PACOTURB II
Series C, Regenerative
Turbine Pumps

Installation, Operating and
Maintenance Instructions

Installation

Piping

Pipes should be carefully lined up so that they are not forced into place, since this can force pump out of alignment. Pipes should be supported independently to prevent strains on pump that could destroy bearings and cause motor overload. Care should be exercised with suction piping to assure it is adequately sized for the flow pumping conditions.

Seals

Pacoturb II, Series C, Regenerative Turbine Pumps are fitted with mechanical seals to eliminate problems caused by using packing. DO NOT RUN PUMP DRY or pump will be damaged. Put some of liquid to be pumped-or other compatible fluid-into the pump before operating for the first time. To replace follow instructions of manufacturer.

Lubrication

Ball bearings are sealed for life and require no further lubrication. Radial contact seals prevent the entry of foreign material and the loss of lubricant.

Adjustments

No adjustments are possible or necessary. Proper clearances have been machined into the pump.

Electrical Wiring

All wiring must conform with Local and National Electrical Codes.

Follow wiring instructions of motor manufacturer.

Starting and Operating

All pumps are carefully tested before shipment, but if difficulties are experienced we suggest the following points:

Observe the following when starting the pump for the first time:

1. Turn the pump over by hand to make sure it is free. If fluid has been allowed to dry inside pump, it may require 2 to 10 foot pounds torque to break loose the first time.

2. Check rotation – which is right hand (clockwise) when viewed from the shaft or coupling end. Jogging the driving motor allows one to observe rotation.

3. Prime pump or open valving to flood pump, whichever is the case.
4. Make sure discharge line is open. Do NOT start pump against a closed discharge valve.

Troubleshooting

Failure to deliver water.
a. Pump not up to speed.
b. Pump not primed.
c. Discharge head beyond pump's shut-off head.
d. Excessive suction lift (over 29 ft. total).
e. Incorrect direction of rotation.
f. Clogged suction trap, strainer or foot valve.

Reduced capacity.
a. Speed too low.
b. Air leaks in suction line.
c. Total head higher than that for which pump was intended.

d. Excessive suction lift (over 20 ft. total).
e. Insufficient positive suction head with hot liquids.
f. Mechanical damage (solid materials will break impeller vanes.)

g. Clogged suction trap, strainer or foot valve.
h. Air entering foot valve or suction system.

Reduced pressure.
a. Speed too low
b. Air in water.
c. Mechanical damage.

Pump loses prime after starting.
a. Leaky suction line.
b. Leak through seal.
c. Excessive suction lift (over 28 ft. total).

Overload on motor or driver.

a. Speed higher than rated.
b. Total head higher than rated.
c. Specific gravity or viscosity higher than anticipated.
d. Mechanical trouble - pump or driver.

Pump vibrates or is noisy.
a. Misalignment.
b. Insecure foundation.
c. Mechanical defects (bent shaft, foreign material binding impeller, worn bearings).
d. Strain due to improperly supported piping.

Disassembly and Reassembly

Disassembly

1. Prior to disassembly, remove all water from pump. Air blown thru will help remove water quickly.

2. Nuts #20 (051 pumps) or capscrews #19 should be removed first.

3. Cover #2 can now be easily removed along with "O" ring #7.

4. Four "O" rings #8 (051 pumps) may then be removed from studs #18 (051 pumps).

5. Impeller #11 is a slip fit on adapter shaft #17 and may be removed by gently tapping on the end of the sleeve using a wood dowel as protection for metal components.

6. Key #23 should be left in place.

7. Loosen setscrew #14A. Collar #14 should then be loose on the smaller step of sleeve #17.

8. a) For Pumps having 56J frame motors – Remove center cap from motor end bracket and insert screwdriver in slot provided. Using a crescent wrench adjusted to slip over adapter shaft #17 but engaging key #23, unscrew the sleeve in a counter-clockwise direction. It may be necessary to tap the wrench lightly in some cases. (in cases of extreme corrosion, the motor stator must be removed and the rotor held carefully in a vise to remove adapter shaft.)

b) For Pumps having 56C or 182CZ motors- The shaft sleeve is keyed to the motor shaft and may be removed using two large blade screwdrivers. Insert the blades of the screwdrivers between the spring holder of the #12 rotating element and the shoulder of the sleeve. Holding the screwdrivers at approximately 3 o'clock and 9 o'clock push the handles inward toward the motor using the motor bracket for leverage. In some cases a rocking motion of the screwdrivers will aid in sleeve removal. In most cases the rotating element will slide off with the sleeve. **Do not attempt to remove the sleeve by rotating it.** (Previous models have used a

threaded shaft. Different procedures are required in those cases – See paragraph 8a.)

9. The rotating element portion of seal #12 may now be pulled from adapter shaft #17.

10. Motor bracket #1 may be removed from motor Seat portion of seal #12 which may be removed from motor bracket using a wood dowel and tapping gently on the exposed portion of the seat.

Reassembly

All parts should be examined carefully for wear or damage. Replace part that shows noticeable wear "O" rings and rubber seal parts should be replaced if abrasion or other damage is indicated. Be sure a light press fit still exists between the shaft and bearing I.D. Look for cracked seal carbons on stationary elements.

1. Parts should be reassembled in reverse order as outlined for disassembly.

2. Lubricate seal parts prior to seat insertion of fitting rotating element onto sleeve. Lubricate all "O" rings.
3. Rotate impeller using screwdriver in motor shaft slot while tightening capscrews (or nuts). Impeller lock up may result from burrs or other foreign material caught between impeller and housing. A short running period while operating at minimum discharge pressure may be necessary prior to final tightening of capscrews (or nuts).

CAUTION: CHECK IMPELLER ROTATION BEFORE FILLING PUMP WITH FLUID. (Change two leads on three phase units to reverse rotation. Single phase units cannot be reversed. They are built to operate only in the correct direction.) ANTI ROTATION COLLARS ARE NOT DESIGNED TO HANDLE NORMAL OPERATION IN REVERSE.

PACOTURB II
Series F, Regenerative Turbine Pumps

Installation, Operating and Maintenance Instructions

INDEX

1 GENERAL

Regenerative turbine pumps, when properly installed and when given reasonable care and maintenance, should operate satisfactorily for a long time. They will not, however have a useful service life equal to that of a low head centrifugal pump which by its nature cannot be subjected to the typical differential pressures produced by the regenerative turbine pump. Because of the high differential pressures expected in these pumps, close running clearances are used to reduce internal losses. Abrasive particles, even microscopic ones in high enough concentrations can destroy the sealing joints between internal cavities. For critical services, keep an identical pump for a standby.

1A INSPECTION OF EQUIPMENT

Immediately upon receipt of the shipment, inspect the equipment for damage or missing components. Check the shipping manifest and report any damage or shortage to the Transportation Company's local agent.

Inspect the crate and any wrappings before discarding them. Parts or accessories are sometimes wrapped individually or fastened to the skid.

Put the instructions that came with the shipment in a place where they will be available to those who will be needing them.

IB STORAGE

If the pump is received some time before it can be used, it should be inspected as described above, recrated and stored in a dry location. Standard shipping containers are not suitable for outdoor storage. In some areas, it may be necessary to cover the pumps exterior surfaces with oil or other rust inhibiting coating.

For storage beyond 30 days, Ethylene Glycol or other protective fluids should be used inside the pump. Protective closures on both inlet and outlet should also be used. Closures alone are not sufficient. Fluids used in the pump should be selected for compatibility with pump materials, particularly when optional seal and gasket materials have been used. Special care must be taken when placing stored pumps into service. After flushing the inside and cleaning the outside, try to turn the pump by hand using the coupling. In the event the impellers do not break loose immediately, it may be helpful to fill the pump with water and try again in a few hours. In the even this procedure proves fruitless, read the disassembly-reassembly instructions. With an understanding of which are the bolts used to clamp the entire assembly together, loosen each of them exactly three full turns. After filling the pump again with water, up to 50 foot pounds of torque may be applied to

the coupling without fear of ruining the impeller vanes. It should begin to turn well before this force is reached. Continue turning the pump while the various fasteners are returned exactly to their original positions.

1C APPLICATION CONSIDERATIONS

1C1 ELECTRICAL WIRING

All electrical equipment and wiring should conform to local and National Electrical Codes. Use motor manufacture's instructions for connecting the motor. Be sure motor rotation speed and direction matches that required for the pump.

1C2 MATERIALS OF CONSTRUCTION

While it is reasonable to assume that good judgment has been used in selecting all the materials in the pump for compatibility with process fluids, actual conditions sometimes vary from original expectations.
Additionally, typical material selection charts do not consider all the temperature pressure and fluid variables. The customer's engineer should be consulted for final judgment on best materials for critical process circumstances.

1C3 VALVES

The first valve that may be considered for a regenerative turbine pumping system might be a pressure relief valve. In view of the fact that this type of pump has a horsepower requirement similar to that of a positive displacement pump (constantly rising along with a pressure increase) a relief valve can be effectively used to limit horsepower. This is helpful when a non-overloading motor is specified. It can be of critical importance if the system flow rate can vary excessively.
There are almost no circumstances where a flow modulating valve will work successfully in a regenerative turbine pumping system. The steep pumping characteristic, with very large pressure changes as flow rate varies, which are typical of these pumps, produce shock waves when flow is modulated that can shorten pump life and may cause damage in other pieces of equipment in the system.
If a shut off valve is necessary in the suction line, use a gate, ball, butterfly or other full port, unrestricted valve. Globe or other flow restricting valves can in some cases reduce pump flow or increase chances of cavitation in the pump.
A swing check valve can be helpful in the suction line when the pump inlet is even slightly higher than the fluid source. It should be the same size as the pump inlet or sized based on reasonable fluid friction losses.
A foot valve is recommended when lifting fluid from a sump. This will save wear and tear on any pump, even those equipped with self priming equipment.
A Y-Strainer is a wise choice immediately ahead of the pump on any newly constructed system. This is advisable due to the probability that foreign material large enough to damage pump clearances may remain even though piping has been flushed.
Valves in the outlet piping of a regenerative turbine pump should always be open as far as possible when the pump is started. This will reduce startup load on the pump and motor. Never start with the discharge valve closed.
Inlet valving should be open when starting any pumping system. Without some fluid in the pump, it can gall and lock up impellers in some cases. Violent pump failure will result from continued operation with the inlet valve closed.

1C4 PRIMING

Regardless of whether self priming equipment is involved or not, always fill the

pump and clear it of air for best seal and pump life. Under most circumstances, regenerative turbine pumps can be made to self prime as long as a small amount of fluid can be recirculated thru the impeller and it doesn't heat up noticeably.

1C5 NPSH (Net Positive Suction Head)

The NPSH required varies with every size of pump and for any given pump it varies with the capacity. The NPSH required by your unit can be obtained from the performance curves or from your Paco Pumps distributor or representative.

If the NPSH available is not equal to or greater than that required by the pump, it must be increased or a different pump selected. The usual method for increasing NPSH is to raise the static head on the pump inlet, H sub s.

By definition, NPSH means: "net positive suction head" above the vapor pressure of the pumped liquid available at the centerline of the pump. It should always be given in feet of pumped liquid. NPSH is actually a measure of the amount of energy available in the pumped liquid to produce the required absolute entrance velocity into the pump. If a pump requires more energy (or NPSH) than is available at a given capacity, the pressure at the inlet will fall below the vapor pressure of the pumped liquid and cavitation will result.

Ps = Pressure in the suction vessel in PSIA.

Pvp = Vapor pressure of the pumped fluid in PSIA

Hs = Static height of the pumped fluid above (+) or below (-) the centerline of the pump.

Hf = All friction losses from the vessel to the pump

$$NPSH = 2.31 \left(\frac{Ps - Pvp}{sp.\ gr.} \right) + Hs - Hf$$

Note: For boiling liquids, P sub s and P sub vp are equal. This item then becomes zero and can be omitted from the equation.

1C6 NOISE

Regenerative turbine pumps typically produce a high pitched whine that increases in intensity as the differential pressure produced in the pump increases. While high frequency sound is attenuated more easily than lower frequencies, piping structures and the fluids in them readily transmit noise. Motors, bearings and other rotating components add to noise and sometimes create objectionable harmonics. Careful pump installation can contribute to noise reduction. Proper alignment of the pump and driver is essential. Adequate supports for the inlet and discharge piping is equally important. A degree of noise reduction may be obtained when the pumping unit is supported free of building structures by the use of vibration isolators and flexible piping and conduit connections. Elastomer type couplings are the best choice to separate motor noises from the fluid and piping structure.

1C7 FREEZING

When ambient temperatures can drop below the freezing point of the fluid in a pump, consideration should be given to heating, insulating or draining it. If the option is draining, and it will be for only a short period, remove the drain plugs. Drain lines to and from the pump as well. It is necessary to blow out the pump with compressed air in order to clear all internal cavities of fluid.

1D RECOMMENDED SPARE PARTS

FOR CRITICAL SERVICES, a duplex installation, with two identical pumping units in parallel, is the safest and many times the most cost effective choice.

FOR IMPORTANT SERVICES, a standby pump, ready for installation is advised. Special pricing and new pump warranty is offered for factory rebuilding. Turn around time can be as short as one day for standard models.
FOR ROUTINE MAINTENANCE, only the mechanical seals and a complete set of "O" ring gaskets are recommended. Should additional components show wear, they are available from stock at the factory.

FOR SERVICING A PUMP THAT DOES NOT PRODUCE RATED HEAD, mechanical seals, "O" ring gaskets, a complete set of impellers and channel rings along with interstage bushings are recommended.
FOR REBUILDING A PUMP, all the components required for servicing plus bearings, shaft and drive keys should be obtained. (A factory rebuild should be considered whenever your disassembly indicates rebuilding is necessary. This is usually more economical when a value is placed on your labor.)
The factory recommendation for spare parts are all of those needed for rebuilding a pump and are shown on the exploded view drawings for each individual type of pump.

INSTALLATION II

PACOTURB II
Regenerative Turbine – Series F
INSTALLATION
A. Location
B. Foundation
C. Leveling
D. Alignment
E. Piping

2 INSTALLATION

In order to insure that pumping equipment is installed properly and to obtain reliable pump operation, it is recommended that only experienced, qualified erecting engineers undertake this task. Read instructions thoroughly before beginning.

2A LOCATION

The first consideration for locating a pump is elevation. The lowest possible elevation is usually the best. This should not be in conflict, however, with the second recommendation that suction piping be as short as possible. Questions regarding possible locations should be resolved by making inlet head calculations including all friction losses. The one producing the highest inlet pressure, other things being equal, should be selected. There are a number of reasons for this precaution. The greater the inlet pressure, the less likelihood of NPSH problems. A flooded suction is particularly helpful on startup when many seals and sometimes entire pumps are ruined before they are properly primed and purged of air.

A dry, easily accessible location is also important. Allow ample clearance around the unit for free air circulation. If a dry location is not available, mount it on a foundation, well above the floor. Specify motor enclosure, pump materials or coatings to suit the worst conditions expected. Place the pump so that it can be easily inspected and serviced during operation. Head room should be provided, particularly where it is likely that lifting devices will be used for heavier assemblies.

2B FOUNDATION

The purpose of the pump foundation is to rigidly support the baseplate to maintain alignment of the installed unit. Baseplates alone are not rigid enough to maintain alignment. If the baseplate is to be grouted to the foundation, it is only necessary to embed its edges. It is unnecessary to completely fill under the baseplate. DO NO GROUT UNIT TO FOUNDATION UNTIL IT HAS BEEN PROPERLY ALIGNED.

The foundation should be a permanent rigid installation of concrete or other material of sufficient mass to absorb all normal vibrations. Foundation bolts should be located or embedded in the concrete by layout or template in relation to the suction and discharge piping. If concrete is used, foundation bolts of the specified size may be enclosed in a pipe sleeve two or three diameters larger than the bolts to compensate for minor variations in alignment.

Close coupled pumps may be mounted on a steel base prior to installation or mounted directly to the foundation. Shims should be placed under one or more of the motor feet so that strain and distortion will not result when mounting bolts are tightened.

2C LEVELING

When the unit is received with the pump and driver mounted on the baseplate, it should be placed on the foundation and the coupling halves disconnected. The coupling should not be reconnected until the alignment operations have been

completed. The baseplate should be supported on metal shims or wedges having a small taper. Some should be placed close to the foundation bolts. Others should be nearest to the greatest weight and spaced to give uniform support to the base.
Adjust these supports until the shafts of the pump and driver are level. Check coupling alignment with a straight edge. A section of pipe can be used to determine if inlet and discharge openings are vertical and properly located. Correct the positions, if necessary, by adjusting the shims.

2D ALIGNMENT
Although flexible coupled pumps are carefully aligned prior to crating and shipping, it is likely that strains imposed during transit to the jobsite have altered this alignment. The following steps are for realigning the assembly after it has been placed on the foundation and leveling has been completed.

The standard coupling supplied with PACOTURB II turbine pumps uses an elastomer member between two internally serrated flanges. They have smooth outsides of equal diameter. These surfaces may be used for alignment purposes. A straight edge held against one or both surfaces should be used to visually determine both angular and parallel misalignment. Thin metal shims should be placed under motor or pump feet to make corrections. If misalignment is of major proportion, this indicates that baseplate is distorted. In that event, use a longer straight edge to correct the baseplate first. It is advisable to tighten either the pump or motor and adjust the other component. Final torquing of the hold down bolts alters the alignment which must then be compensated for. Torquing both at the same time is quite difficult.

After all leveling and alignment operations have been completed, piping may begin. After piping has been completed, (see 2E1 piping alignment) alignment of the unit should be checked again to be certain that no piping strains are causing distortion. After approximately two weeks of operation, alignment should be checked again to be sure that temperature changes, piping strain, or foundation variations have not caused misalignment. If alignment has been maintained over this period, the pump and driver may be dowelled to the baseplate.

2E PIPING

2E ALIGNMENT
It is important that all piping be lined up and not forced into place. It is best to begin piping at the pump. When the lines are ended at the pump, particularly if the last piece is cut a little too short or long, the pump will be forced to meet the pipe and strain or distortion will result.

2E2 PIPING SUPPORT
The pump should never be allowed to support piping. Other means should be provided for carrying the piping to avoid misalignment and distortion. Consideration should be given to thermally induced expansion and contraction, particularly in long runs of straight pipe.

2E3 PIPING SIZE
In general, inlet and outlet pipe sizes should be equal to or larger than those of the pump. This should not, however, be the determining factor. Many things including installation cost and operating cost are involved in the decision. Careful use of the pipe and fitting friction loss tables as shown in the Hydraulic Institute manual along with the appropriate pump performance curve should be the basis for judgments.

OPERATION III

PACOTURB II
Regenerative Turbine Pumps – Series F
A. Rotation
B. Foreign Material
C. Electrical
D. Adjustments
E. Cooling Water
F. Priming
G. Starting
H. Stopping

3 OPERATION

3A ROTATION

The standard direction of rotation is right handed, or clockwise when looking at the end of the pump with the driving shaft. A rotation arrow is normally located on the pump to indicate the correct direction of rotation. It is possible to build PACOTURB II turbine pumps for left hand or Cover Drive rotation when there is reason to do this. If there is reason to suspect other than standard rotation it may be advisable to check with the factory. Serial number records will indicate correct rotation.

Since there are substantial performance variations and the potential of pump damage from operation in reverse, always confirm correct motor rotation prior to connection of the coupling. If this is not possible, or a final rotation check is being performed, jog the motor briefly. Observe rotation as it comes to a stop. Rotation should be in the direction the rotation arrow points. If the motor operates in the wrong direction, interchange any two leads on three phase motors. Single phase motors will require wiring changes as indicated inside the connection box cover. Some single phase motors may not be reversible. On standard pumps, the inlet is the opening nearest the driving end. The discharge is at the end opposite the driver. On Cover Drive pumps, these openings are reversed.

3B FOREIGN MATERIAL

All regenerative turbine pumps have close running clearances in order to maintain reasonable efficiencies. In view of this, it is advisable to take extra precaution to insure that foreign material no larger than .0005 inches is allowed to pass thru the pump. Even particles of this size will damage the running clearances if allowed to continue. Regenerative turbine pumps should not be used for slurries.

Larger particles, weld spatter and other material that is usually found in new piping systems particularly, will bend regenerative turbine impeller vanes and sometimes lock up the pump. If a new pump does not operate properly, the first suspicion should be damage from foreign material.

3C ELECTRICAL

Be aware of and follow the appropriate local and national electrical codes. Do not make wiring alterations that can affect motor rotation without reconfirming correct rotation. Select starter heaters and wiring for the maximum current the motor can use at full service factor loads. Regenerative turbine pumps will typically use extra power for a period until they run in. This can take three to four weeks depending on the duty cycle. During this period, impellers are finding their hydraulically balanced position.

3D ADJUSTMENTS

No adjustments should be required or are advisable on new pumps. In view of the close fits however, it is not uncommon for regenative turbine pumps to be difficult or impossible to turn over by hand by the time they have been shipped, mounted, and allowed to dry out inside. In these cases, it may be necessary to fill the pump with fluid and loosen the thrubolts exactly one turn (loosen guide rods also on pumps that have them – see the appropriate assembly drawings). DO NOT LOOSEN BEARING ARMS – they are difficult to adjust except as part of the assembly or reassembly process. With the thrubolts loose, light tapping with a soft mallet on the exposed end of the pump shaft along with torque applied to the coupling should have the desired effect. If possible, spin the pump (or operate with minimal or zero discharge pressure) while the thrubolts are retightened exactly one turn. This will allow residue to be flushed from close fitting ring and impeller surfaces. With the large close fitting surface area inside regenerative turbine pumps, it takes only microscopic residue to produce substantial resistance to rotation. Once loosened however, this material is quickly dispersed. Impellers quickly find their hydraulic center. Normal operation may be expected.

3E COOLING WATER

When pumping hot fluids, consideration should be given to cooling the seals and/or selecting materials that will give satisfactory seal life. The actual temperature at the seal faces, the most critical area, will always exceed the surrounding fluid temperature. If seal flushing lines have not been installed, heat can build up in the seal faces to a degree that may destroy the fluid film necessary to prevent rapid wear. In some cases it is necessary to cool the seal flushing fluid. Refer to seal manufacturers charts for guidance or to selection data in the PACOTURB II Bulletin any time fluids handled can reach or exceed their boiling point.

3F PRIMING

Pumps should not be operated unless they are completely filled with liquid, as there is a danger of injuring some parts of the pump which depend upon liquid for their lubrication. Impellers tend to seize quickly when the pump is run dry. Seal faces are easily damaged from heat buildup without lubrication.

Pumps are easily primed with a vacuum pump. An ejector or liquid ring vacuum pump is best because they are not damaged in the event liquid enters them. If other vacuum pumps are used, the system should be designed to prevent water from entering. Connect the vacuum line to the discharge side of the pump, either in the discharge opening or the drain tap. A foot valve is not necessary when this kind of a device is used.

When a vacuum pump is not practical, a foot valve in the suction inlet can be used to prevent liquid from running out. The pump and suction line can then be filled completely from an outside source. A vent opening will be necessary during filling to let air escape. A tight foot valve will keep the pump constantly primed so that automatic operation is possible. The valve should be inspected regularly to see that it does not develop leaks and allow the pump to run dry.

Self priming attachments are available for PACOTURB II turbine pumps to allow priming when neither a vacuum pump or foot valve is possible. Refer to specific literature for details. There are three components to the self primer. A check valve is necessary to maintain a vacuum in the suction line as surging occurs in the pump an air eliminator is used on the discharge side to separate air from liquid so that the liquid may be used again and again as air is carried thru the pump. A recirculating line carries liquid from the air eliminator back to the suction. A fluid chamber is sometimes added on the inlet side to provide an additional supply of fluid to speed up priming. Small suction lines are desirable to minimize priming time. Using the self priming attachments, it is only necessary to open the plugs in both inlet and outlet chambers and pour fluid in one until both are full. Tighten both plugs tightly. Turn on the pump. Priming time is dependent on lift, volume of air in the suction line and the size of the regenerative turbine pump selected. If priming time is long and the pump becomes warm, it may be advisable to refill the priming chambers with fresh liquid. Most turbine pumps will pull twenty-six to twenty-eight inches of mercury vacuum with cold water in the pump but have very little capacity and therefore are not very practical at lifts over twenty-two feet.

The best way to prime a pump and keep it primed is to use a flooded suction. While this is not always practical, it does provide a number of advantages. The likelihood of pump damage from dry running is all but eliminated. Suction lines may be large thus reducing line losses and minimizing the potential of cavitation damage. There are no check valves or other priming devices to fail or require maintenance. Whenever possible, design pumping systems with a flooded suction.

3G STARTING

Before starting a pump for the first time, be sure that all the preceding operations have been carried out. Proper rotation, priming and a free turning pump are most important. Start the pump with the minimum possible line restrictions. Open discharge valves before pressing the starter. Start. Let the system clear of air. Listen for foreign material being carried thru the pump. Slowly close necessary valves or otherwise place the pump into service. Listen for indications of undue load or other sounds that would indicate problems. A clip-on ammeter should show a steady load after about fifteen minutes of operation.

3H STOPPING

It is best to stop the pump with the least discharge head possible both for minimizing strain on components and to be in a low power mode in anticipation of restarting. If the pump will be down for more than a few days it may be advisable to drain it. Follow instructions for long term storage. After any prolonged stoppage, turn the pump over by hand before restarting to be sure that it is free.

MAINTENANCE IV

PACOTURB II
Regenerative Turbine Pumps – Series F
A. Seals
B. Flushing Lines
C. Cooling Water
D. Lubrication
E. Interstage Bushings

4 MAINTENANCE

4A SEALS

Mechanical seals have been used in PACOTURB II regenerative turbine pumps to eliminate the type of maintenance that is typically needed for packing boxes. This does not mean they can be totally ignored. Shortly after a new installation has been started, it is advisable to look for some evidence of seal leakage. Early leakage from the inlet end of the pump suggests that either the system was not properly cleared of air before starting and this seal was damaged or there may be an inlet line restriction that was or is letting air in.

Maintenance on seals consists primarily of periodic observation, looking for the first signs of failure. An occasional drip that continues to worsen is an indication that the seal has failed and must be replaced. Follow the appropriate disassembly – reassembly instructions. Always shut down a pump with failed seals as soon as practical. Leaky seals are usually followed by bearing failures and then gross pump damage as rotating parts become misaligned.

4B FLUSHING LINES

If your pump is equipped with flushing lines, it is a good idea to confirm that they are open before each operating season or once a year. To do this, unscrew the connections to each seal chamber and put pipe plugs in the seal chamber taps. Jog the pump to confirm that there is flow from each end of the flush lines. If there is any suspicion that they may be clogged, remove and replace them. Note that on all except single stage pumps, the line to the lower pressure end of the pump, the inlet end, is crimped to prevent all the flow from being diverted to this end. The easiest way to duplicate this restriction is to put a valve in the lower pressure line. With the seal chamber line open to the atmosphere, turn on the pump and adjust the flow to a trickle or a slow continuous stream. Replace the line.

4D LUBRICATION

Sealed ball bearings are standard in all PACOTURB II pumps. Unless special high temperature grease has been specified, the maximum continuous operating temperature for bearings is two hundred fifty degrees fahrenheit. While it is not advisable to routinely disassemble sealed bearings, it is possible to remove the seals during disassembly and determine if they were the cause of the problem. Use new bearings for reassembly. While the pump is in service, listen for unusual sounds or changes in bearing noise. A screwdriver held between the ear and the bearing housing while the pump is rotated by hand is sometimes helpful if there is too much ambient noise when the system is operating.

4E INTERSTAGE BUSHINGS

PACOTURB II regenerative turbine pumps with more than one stage use floating bushings between stages. Their only purpose is to minimize leakage between stages. All radial loads are either hydraulically balanced or handled by the ball bearings on each end of the pump.

These bushings are held in position by the differential pressure between stages. In some cases they may be heard to snap into position as pressure rises from zero. This usually occurs before 40 psi depending on the number of stages in the pump. When they become worn, excess leakage between stages is likely to overcome the axial balance of the impellers. The impeller on the high pressure end (end opposite the shaft extension) is usually the first to be forced out of position, followed by the next highest if the pump is allowed to continue operation. The first evidence of unbalanced impellers is usually an increase in power consumption. Good practice would be to measure amps with a clip-on or other type ammeter while the pump is operating at normal pressure. A periodic ammeter check or at least a yearly check will then have a benchmark for reference. Any indication of either worn interstage bushings or unbalanced impellers should be reason to shut the system down for service.

SERVICE V

FLEXIBLE COUPLED PUMPS – SERIES F
1 ¼" x 1 ¼" Suction & Discharge
A. Preliminary
B. Tools and equipment
C. Disassembly
D. Inspection of components
E. Reassembly
F. Testing and final adjustments

5 SERVICE

5A PRELIMINARY

Before pump service begins, note the details of the system prior to removal of the pump. This is sometimes helpful in determining the cause of failure when pump life has been less than expected.

Disconnect inlet and outlet piping. Disconnect and separate coupling halves. Remove any dowel pins from the pump feet. Remove pump mounting bolts. Lift the pump carefully from the baseplate. The feet are easily broken if the pump is dropped. A hoist or other mechanical lifting aid may be necessary on larger models.

5B TOOLS AND EQUIPMENT

1) Soft mallet
2) Two jaw gear puller
3) Snap ring pliers (for removing internal Truarc snap rings)
4) Two large screwdrivers
5) Wood blocks as shown
6) Side cutters (for removing keys from the shaft)
7) Penetrating oil
8) 5/16" drive pin punch
9) Set of metal numbering stamps
10) 10 or 12 inch crescent wrench
11) 9/16" box end wrench or socket
12) 9/16" open end wrench

5C DISASSEMBLY

1. Starting at the discharge end of the pump, remove the four nuts (#20) and four thru bolts (#19).

2. Remove the two nuts (#20) that hold the outboard bearing arm (#3) in position.

3. The bearing arm (#3) may now be removed. A gear puller may be necessary. The outboard ball bearing (#24) should now be removed. A gear puller will have to be used for this operation. If the bearing can be removed too easily, a worn bearing surface may be indicated. Replace the shaft and bearing as necessary before reassembly.

4. Slide the flinger (#21) off the shaft.

5. Carefully loosen the two remaining nuts (#20). Relieve the tension evenly by turning each nut a little at a time. This will prevent the guide rods from becoming distorted.

6. Using a soft mallet, loosen the outboard cover (#1) by tapping lightly around the outside edge. Slip the cover off the guide rods (#18) being careful not to bend them.

7. The seal cup (#2) may be removed by tapping it towards the inside of the cover (#1). Using a wooden block or dowel for this operation, rather than something metal, will prevent damage to the seal cup or seal seat (#12.5).

8. If the seal seat (#12.5) must be reused, use a wooden dowel sized to fit through the hole in the seal cup to tap it out. Ceramic seal seats are

particularly easy to damage. Normally, always replace the seats when servicing the pump.

9. Slide the outboard seal rotating element (#12 or #13) from the shaft.

10. If the rotating element cannot be removed easily, it may be necessary to apply penetrating oil or some other lubricant compatible with the seal material. If any doubt exists as to what type of elastomer is used in a particular seal element, check the purchase records. Reuse of seals is not recommended, regardless of its apparent condition, and replacement during reassembly is usually a wise choice. One & two stage pumps use a 7/8 inch type 21 crane or equivalent seal while three & four stage pumps utilize a 1 inch type 21B crane or equivalent seal on the high pressure end only.

11. Remove the two "O" rings (#8) from the guide rods (#18).

12. If a complete disassembly is to be performed, all the channel rings (#9 & #10) should be suitably marked at this time so that the original orientation and position can be retained during reassembly. Note or mark these rings such that the top to bottom relationship as well as the order is maintained. Number stamps are preferable to less permanent markings which tend to be lost during cleaning.

13. Gently tapping the rings around the outside edges with a soft mallet will loosen them. Separate the first channel ring (#9) and slide it off the guide rods exercising care to prevent damage. Should prying be necessary, it should be done evenly and with great care.

14. On three & four stage pumps, the drive collar (#14) must be removed before further disassembly can continue. A small screwdriver or pocket knife can be useful for this task. Damage to the ring groove should be avoided.

15. Slide the impeller (#11) off the shaft. Penetrating oil should be used if resistance occurs. Prying impellers off the shaft almost always ruins the impeller.

16. Remove the next channel ring (#10) using the same care as with the first.

17. Remove the key (#23) from the shaft. Diagonal side cutters or end nippers are helpful for this job.

18. For disassembly of single stage pumps (141 models) proceed to step #20. For all other models (142, 143, & 144) proceed to next step.

19. Slide off the next channel ring (#9). Along with the ring will come an interstage bushing (#16). Note the direction the bushing is facing so that the same surfaces will be in contact after reassembly.

20. Remove the remaining channel rings, impellers and interstage bushings. Stacking the parts as they are removed will help in maintaining the proper orientation and in keeping the impellers with the same pair of channel rings. On badly corroded pumps it may be easier to drive the guide rods (#18) back through each

ring rather than sliding the ring the entire length of the rods. If this is to be done, care should be taken not to "mushroom" the rod ends by tapping with too much force. A soft face hammer and/or brass rod is recommended. Penetrating oil helps greatly.

21. Turn the pump around and remove the two nuts (#20) holding the bearing arm (#3) in place.

22. Removing the bearing arm will require the use of a gear puller since the bearing (#24) is held in the bearing arm by means of a snap ring (#4). Removal of the bearing arm will bring the bearing along with it.

23. Slide the rubber flinger (#21) off the shaft.

24. The remaining internal parts; the shaft (#17) and the seal rotating assembly (#12) will slide easily out of the cover (#1).

25. The shaft extension end seal element (#12) can be removed in the same manner as was the outboard rotating element.

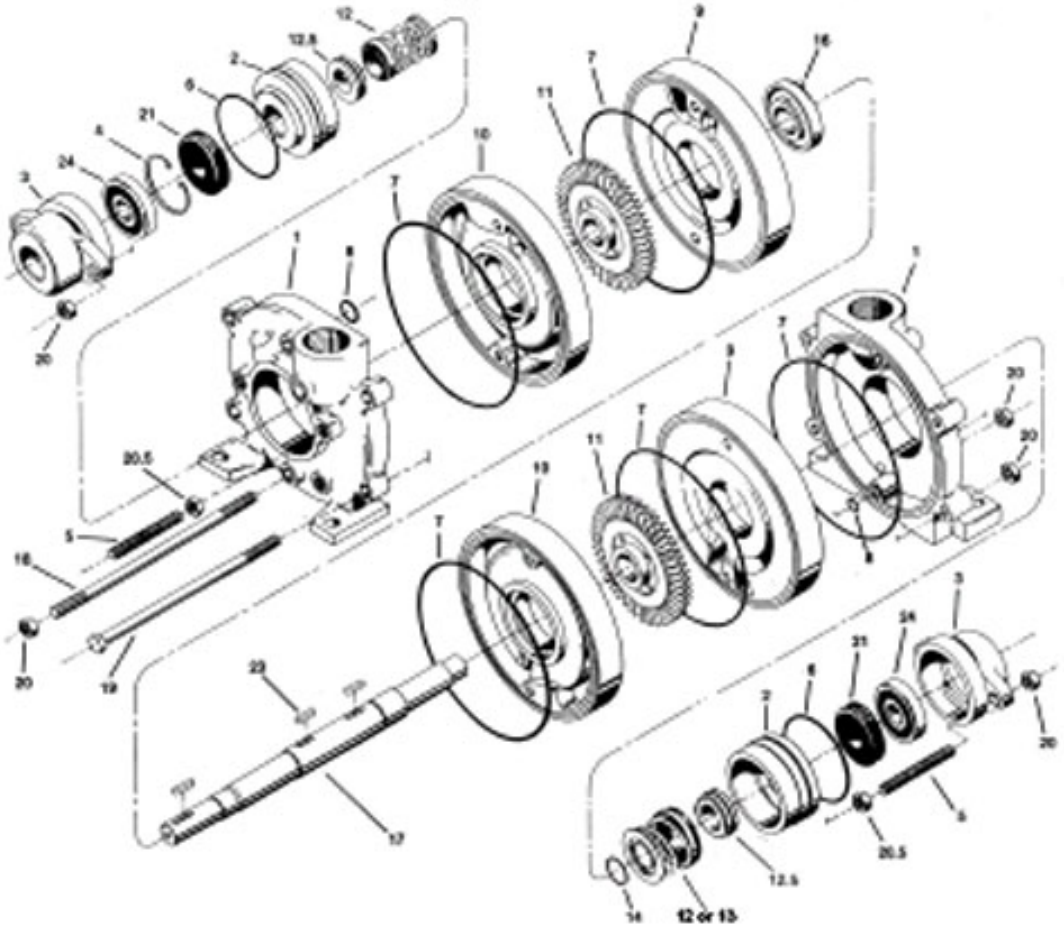
26. To complete the disassembly, remove the two "O" rings (#8) and two guide rods (#18).

27. Press out the shaft extension end stationary seat (#12.5) using the same procedure as on the outboard seat.

28. The remaining seal cup (#2) can be removed from the cover by driving it outward from the inside.

PACO PUMPS

Frame Mounted Regenerative Turbine Cross Section



Part No.	Name	Description	Part No.	Name	Description
1	Cover	Inlet & Discharge	13	Seal Rotating Element	Balanced (units and 143 & 144 series)
2	Seal Cup		14	Drive Collar	Spiroloc
3	Bearing Arm		16	Interstage Bushing	142, 143, 144 series
4	Snap Ring	Bearing Retaining (inlet end only)	17	Shaft	
5	Stud	Bearing Arm	18	Guide Rod	
6	"O" Ring	Medium - Seal Cup	19	Thru Bolt	Casing
7	"O" Ring	Large - Casing	20	Nut	Casing and Bearing Arm
8	"O" Ring	Small - Guide Rod	20.5	Jam Nut	Bearing Arm
9	Clearance Ring	Right - 1400 (outer end ring)	21	Flinger	
10	Clearance Ring	Left - 1400 (inlet end ring)	22	Drain Plug	
11	Impeller		23	Key	Impeller and shaft
12	Seal Rotating Element	Unbalanced (inlet end - all pumps (outlet end - 141 & 142 series)	24	Ball Bearing	Sealed
12.5	Seal Stationary Seat	Both Seals			

5D INSPECTION OF COMPONENTS

Thoroughly clean all parts. All components should be examined for wear and corrosion. Replace parts that show visible wear. If the pump was no longer producing sufficient pressure or capacity, it is a safe assumption that clearances between rings and impeller exceed an acceptable amount. At least the impellers should be replaced in this case. If the total side running clearance for an impeller exceeds .007", it is unlikely that pump performance will reach that of a new pump except at lower discharge pressures.

"O" rings and other elastomeric components should be replaced if they have been deformed or cut.

If seal components must be reused, carefully inspect for microscopic cracks and nicks. Scratches that might be ignored elsewhere can produce leakage if they are on seal carbons and seat wearing surfaces. Cleanliness is imperative when working with mechanical seals. Almost unnoticeable particles between seal faces can be, and often are, the cause of early seal failures.

Check to be certain that a press fit still exists between the shaft and the bearings. New bearings, or at least cleaned and regreased bearings, are recommended.

All impellers and interstage bushings are designed to float, therefore they should move easily on the shaft. No more than .010" diametral clearance should exist between the shaft and the inside of an insterstage bushing. More than this can produce hydraulic unbalance that can quickly wear out the impellers. As long as impellers can be moved on the shaft by hand, they are loose enough. If they can be rocked or wobbled, they are definitely too loose and must be replaced.

Check the shaft for galling, pitting, and corrosion. If there are worn areas between stages of multistage pumps, the shaft should be replaced. Pitting or corrosion in the area where the seal comes in contact is also cause for shaft replacement. This will cause leakage under the seal. Surface corrosion must be removed so that seals can slide freely during assembly. The shaft diameter should be no smaller than .002 inch below the nominal fractional seal sizes. Remove any nicks or burrs which may have occurred during disassembly. Reclean parts as necessary.

5E REASSEMBLY

1. Begin reassembly with the inlet cover (#1). Thread two nuts (#20) onto the guide rods (#18), and slide them through the two holes at six and twelve o'clock. Push them in until the underside of the nuts contacts the cover.

2. Slide the two "O" rings (#8) over the extended ends of the guide rods until they touch the cover.

3. It is recommended that the assembly be placed on blocks in a vertical position as shown.

4. Place an "O" ring (#7) into the groove in the face of the cover (#1). Slide a left hand channel ring (#10) onto the guide rods with the water channel facing up. With the pump feet in the "six o'clock" position, the large inlet

opening should be at "eleven o'clock".

5. Put another "O" ring (#7) and a key (#23) into place.

6. Slide an impeller (#11) onto the shaft (#17) and over the key (#23) nearest the drive end. Place the impeller-shaft assembly into the ring, with the shaft extension down. If the blocking is the correct height, the shaft end should contact the bench at the same time the impeller covers the key.

7. Slide a right hand channel ring (#9) onto the guide rods with the water channel facing downward, toward the impeller. The small outlet opening should be in the "one o'clock" position. This completes one stage: a stage consisting of one left hand channel ring (#10), a right hand channel ring (#9), and an impeller (#11) between them.

8. Single stage pumps should proceed to step #17. Pumps with more than one stage proceed to next step.

9. Slide an interstage bushing onto the shaft. The smooth wearing face should be installed against the ring (#9).

10. Place another "O" ring (#7) into position.

11. Slide another left hand channel ring (#10) into place with the water channel facing up. This time, however, place the large inlet opening in the "five o'clock" position. By locating successive stages 180 degrees from the last, hydraulic loads are radially balanced.

12. Add another Key (#23) and an impeller (#11).

13. Put another "O" ring (#7) into place.

14. To complete the second stage assembly, install a right hand channel ring (#9) facing downward toward the impeller. The small discharge opening should be in the "seven o'clock" position.

15. Continue installing stages depending on how many stages are in the pump. Don't forget the interstage bushings and the "O" rings (#7). Remember also to stagger the ring sets to balance radial loads. The odd numbered stages should have openings at the top of the pump as described for the first stage installation. Even numbered stages should have their openings downward as indicated for the second stage.

16. After the last impeller has been installed in three or four stage pumps, a drive collar (#14) must be installed to locate the seal rotating element. If the groove is hidden, tap the shaft gently from the coupling end until it just becomes visible.

17. Add the last "O" ring (#7) and two "O" rings (#8) onto the guide rods (#18).

18. Slide the cover (#1) over the exposed guide rods bringing it up against the last channel ring. Check to make sure the feet on both covers are in the "six o'clock" position.

19. Install two nuts (#20) onto the guide rods and tighten enough to hold the

entire assembly in place. Do not try to tighten them to their final position.

20. Carefully press seal seats (#12.5) into both seal cups (#2). A clean soft material should be used between the seal face and pressing tools. The smoothest side of the seat should face up. Caution: Dirt and scratches can quickly ruin seals. Place an "O" ring (#6) into the groove around each seal cup.

21. When installing seats and rotating elements, a thin film of compatible lubricant may be applied to seal surfaces. This will help seals to become mated when they first come in contact. Glycerine, ethylene, glycol, and mineral oil are sometimes selected for use on standard seals which use EPR elastomer. Do not use a petroleum based lubricant on standard seals.

22. The seal rotating element can now be installed. One and two stage pumps position both seals (#12) by a shoulder on the shaft. Three and four stage pumps locate the rear seal (#13) by means of a drive collar (#14). The seal rotating element, when lubricated, must be allowed to move freely on the shaft. This will enable the seal to seek a hydraulic balance upon operation.

23. Install the seal cup with the face of the seal towards the rotating element. A short length of pipe will help to tap the cup down until it contacts the ring.

24. Press a finger (#21) onto the shaft until it is against the seal cup.

25. Solidly supporting the bottom end of the shaft, drive or press a ball bearing (#24) onto the shaft until it rests firmly against the shoulder on the shaft. A sleeve properly sized to contact only the inner bearing race will be helpful for this operation.

26. Tap a bearing arm (#3) over the bearing and retain with two nuts (#20). They should be finger tight only.

27. Remove the pump from the support blocks and place it on its feet.

28. Insert the four thru bolts (#19) and install nuts (#20). Tighten all six nuts evenly until about one full turn before being fully torqued. Return the assembly to the wood blocking with its shaft extension up. Install the seal rotating element (#12), the seal cup assembly (#2), and flinger (#21) with the same procedure as on the other end.

29. Drive a ball bearing (#24) into a bearing arm (#3), applying force to the bearing's outer race only. Insert a snap ring (#4) into the groove provided in the bearing arm. The beveled side of the snap ring faces away from the bearing.

30. Place a metal support under the shaft opposite the extension. A 3/8" or 1/2" nut works well. The pump will be unstable in this position. It is well to have necessary tools at an easy reach. Drive the bearing arm assembly onto the shaft until the bearing rests against the shoulder provided. Driving should be done with a sleeve contacting the inner

race only. Secure with two nuts (#20) finger tight.

5F TESTING AND FINAL ADJUSTMENTS

1. Check to be sure the pump rotates freely. If not, determine why and resolve any problems before proceeding. Incorrect assembly or the presence of foreign material has probably occurred.

2. For optimum final adjustment, remount the pump, make coupling and piping connections. Check for correct rotation.

3. Open the inlet and outlet valves and start the pump when fluid has displaced air from it. The pump may leak at this time, but a fully open discharge should prevent substantial fluid losses.

4. Evenly tighten all six nuts (#20). A noticeable change in RPM is an indication that the nuts are not being tightened evenly. Torque to 20 foot pounds.

5. Evenly tighten the two nuts (#20) on the driver end bearing arm. Torque no higher than 5 foot pounds. If signs of distress are evident, back off evenly until the pump runs smoothly again. Lock the bearing arm in place by turning the two jam nuts (#20.5) in a counterclockwise direction. The bearing arm is now correctly positioned and should remain so until service is again required.

6. Evenly tighten the two nuts (#20) on the discharge end of the bearing arm. With a new pump or one with new rings and impellers, these nuts cannot be tightened very much before distress becomes noticeable. Back off slightly until the pump runs smoothly. Use the two jam nuts (#20.5) to lock this bearing arm in position as was done in step #5. (On an older pump, the nuts (#20) on both ends may be tightened up to 20 foot pounds.) Depending on the condition of the pump, tightening these nuts can improve and sometimes restore performance. Jam nuts (#20.5) should always be loose enough to allow sensitive adjustment of bearing arms when performing these operations. Turn them counterclockwise until they contact bearing arms when adjustments are complete.

7. This completes the necessary adjustments. The pump is now ready for service.

If an Amprobe or other current measuring device is used as the system is returned to normal operation, a variation or wavering will be noticed as the pump impellers seek their hydraulic balance. It sometimes requires a few hours or even days to complete this positioning.

SERVICE V
Flexible Coupled Pumps – Series F
2" x 2" Suction and Discharge

5 SERVICE

5A PRELIMINARY

Before pump service begins, note the details of the system prior to removal of the pump. This is sometimes helpful in determining the cause of failure when pump life has been less than expected.

Disconnect inlet and outlet piping. Disconnect and separate coupling halves. Remove any dowel pins from the pump feet. Remove pump mounting bolts. Lift the pump carefully from the baseplate. The feet are easily broken if the pump is dropped. A hoist or other mechanical lifting aid may be necessary on larger models.

5B TOOLS AND EQUIPMENT

1) Soft mallet
2) Three jaw Puller
3) Snap ring pliers (for removing internal Truarc snap rings)
4) Two large screwdrivers
5) Wood blocks (as shown)
6) Side cutters (for removing keys from the shaft)
7) Penetrating oil
8) 5/16" drive pin punch
9) Set of metal numbering stamps
10) 10 or 12 inch adjustable wrench
11) Spanner Wrench
12) 1 1/8" box end wrench or socket
13) 9/16" combination wrench
14) ¾" combination wrench or socket

5C DISASSEMBLY

1. Starting at the discharge end of the pump, remove the seven nuts (#20B) and seven thru bolts (#19B).

2. Remove the three nuts (#20) that hold the outboard bearing arm (#3B) in position.

3. The bearing arm (#3B) may now be removed. A gear puller may be necessary. The outboard ball bearing (#24B) will now be exposed. Locate the tab on the bearing lock washer (#39B) which is holding the bearing lock nut (#38B) in place. Bend this tab straight by prying underneath it with a screwdriver or chisel. Once the tab has been lifted somewhat, use a pin punch or drift to tap the tab out of the slot in the bearing lock nut (#38B). Using a spanner wrench or punch, loosen and remove the bearing lock nut (#38B). Slide the lock washer from the shaft. The outboard ball bearing (#24B) should now be removed. A gear puller will have to be used for this operation. If the bearing can be removed too easily, a worn bearing surface may be indicated. Replace the shaft and bearing as necessary before reassembly.

4. Slide the flinger (#21B) off the shaft.

5. Carefully remove the two remaining nuts (#20A). Relieve the tension evenly by turning each nut a little at a time. This will prevent the guide rods from becoming distorted.

6. Using a soft mallet, loosen the outboard cover (#1B) by tapping lightly around the outside edge. Slip the cover off the guide rods (#18B) being careful not to bend them.

7. The seal cup (#2B) may be removed by tapping it towards the inside of the cover (#1B). Using a wooden block or dowel for this operation, rather than something metal, will prevent damage to the seal cup or seal seat (#12.5B).

8. If the seal seat (#12.5B) must be reused, use a wooden dowel sized to fit through the hole in the seal cup to tap it out. Ceramic seal seats are particularly easy to damage. Normally, always replace the seats when servicing the pump.

9. Slide the outboard seal rotating element (#12B or #13B) from the shaft. If the rotating element cannot be removed easily, it may be necessary to apply penetrating oil or some other lubricant compatible with the seal material. If any doubt exists as to what type of elastomer is used in a particular seal element, check the purchase records. Reuse of seals is not recommended, regardless of its apparent condition, and replacement during reassembly is usually a wise choice. One & two stage pumps use a 1 3/8 inch type 21 crane or equivalent seal while three & four stage pumps utilize a 1 ½ inch type 32B crane or equivalent seal on the high pressure and only.

10. Remove the two "O" rings (#8B) from the guide rods (#18B).

11. If a complete disassembly is to be performed, all the channel rings (#9B & #10B) should be suitably marked at this time so that the original orientation and position can be retained during reassembly. Note or mark these rings such that the top to bottom relationships as well as the order is maintained. Number stamps are preferable to less permanent markings which tend to be lost during cleaning.

12. Gently tapping the rings around the outside edges with a soft mallet will loosen them. Separate the first channel ring (#9B) and slide it off the guide rods exercising care to prevent damage. Should prying be necessary, it should be done evenly and with great care.

13. On three & four stage pumps, the drive collar (#14B) must be removed before further disassembly can continue. A small screwdriver or pocket knife can be useful for this task. Damage to the ring groove should be avoided.

14. Slide the impeller (#11B) off the shaft. Penetrating oil should be used if resistance occurs. Prying impellers off the shaft almost always ruins the impeller.

15. Remove the next channel ring (#10B) using the same care as with the first.

16. Remove the key (#23) from the shaft. Diagonal side cutters or end nippers are helpful for this job.

17. For disassembly of single stage pumps (151/161 models) proceed to step #20. For all other models proceed to next step.

18. Slide off the next channel ring (#9B). Along with the ring will come an interstage bushing (#16B). Note the direction the bushing is facing so that the same surfaces will be in contact after reassembly.

19. Remove the remaining channel rings, impellers and interstage bushings. Stacking the parts as they are removed will help in maintaining the proper orientation and in keeping the impellers with the same pair of channel rings. On

badly corroded pumps it may be easier to drive the guide rods (#18B) back through each ring rather than sliding the ring the entire length of the rods. If this is to be done, care should be taken not to "mushroom" the rod ends by tapping with too much force. A soft face hammer and/or brass rod is recommended. Penetrating oil helps greatly.

20. Turn the pump around and remove the three nuts (#20) holding the bearing arm in place.

21. Remove the bearing locknut (#38B) and lock washer (#39B) the same way as on the discharge end.

22. Removing the bearing arm will require the use of a gear puller since the bearing (#24B) is held in the bearing arm by means of a snap ring (#4B). Removal of the bearing arm will bring the bearing along with it.

23. Slide the rubber flinger (#21B) off the shaft.

24. The remaining internal parts; the shaft (#17B), and the seal rotating assembly (#12B) will slide easily out of the cover (#1B).

25. The shaft extension end seal element (#12B) can be removed in the same manner as was the outboard rotating element.

26. To complete disassembly, remove the two "O" rings (#8B) and two guide rods (#18B).

27. Press out the shaft extension end stationary seat (#12.5B) using the same procedure as on the outboard seat.

28. The remaining seal cup (#2B) can be removed from the cover by driving it outward from the inside.

5D INSPECTION OF COMPONENTS

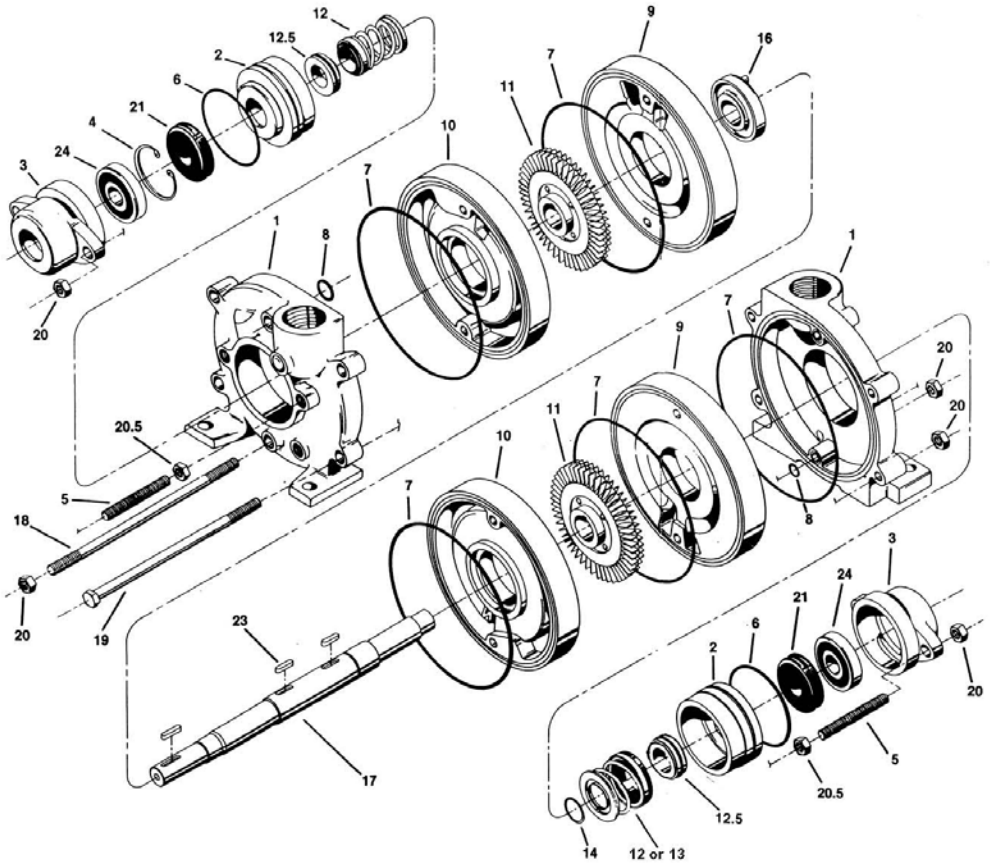
Thoroughly clean all parts. All components should be examined for wear and corrosion. Replace parts that show visible wear. If the pump was no longer producing sufficient pressure or capacity, it is a safe assumption that clearances between rings and impeller exceed an acceptable amount. At least the impellers should be replaced in this case. If the total side running clearance for an impeller exceeds .009", it is unlikely that pump performance will reach that of a new pump except at lower discharge pressures.

"O" rings and other elastomeric components should be replaced if they have been deformed or cut.

If seal components must be reused, carefully inspect for microscopic cracks and nicks. Scratches that might be ignored elsewhere can produce leakage if they are on seal carbons and seat wearing surfaces. Cleanliness is imperative when working with mechanical seals. Almost unnoticeable particles between seal faces can be, and often are, the cause of early seal failures.

Check to be certain that a press fit still exists between the shaft and the bearings. New bearings, or at least cleaned and regrease bearings, are recommended.

All impellers and insterstage bushings are designed to float, therefore they should move easily on the shaft. No more than .010" diametral clearance should exist between the shaft and the inside of an interstage bushing. More than this can produce hydraulic unbalance that can quickly wear out the impellers. As long as



Part No.	Name	Description	Part No.	Name	Description
1	Cover	Inlet & Discharge	13	Seal Rotating Element	Balanced (outlet end- 143 & 144 series)
2	Seal Cup		14	Drive Collar	Spirolox
3	Bearing Arm		16	Interstage Bushing	142, 143, 144 series
4	Snap Ring	Bearing Retaining (inlet end only)	17	Shaft	
5	Stud	Bearing Arm	18	Guide Rod	
6	"O" Ring	Medium- Seal Cup	19	Thru Bolt	Casing
7	"O" Ring	Large- Casing	20	Nut	Casing and Bearing Arm
8	"O" Ring	Small- Guide Rod	20.5	Jam Nut	Bearing Arm
9	Channel Ring	Right- 140R (outer end ring)	21	Flinger	
10	Channel Ring	Left- 140L (inlet end ring)	22	Drain Plug	
11	Impeller		23	Key	Impeller and shaft
12	Seal Rotating Element	Unbalanced (inlet end- all pumps) (outlet end- 141 & 142 series)	24	Ball Bearing	Sealed
12.5	Seal Stationary Seat	Both Seals			

impellers can be moved on the shaft by hand, they are loose enough. If they can be rocked or wobbled, they are definitely too loose and must be replaced.

Check the shaft for galling, pitting, and corrosion. If there are worn areas between stages of multistage pumps, the shaft should be replaced. Pitting or corrosion in the area where the seal comes in contact is also cause for shaft replacement. This will cause leakage under the seal. Surface corrosion must be removed so that seals can slide freely during assembly. The shaft diameter should be no smaller than .002 inch below the nominal fractional seal sizes. Remove any nicks or burrs which may have occurred during disassembly. Reclean parts as necessary.

5E REASSEMBLY

1. Begin reassembly with the inlet cover (#1B). Thread two nuts (#20A) onto the guide rods (#18B), and slide them through the two holes at six and twelve o'clock. Push them in until the underside of the nuts contacts the cover.

2. Slide two "O" rings (#8B) over the extended ends of the guide rods until they touch the cover.

3. It is recommended that the assembly be placed on blocks in a vertical position as shown.

4.Place an "O" ring (#7B) into the groove in the face of the cover (#1B). Slide a left hand channel ring (#10B) onto the guide rods with the water channel facing up. With the pump feet in the "six o'clock" position, the large inlet opening should be at "eleven o'clock".

5. Put another "O" ring (#7B) into place.

6. Slide an impeller (#11B) onto the shaft (#17B) and over the key (#23) nearest the drive end. Place the impeller-shaft assembly into the ring, with the shaft extension down. If the blocking is the correct height, the shaft end should contact the bench at the same time the impeller covers the key.

7. Slide a right hand channel ring (#9B) onto the guide rods with the water channel facing downward, toward the impeller. The small outlet opening should be in the "one o'clock" position. This completes one stage; a stage consisting of one left hand channel ring (#10B), a right hand channel ring (#9B), and an impeller (#11B) between them.

8. Single stage pumps should proceed to step #17. Pumps with more than one stage proceed to next step.

9. Slide an insterstage bushing onto the shaft. The smooth wearing face should be installed against the ring (#9B).

10. Place another "O" ring (#7B) into position.

11. Slide another left hand channel ring (#10B) into place with the water channel facing up. This time, however, place the large inlet opening in the "five o'clock" position. By locating successive stage 180 degrees from the last, hydraulic loads are radially balanced.

12. Add another Key (#23) and an impeller (#11B).

13. Put another "O" ring (#7B) into place.

14. To complete the second stage assembly, install a right hand channel ring (#9B) facing downward toward the impeller.

The small discharge opening should be in the "seven o'clock" position.

15. Continue installing stages depending on how many stages are in the pump. Don't forget the interstage bushings and the "O" rings (#7B). Remember also to stagger the ring sets to balance radial loads. The odd numbered stages should have openings at the top of the pump as described for the first stage installation. Even numbered stages should have their openings downward as indicated for the second stage.

16. After the last impeller has been installed in three or four stage pumps, a drive collar (#14B) must be installed to locate the seal rotating element. If the grove is hidden, tap the shaft gently from the coupling end until it just becomes visible.

17. Add the last "O" ring (#7B) and two "O" rings (#8B) onto the guide rods (#18B).

18. Slide the cover (#1B) over the exposed guide rods bringing it up against the last channel ring. Check to make sure the feet on both covers are in the "six o'clock" position.

19. Install two nuts (#20A) onto the guide rods and tighten enough to hold the entire assembly in place. Do not try to tighten them to their final position.

20. Carefully press seal seats (#12.5B) into both seal cups (#2B). A clean soft material should be used between the seal face and pressing tools. The smoothest side of the seat should face up. Caution: Dirt and scratches can quickly ruin seals.

21. When installing seats and rotating elements, a thin film of compatible lubricant may be applied to seal surfaces. This will help seals to become mated when they first come in contact. Glycerine, ethylene glycol, and mineral oil are sometimes selected for use on standard seals which use EPR elastomer. Do not use a petroleum based lubricant on standard seals.

22. The seal rotating element can now be installed. One and two stage pumps position the seal (#12B) by a shoulder on the shaft. Three and four stage pumps locate the seal (#13B) by means of a drive collar (#14B). The seal rotating element, when lubricated, must be allowed to move freely on the shaft. This will enable the seal to seek a hydraulic balance upon operation.

23. Install the seal cup with the face of the seal towards the rotating element. A short length of pipe will help to tap the cup down until it contacts the ring.

24. Install flinger.

25. Solidly supporting the bottom end of the shaft, drive or press a ball bearing (#24B) onto the shaft until it rests firmly against the shoulder on the shaft. A sleeve properly sized to contact only the inner bearing race will be helpful for this operation.

26. Slide the bearing lock washer (#39B) on the shaft taking care that the washer "key tab" fits into the keyway in the shaft. The conical shape should face outward.

27. With the conical shape facing inward, thread the lock nut (#39B) on the shaft, contacting the lockwasher (#39B)

28. Tighten the locknut firmly with a spanner wrench, or a punch if necessary.

29. Locate the tab on the lockwasher which aligns itself with a slot in the locknut. Bend this tab down into the slot, locking the locknut in place.

30. Install an "O" ring (#6B), into the chamfer around o.d. of seal cup.

31. Tap a bearing arm (#3B) over the bearing and retain with three nuts (#20). They should be finger tight only.

32. Remove the pump from the support blocks, and place it on its feet.

33. Insert the seven thru bolts (#19B) and install nuts (#20B). Tighten all nine nuts (thru bolts and guide rods) evenly until they are about one full turn short of being fully torqued. Return the assembly to the wood blocking with the shaft extension up. Install the seal rotating element (#12B), seal cup assembly (#2B), and flinger (#21B) with the same procedure as o the other end.

34. Drive a ball bearing (#24B) into a bearing arm (#3B), applying force to the bearing's outer race only. Insert a snap ring (#4B) into the groove provided in the bearing arm. The beveled side of the snap ring faces away from the bearing.

35. Remove the pump from the blocking, but leave in same position.

36. Place a metal support under the shaft opposite the extension. A ¾" nut works well. The pump will be unstable in this position. It is well to have necessary tools at an easy reach. Install another (#6B) O-ring as before. Drive the bearing arm assembly onto the shaft until the bearing rests against the shoulder provided. Driving should be done with a sleeve contacting the inner race only. Secure with three nuts (#20), finger tight.

37. Install a bearing lockwasher (#39B) and bearing lock nut (#38B), using the same procedure as on the discharge end.

5F TESTING AND FINAL ADJUSTMENTS

1. Check to be sure the pump rotates freely. If not, determine why and resolve any problems before proceeding. Incorrect assembly or the presence of foreign material has probably occurred.

2. For optimum final adjustment, remount the pump, make coupling and piping connections. Check for correct rotation.

3. Open inlet and outlet valves and start the pump when fluid has displaced air from it. The pump may leak at this time, but a fully open discharge should prevent substantial fluid losses.

4. Evenly tighten all 7 -3/4" nuts (#20B), and the 4 -1/2" nuts (#20A). A noticeable change in RPM is an indication that the nuts are not being tightened evenly. Torque the ¾" nuts to 90 foot pounds, and the ½" nuts to 35 foot pounds.

5. Evenly tighten the three nuts (#20) on the driver end bearing arm. Torque no higher than 5 foot pounds. If signs of distress are evident, back off evenly until the pump runs smoothly again. Lock the bearing arm in place by turning the three jam nuts (#20.5) in a counterclockwise direction. The bearing arm is now correctly positioned and should remain so until service is again required.

6. Evenly tighten the two nuts (#20) on the discharge end of the bearing arm. With a new pump or one with new rings and impellers, these nuts cannot be tightened very much before distress becomes

noticeable. Back off slightly until the pump runs smoothly. Use the two jam nuts (#20.5) to lock this bearing arm in position as was done in step #5. (On an older pump, the nuts (#20) on both ends may be tightened up to 20 foot pounds.) Depending on the condition of the pump, tightening these nuts can improve and sometimes restore performance. Jam nuts (#20.5) should always be loose enough to allow sensitive adjustment of bearing arms when performing these operations. Turn them counterclockwise until they contact bearing arms when adjustments are complete.

7. This completes the necessary adjustments. The pump is now ready for service.

If an Amprobe or other current measuring device is used as the system is returned to normal operation, a variation or wavering will be noticed as the pump impellers seek their hydraulic balance. It sometimes requires a few hours or even days to complete this positioning.

TROUBLE SHOOTING VI

Flexible Coupled Pumps – Series F
A. Failure To Pump
B. Reduced Capacity
C. Reduced Pressure
D. Loses Prime
E. Excessive Power Consumption
F. Vibrates Or Is Noisy
G. Mechanical Problems
H. Seal Leakage

6 TROUBLESHOOTING

6A FAILURE TO PUMP:

1. Pump not up to speed – Use a tachometer to determine actual RPM. Check voltage and wiring connections.

2. Pump not primed – Confirm that pump and all inlet piping are filled with fluid.

3. Discharge head too high – Install a pressure gage at the pup discharge to determine the actual operating pressure. Compare readings with pump performance curve. A larger pump may be necessary.

4. Excessive suction lift – Relocate pump, supply tank or both to minimize suction lift.

5. Wrong direction of rotation – Compare pump rotation with arrows on pump. Standard pumps rotate in a clockwise direction when looking at the shaft extension end. Reverse two leads on three phase motors to change rotation.

6. Clogged suction line, strainer or foot valve – Inspect and clean out if necessary.

7. Air pocket in suction line – Look for high spots in inlet piping system. Evacuate the system with a vacuum pump if necessary.

6B REDUCED CAPACITY:

1. Pump not up to speed – Use a tachometer to determine actual RPM. Check voltage and wiring connections.

2. Excessive suction lift – Relocate pump, supply tank or both to minimize suction lift.

3. Insufficient NPSH – Relocate pump, supply tank or both to improve NPSH available if possible. Increase suction pressure. Reduce fluid temperature. Select a pump with lower NPSH requirements.

4. Mechanical damage – Rotate the pump by hand to determine if there are tight spots. Broken or bent impeller vanes can sometimes be noticed in this manner. If there is suspicion of damage, remove the pump from service and disassemble for inspection.

5. Air leak in the suction line – Fill the system with fluid and hydrostatically test. Tighten connections or replace leaky components.

6. Air pockets in the suction piping – Operating the system at maximum flow conditions will usually clear the lines. Evacuate the system with a vacuum pump if necessary.

7. Suction lines, strainer or foot valve too small or clogged – Inspect and clean out as necessary. Fittings and lines should be at least equal to the pump suction size.

8. Discharge head too high – Install a pressure gage at the pump discharge to determine the actual operating pressure. Compare readings with pump performance curve. A larger pump may be necessary.

9. Excessive wear – If a pump had previously performed satisfactorily and now gives evidence of reduced performance, it should be disassembled and examined for wear after the simpler possible problems have been pursued.

6C REDUCED PRESSURE:
1. Pump not up to speed – Use a tachometer to determine actual RPM. Check voltage and wiring connections.

2. Air or vapor in liquid – Install a separator in suction line. Check seal on inlet end of pump to determine if air is being drawn in. Hydrostatically test the system to insure that there are no leaks.

3. Mechanical wear or damage – Rotate the pump by hand to determine if there are tight spots. Broken or bent impeller vanes can sometimes be noticed in this manner. If there is suspicion of damage or wear, remove the pump from service and disassemble for inspection. Look for worn impeller, rings and interstage bushing.

4. System head less than expected – Replace pump with higher capacity unit or add a valve or orifice to increase line resistance.

6D PUMP LOOSES PRIME AFTER STARTING:
1. Leak in suction line – Fill the system with fluid and hydrostatically test. Tighten connections or replace leaky components.

2. Air entering pump thru inlet seal or "O" rings – Hydrostatically test the pump looking for leaks. Replace faulty seals or "O" rings.

3. Insufficient NPSH or too much suction lift – Relocate pump, supply tank or both to improve inlet conditions. Increase suction pressure. Reduce fluid temperature. Select a pump with lower NPSH requirements.

6E EXCESSIVE POWER CONSUMPTION:
1. Speed too high – Check RPM with tachometer.

2. Discharge head too high – Install a pressure gage at the pump discharge to determine the actual operating pressure. Compare readings with pump performance curve. A different pump, motor or both may be necessary.

3. Specific gravity or viscosity too high – Check fluid involved. A different motor may be necessary.

4. Mechanical damage – Turn pump over by hand. After a few days run in period, all models should turn over by hand with no sticky spots. An exception to this is when the pump has been idle for some time. In this case, run in for a few hours before checking for sticky spots. If there is suspicion of damage, remove the pump from service and disassemble for inspection.

5. Pump not fully broken in – While it is normal for new pumps to consume higher than normal current during the break in period, if this persists beyond a few weeks of use, it is unlikely that further operation will result in power reduction.

6. Pump not properly adjusted – Loosen all nuts on pump about one turn. Follow procedures in 5F TESTING AND FINAL ADJUSTMENTS for repositioning fasteners.

6F PUMP VIBRATES OR IS NOISY:

1. Pump and motor are misaligned – Follow installation instructions for proper alignment.

2. Insecure mounting – Follow instructions in section on foundations.

3. Piping load on pump – Provide piping supports and confirm that no strain remains on the pump.

4. Mechanical damage – If mechanical damage is suspected, check first to determine if pump turns freely. Disassemble for inspection if sticky spots are found.

5. Pump has a high pitched whine – This is typical of a regenerative turbine pump. The intensity should increase as pressure increases. Over a period of a few weeks the noise level will diminish and will be noticeably quieter as it approaches a worn out condition.

6G MECHANICAL PROBLEMS:

1. Short bearing life – Incorrect adjustment of the bearing arms. Leaky seals. Pump temperature too hot for grease used in bearings. Coupling misalignment. Piping load on pump. RPM or pump pressure too high.

2. Pump locked up – Pump dried out and close clearances rusty. Follow installation instructions for loosening the pump. Foreign material in pump. Flush out. Disassemble if not successful.

3. Pump leaks – Seal or "O" rings are usually the problem. Disassembly and replacement is the solution if tightening the six thru bolts has no effect.

6H SEAL LEAKAGE

1. Worn seat or rotating element – Seals will last many years operating on clear cold water or other fluids with reasonable lubricity. Particles of solids, even microscopic in size, increase normal wear rates. Temperatures nearing the fluids boiling point can reduce lubricity which in turn increases wear. Some chemicals will either erode the seal faces or plate out on the seal faces producing an abrasive effect. Immediate seal replacement is recommended when leaks become evident since bearings are quickly ruined as a result of moisture. Severe mechanical damage results when the bearings fail.

2. Improperly installed seat or rotating element – Particularly if a seal has recently been replaced, look for missing "O" rings around the seat, seat in cocked or backward. Smooth surface should face the rotating element. The rotating element may be in backward or improperly positioned. Refer to the appropriate seal diagrams and instructions to confirm correct seal orientation. Rotating elements sometimes stick in the wrong position if left partially assembled for a period. Make sure a rotating element can be moved axially on the shaft before closing up the pump and then try to do final adjustments as soon as practical.

3. Seat broken during assembly – Ceramic seats are particularly vulnerable to damage. Carefully follow reassembly instructions for seals. It should also be noted that seal carbons and seal seats can be damaged if the shaft is forced too far in either direction during pump reassembly. Tapping bearings into place without supporting the opposite end of the shaft almost always produces a damaged seal. Many seals are

damaged by overzealous hammering when normal use. This is normally not a problem for the first seal assembly since the elastomer is conforming as this action occurs. A new seal can leak before it conforms if the pits are large enough. If any pits are visible to the unaided eye, shaft replacement is advised.

installing the shaft coupling onto the pump.

TERMS AND CONDITIONS OF SALE

SECTION 1: THE CONTRACT

The Contract shall be comprised of the following terms, together with such terms and conditions as are set forth in Seller's written proposal or quotation (the "Quotation"), including any documents, drawings or specifications incorporated therein by reference, and any additional or different terms proposed in Buyer's purchase order (the "Purchase Order") that are accepted by Seller in writing, which together shall constitute the entire agreement between the parties, provided, however, that preprinted terms on Buyer's purchase order or invoice shall not apply and Seller gives notice of objection to such terms. An offer by Seller in its Quotation that does not stipulate an acceptance date is not binding. This Contract shall be deemed to have been entered into upon written acknowledgment of the Purchase Order by an officer or authorized representative of Seller, which may not be modified, supplemented, or waived except in a writing executed by an authorized representative of the party to be bound.

SECTION 2: PRICE

The price quoted in the Quotation shall be the Purchase Price unless otherwise agreed in the Purchase Order. The Purchase Price for equipment shall include packing for shipment. Field Services shall be provided at Seller's standard rates. All other costs, including packing for storage, freight, insurance, taxes, customs duties and import/export fees, or any other item not specified in the Contract, shall be paid by Buyer unless separately stated in the Quotation and included in the price quoted. Any sales, use, or other taxes and duties imposed on the transaction or the equipment supplied shall be paid or reimbursed by Buyer.

SECTION 3: PAYMENT TERMS

Payment shall be due within 30 days of the date of Seller's invoice in U.S. funds unless otherwise agreed. If Buyer does not observe the agreed dates of payment, Buyer shall pay interest to Seller on overdue amounts at a rate that is the higher of: 9% per annum or a rate 5% in excess of the rate borne from time to time by new issues of six-month United States Treasury bills. Seller shall be entitled to issue its invoice for the Purchase Price for equipment upon the earlier of shipment, or notice to Buyer that Seller is ready to ship, and for services, upon completion. If the Purchase Price exceeds $250,000 USD, Buyer shall pay the Purchase Price in Progress payments as follows: Fifteen percent (15%) upon submittal of general arrangement drawings, thirty five percent (35%) after receipt of first Bowl Casting, twenty percent (20%) after first case/bowl hydro test or bowl machining and thirty percent (30%) after notification of ready to ship.

SECTION 4: ACCEPTANCE AND INSPECTION

All equipment shall be finally inspected and accepted by Buyer within 14 days after delivery or such other period of time as is agreed in the Purchase Order. Buyer shall make all claims (including claims for shortages), excepting only those provided for under the warranty clause contained herein, in writing within such 14-day period or they are waived. Services shall be accepted upon completion. Buyer shall not revoke its acceptance. Buyer may reject the equipment only for defects that substantially impair its value, and Buyer's remedy for lesser defects shall be in accordance with Section 10, Warranty. If tests are made by Buyer to demonstrate the ability of the equipment to operate under the contract conditions and to fulfill the warranties in Section 10, Buyer is to make all preparations and incur all expenses incidental to such tests. Seller will have the right of representation at such tests at its expense, and the right to technically direct the operation of the equipment during such tests, including requiring a preliminary run for adjustments.

SECTION 5: TITLE AND RISK OF LOSS

Full risk of loss (including transportation delays and losses) shall pass to Buyer upon delivery, regardless of whether title has passed to Buyer, transport is arranged or supervised by Seller, or start-up is carried out under the direction or supervision of Seller. Delivery shall be ex works, INCOTERMS 2000. Loss or destruction of the equipment or injury or damage to the equipment that occurs while the risk of such loss or damage is borne by Buyer does not relieve Buyer of its obligation to pay Seller for the equipment.

SECTION 6: PATENT OR TRADEMARK INFORMATION

If the equipment sold hereunder is to be prepared or manufactured according to Buyer's specifications, Buyer shall indemnify Seller and hold it harmless from any claims or liability for patent or trademark infringement on account of the sale of such goods.

SECTION 7: CHANGES

Buyer may request, in writing, changes in the design, drawings, specifications, shipping instructions, and shipment schedules of the equipment. As promptly as practicable after receipt of such request, Seller will advise Buyer what amendments to the Contract, if any, may be necessitated by such requested changes, including but not limited to amendment of the Purchase Price, specifications, shipment schedule, or date of delivery. Any changes agreed upon by the parties shall be evidenced by a Change Order signed by both parties.

SECTION 8: CANCELLATION OR TERMINATION

Buyer shall have the right to cancel the Contract upon 15 days' prior written notice to Seller, and Seller shall stop its performance upon the receipt of such notice except as otherwise agreed with Buyer. If Buyer cancels the Contract, it shall pay: (a) the agreed unit price for equipment or components completed and delivered, (b) additional material and labor costs incurred, and for engineering services supplied by Seller with respect to the canceled items, which shall be charged to Buyer at Seller's rates in effect at the time of cancellation, but which shall not exceed the contract price for such items, and (c) such other costs and expenses, including cancellation charges under subcontracts, as Seller may incur in connection with such cancellation or termination.

SECTION 9: DELIVERY AND DELAYS

Seller shall use its best efforts to meet quoted delivery dates, which are estimated based on conditions known at the time of quotation. Seller shall not be liable for any nonperformance, loss, damage, or delay due to war, riots, fire, flood, strikes or other labor difficulty, governmental actions, acts of God, acts of the Buyer or its customer, delays in transportation, inability to obtain necessary labor or materials from usual sources, or other causes beyond the reasonable control of Seller. In the event of delay in performance due to any such cause, the date of delivery or time for completion will be extended to reflect the length of time lost by reason of such delay. Seller shall not be liable for any loss or damage to Buyer resulting from any delay in delivery.

SECTION 10: WARRANTY

Seller warrants that the equipment or services supplied will be free from defects in material, and workmanship for a period of 12 months from the date of initial operation of the equipment, or 18 months from the date of shipment, whichever shall first occur. In the case of spare or replacement parts manufactured by Seller, the warranty period shall be for a period of six months from shipment. Repairs shall be warranted for 12 months or, if the repair is performed under this warranty, for the remainder of the original warranty period, whichever is less. Buyer shall report any claimed defect in writing to Seller immediately upon discovery and in any event, within the warranty period. Seller shall, at its sole option, repair the equipment or furnish replacement equipment or parts thereof, at the original delivery point. Seller shall not be liable for costs of removal, reinstallation, or gaining access. If Buyer or others repair, replace, or adjust equipment or parts without Seller's prior written approval, Seller is relieved of any further obligation to Buyer under this section with respect to such equipment or parts. The repair or replacement of the equipment or spare or replacement parts by Seller under this section shall constitute Seller's sole obligation and Buyer's sole and exclusive remedy for all claims of defects.

SELLER MAKES NO OTHER WARRANTY OR REPRESENTATION OF ANY KIND WITH RESPECT TO THE EQUIPMENT OR SERVICES OTHER THAN AS SPECIFIED IN THIS SECTION 10. ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE HEREBY DISCLAIMED.

For purposes of this Section, the equipment warranted shall not include equipment, parts, and work not manufactured or performed by Seller. With respect to such equipment, parts, or work, Seller's only obligation shall be to assign to Buyer any warranty provided to Seller by the manufacturer or supplier providing such equipment, parts or work.

No equipment furnished by Seller shall be deemed to be defective by reason of normal wear and tear, failure to resist erosive or corrosive action of any fluid or gas, Buyer's failure to properly store, install, operate or maintain the equipment in accordance with good industry practices or specific recommendations of Seller, or Buyer's failure to provide complete and accurate information to Seller concerning the operational application of the equipment.

SECTION 11: TECHNICAL DOCUMENTS

Technical documents furnished by Seller to Buyer, such as drawings, descriptions, designs and the like, shall be deemed provided to Buyer on a confidential basis, shall remain Seller's exclusive property, shall not be provided in any way to third parties, and shall only be used by Buyer for purposes of installation, operation and maintenance. Technical documents submitted in connection with a Quotation that does not result in a Purchase Order shall be returned to Seller upon request.

SECTION 12: LIMITATION OF LIABILITY

Seller shall in no event be liable for any consequential, incidental, indirect, special or punitive damages arising out of the Contract, or out of any breach of any of its obligations hereunder, or out of any defect in, or failure of, or malfunction of the equipment, including but not limited to, claims based upon loss of use, lost profits or revenue, interest, lost goodwill, work stoppage, impairment of other equipment, environmental damage, nuclear incident, loss by reason of shutdown or nonoperation, increased expenses of operation, cost of purchase of replacement power or claims of Buyer or customers of Buyer for service interruption whether or not such loss or damage is based on contract, tort (including negligence and strict liability) or otherwise.

Seller's maximum liability under this Contract shall not exceed the Purchase Order amount of the equipment or portion thereof upon which such liability is based. All such liability shall terminate upon the expiration of the warranty period, if not sooner terminated.

SECTION 13: THIS COMPANY IS AN EQUAL OPPORTUNITY EMPLOYER

This agreement incorporates by reference applicable provisions and requirements of Executive Order 11246 and FAR Section 52.222-26 (covering race, color, religion, sex and national origin); the Vietnam Era Veterans Readjustment Assistance Act of 1974 and FAR Section 52.222-35 (covering special disabled and Vietnam era veterans); and the Rehabilitation Act of 1973 and FAR Section 52.222-36 (covering handicapped individuals). By acceptance of this agreement Buyer certifies that it does not and will not maintain any facilities in a segregated manner, or permit its employees to perform their services at any location under its control where segregated facilities are maintained, and further that appropriate physical facilities are maintained for both sexes. Buyer agrees that it will obtain a similar certificate prior to award of any nonexempt lower-tier subcontracts.

SECTION 14: LAW AND ARBITRATION

The Contract shall be governed by the law of the State of Texas. Any disputes arising out of this Contract shall be resolved by informal mediation in any manner that the parties may agree within 45 days of written request for mediation by one party to the other. Any dispute that cannot be resolved through mediation shall be resolved by binding arbitration conducted in English in Portland, Oregon under the Commercial Rules of the American Arbitration Association except as otherwise provided in this Section. The arbitration shall be conducted by three arbitrators chosen in accordance with said Rules. The arbitrators are not entitled to award damages in excess of compensatory damages. Judgment upon the award may be entered in any court having jurisdiction.

Check our worldwide offices at
www.paco-pumps.com