INSTALLATION.

1.To prevent seal damage, the mechanical seal is not installed in the discharge head prior to shipment. Unbolt the seal housing from the discharge head and clean out any debris that may have fallen into the seal cavity. Reinstall the housing.

2.The end of the shaft that will protrude above the seal when it is installed, should be turned down to a slightly smaller size than the I.D. of the seal. This is done so that the o-rings inside the seal will not be scored as they are slid over the shaft threads. If that is not the case, wrap one round of Teflon tape over the threads to act as a barrier.

3.Make sure that the bottom of the seal has either a gasket or an o-ring to prevent fluid leakage between the seal housing and the mechanical seal itself.

4.Some seals have a spacer supplied by the factory to pre-set the tension on the seal faces. Set the impellers first, then tighten the set screws in the sleeve collar before removing this spacer.

5.Before bolting down the seal make sure the gland ports are pointing in the right direction so that the least amount of piping has to be done.

6.The most common seal piping is API plan 13, by which the flush port on the seal gland is piped back to the sump or suction can or to a disposal site. The pressure at the destination of the piping must be less than the discharge pressure of the pump.

7.Make sure that any time the impellers are adjusted, that the set screws in the sleeve collar are loosened. Check the instructions from the seal manufacturer to determine the proper gap that has to be reset beneath the collar before re-tightening the set screws.

APPENDIX B - INSTALLING A SOLID SHAFT DRIVER AND COUPLING

1.If the coupling is not a spacer type, skip to step #5 and install the half coupling on the pump shaft first. If a spacer is being used, move on to step #2.

2.Using a cable sling or chain, hoist the driver and clean the bottom mounting surface making sure to remove paint, burrs, or other foreign matter that would misalign the driver. Lower the driver onto the discharge head slowly and align the holes in the motor base with those in the top of the discharge head. Install the four driver cap screws loosely.

3.The proper direction of rotation MUST be determined before proceeding further. If the driver is a motor, make sure it has the proper lubrication. Grease lubricated bearings are pre-greased, but should be checked. If grease must be added, be sure to remove relief plugs to keep from damaging the grease seals. The oil reservoirs for oil-lubricated bearings should be filled. Lubrication instructions are normally furnished with the driver or are on a plate on the driver. Wire up the motor and engage the starter momentarily to obtain rotation. The motor should rotate counterclockwise looking down on it from above. Three phase motors may be reversed in direction of rotation by switching any two of the three leads. Consult the instructions furnished with single phase motors for changing the direction of rotation.

4.Now it’s time to install the rigid driver coupling. Clean off all threads and machined faces of debris. Clean up any small burrs by lightly using a flat file. Do not excessively file any of the faces. Slip the square key into the vertical key way in the driver shaft. Slide the driver half coupling up onto the driver shaft and key until it is above the circular groove. Slip the two-half split rings into the circular and allow the half coupling to drop down over the top of them. The split rings should slip up into a counterbore in the coupling, which keeps them from falling out.

5.Install the half coupling that goes on the pump shaft next. Slide it all the way down the shaft with the flange side up. Put the square key in and push it down below the threads. Thread the adjusting nut onto the pump shaft. Make sure the male register on the nut is facing up to match the adjoining coupling section. If a spacer is not used, adjust the nut so that the gap between it and the top coupling is approximately 1/8". If the operating pressures are to exceed 150 psi, increase the gap to 1/4".

6.If a spacer is being used, install it now. Mate the male register with the driver half of the coupling and install the shorter of the bolts supplied. Make sure that the Teflon filled lock nuts are used so that they will not vibrate off.

Tighten the bolts in small increments by alternating back and forth with bolts that are approximately 180 degrees apart. Now thread the adjusting nut up or down so that the gap between it and the spacer is approximately 1/8". If the operating pressures are to exceed 150 psi, increase the gap to 1/4".

7.Line up the bolt holes in the remaining pieces and insert the leftover long bolts from the bottom up. The Teflon filled lock nuts will be tightened on the nuts until the adjusting nut and the spacer or top hub is firmly mated. As the gap is closed the impellers are being lifted off the bottom of the bowl so that the lateral is set. Tighten the bolts in small increments by alternating back and forth with bolts that are approximately 180 degrees apart.

8.If a mechanical seal is being used, the set screws in the sleeve collar can be tightened to the shaft at this time. Also, if the seal is supplied with a spacer to set the proper tension, it can be removed after the set screws are in place.

9.Continue with the installation at Section V-C.

APPENDIX C - USING A ONE-PIECE HEAD SHAFT

In some cases the discharge head may be too short to accommodate a head shaft that terminates between the stuffing box or mechanical seal and driver. If that is the case the last shaft coupling will be below the head and the head shaft will be protruding above the head. A great deal of care should be taken not to bend the shafting.

Remove the cover or bonnet from the driver. Remove the motor coupling using extreme caution. If the driver is equipped with a non-reverse ratchet assembly, make sure that the back stop balls or pins do not fall into the driver. It may become necessary to dismantle a vertical hollow shaft motor to retrieve a back stop ball or pin. Using a cable sling or chain, hoist the driver and clean the bottom mounting surface making sure to remove paint, burrs, or other foreign matter that would misalign the driver.

Exercise extreme caution when lowering the driver down over the head shaft. Any deformation of this shaft may spring the shaft and cause undue vibration and wear. Make sure the driver is lowered down directly from above the head. Guide the driver over the head shaft. Slowly lower the driver onto the discharge head and align the holes in the motor base with those in the top of the discharge head. Install the four driver cap screws loosely.

Continue the installation by checking the head shaft alignment per Section IV - B.

APPENDIX D - OIL-LUBRICATED PUMPS

If the unit is oil-lubricated, the tension on the enclosing tube should be factory preset. The tension nut in the discharge head should have a lock down cap screw which keeps the tension nut from backing off. Make sure that the lock down cap screw is tight and that all the bolts in the tension plate are tight.

If a one-gallon oil pot is furnished, slip the bracket foot under a washer under one of the driver cap screws and on top of the motor base. This cap screw will generally be longer than the others. Tighten it down securely.

If a solenoid oiler is provided, thread it into the oil pot first. The solenoid will be shipped in the oil pot with the other oil line accessories. Thread the oil dripper into the oil pot or the solenoid. Connect the oil line(copper tubing) to the other end of the dripper and to the tension nut. Wire up the solenoid oiler to the control panel and leave in open position for the time being until the drip rate can be established. Make sure all the accessory parts are removed from the oil pot and fill it with turbine oil. Allow about 1/2 pint of oil to run through the oil line and then set the dripper so that the oil drops at the minimum rate of drops per minute as listed below. Refill the oil pot up completely and secure the lid.

Tube Size	Minimum Number of Drops/Min.
1 1/2" - 2"	5
2 1/2"	7
3" - 3 1/2"	10
4"	12

Make sure that either the oil flow is started manually or automatically at least 5 minutes prior to start-up of the pump.

Continue the start-up with the field testing at Section V-D

APPENDIX E - INSTALLING A PUMP WITH A BELOW-GROUND DISCHARGE

A short-coupled pump with a below ground discharge will install very similar to one with an above ground discharge except for the obvious differences. There are, however, a couple of specific precautions that should be taken to ensure a proper installation.

- If a separate baseplate is used make sure the center hole is of sufficient size so that the discharge flange will fit through.
- Lower the unit slowly so that the discharge flange does not hit the foundation or baseplate.

- It is extremely important that the discharge flange is not pushed or pulled or forced in any way into alignment with the discharge piping. This requirement is even more critical than with an above ground discharge. Also, make sure that the discharge flange is not supporting the weight of the discharge piping.

- In higher pressure situations above 250 psi, a support should be placed 180 degrees from the discharge to prevent misalignment.

APPENDIX F - CHANGING STUFFING BOX PACKING

1.Turn off the motor or engine. Make sure the driver is properly disconnected from the control panel or any device that may automatically engage the pump.

2.In some cases, there may be insufficient room in the discharge head to allow the packing to be replaced without removing the motor or gear drive. If there is sufficient room skip to step #3. If not, remove the equipment as required. The piping in the bypass port may have to be removed also. Unbolt and remove the stuffing box from the discharge head.

3.Loosen and remove the nuts on the packing gland studs and lift and separate the packing gland pieces to remove them. Remove the packing using a packing puller or bent wire. To remove the lantern rings, insert a wire into the notches on top of the lantern that are 180 degrees apart. The notches are on the outer rim of the lantern ring next to the stuffing box bore. If the o.d. of the stuffing box is 6" there will be another set of packing and another lantern ring. Larger stuffing boxes will have more packing, but not another lantern ring. If any of the packing or lantern rings are stuck and cannot be removed, then the stuffing box will have to be pulled out of the head to get to the packing.

4.Check the shaft to see if it's too worn to be repacked. The size of the shaft can be significantly reduced by the wear of the packing. If that is the case the entire shaft should be replaced.

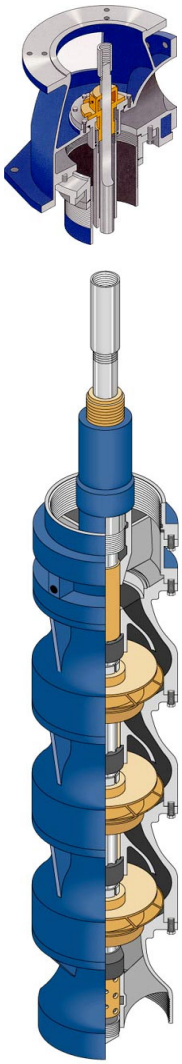
5.Replace the stuffing box in the head if it was removed. Make sure that the o-ring is intact on the bottom of the stuffing box. Also make sure the ports are aligned correctly so that they can be properly re-piped. After the stuffing box is tightened down, re-attach the pressure relief port drain pipe.

6.Start by inserting a new lantern ring if the stuffing box has a 6" o.d. Otherwise, work in 4 rings of packing using the packing gland to help push each ring down. Be sure and stagger the joints where the packing makes a complete circle by at least 90 degrees. Contact the factory for the correct size packing, if it is not known. Insert an intermediate lantern ring and use something thin and slender, such as a screw driver, to work it all down to the bottom. Add 2 or 3 more rings of packing, using the same method as above, until the stuffing box is almost full.

7.Fit the two pieces of the packing gland together around the shaft and slide them into the stuffing box bore. Thread the nuts for the packing gland studs down until they just hold the packing gland in place. DO NOT TIGHTEN THEM OVER FINGER TIGHT.

8.Replace the driver and head shaft as required per Section IV.

9.Restart the unit per Section V.



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