DPUMP

Installation, Operation and Maintenance Instruction Manual

Horizontal Centrifugal Pumps

Section 1 INTRODUCTION

This manual contains instructions and guidelines for the installation, operation and maintenance of the DPUMP standard.

These pumps all use the standard power end or the upgraded power end. This means that both of these power ends are the new improved design.

There are many factors affecting the successful installation, operation and maintenance of a pump. From one pump to the next there is typically significant variation in these factors. This makes it impossible to create a bulletin that covers all situations. Therefore, the information contained herein is meant to serve only as a general guideline. If detailed questions or problems arise, contact your nearest DPUMP Distributor or call Comercializadora FEOC S.A. de C.V. Engineering Department.

It is extremely important that this entire bulletin be read prior to installation or start-up of the pump. This is important for safety, for proper performance of the pump, and for maximum Mean Time Between Planned Maintenance (MTBPM).

THE COMPANY

We are a recognized company due to our quality, efficiency and the technical support we offer.

COMERCIALIZADORA FEOC S.A. de C.V. is proud for being a Mexican manufacturer company on ANSI horizontal centrifugal pumps.

Our brand DPUMP is recognized as the premier name in ANSI chemical process pumps.

COMERCIALIZADORA FEOC S.A. de C.V. provides technical support and special services specific to the needs of chemical processors. The materials our pumps are made of is a wide range and due of that they can handle corrosive and abrasive liquids in almost all grades of it.

Committed to continuous quality improvement, our brand DPUMP chemical service process pumps are truly world class products and has become the unchallenged leader in hydraulic design engineering, materials expertise and application know-how.

Section 2 SAFETY CONSIDERATIONS

The DPUMP process pump has been designed and manufactured for sale operation. In order to ensure safe operation, it is very important that this manual be read in its entirety prior to installing or operating the pump. COMERCIALIZADORA FEOC S.A. de C.V. shall not be liable for physical injury, damage or delays caused by a failure to observe the instructions for installation, operation and maintenance contained in this manual.

Remember that every pump has the potential to be dangerous, because of the following factors:

- Parts are rotating at high speeds
- High pressures may be present
- High temperatures may be present
- Highly corrosive and/or toxic chemicals may be present

Paying constant attention to safety is always extremely important. However, there are often situations that require special attention. These situations are indicated throughout this book by following symbols:

⚠ DANGER

DANGER- Immediate hazards which WILL result in severe personal injury or death.

⚠ WARNING

WARNING- Hazards or unsafe practices which COULD result in severe personal injury or death.

⚠ CAUTION

CAUTION- Hazards or unsafe practices which COULD result in minor personal injury or product or property damage.

Several important general precautions are listed below:

1. TAKE CARE OF BEARING LUBRICATION. The standard bearing housing bearings are oil bath lubricated and are not lubricated by FEOC. Where bearings are oil lubricated and employed in units that may be out of service for extended periods, fill the bearing housing to the center of the oil sight glass with the proper type oil and turn over the drive shafts periodically to relubricate all bearing surfaces at intervals of one-to-three months.

1. DO NOT RUN EQUIPMENT DRY OR START THE PUMP WITHOUT THE PROPER PRIME (Casing Flooded).

2. DO NOT EXCEED THE MAXIMUM DESIGN PRESSURE (MDP) AT PUMP OPPERATING TEMPERATURE. See Figure 2-1 for general pressure versus temperature ratings of common alloys.

3. ALWAYS LOCK OUT POWER TO THE DRIVER BEFORE PERFORMING PUMP MAINTENANCE.

4. NEVER OPERATE THE PUMP WITHOUT COUPLING GUARD AND ALL OTHER SAFETY DEVICES CORRECTLY INSTALLED.

5. DO NOT APPLY HEAT TO DISASSEMBLE THE PUMP OR TO REMOVE THE IMPELLER. Entrapped liquid could cause an explosion.

6. NEVER OPERATE THE PUMP FOR MORE THAN SHORT INTERVAL WITH THE DISCHARGE VALVE CLOSED. The length of the interval depends on several factors including the nature of the fluid pumped and its temperature. This interval must be determined by the customer's Engineering personnel.

7. NEVER OPERATE THE PUMP WITH THE SUCTION VALVE CLOSED.

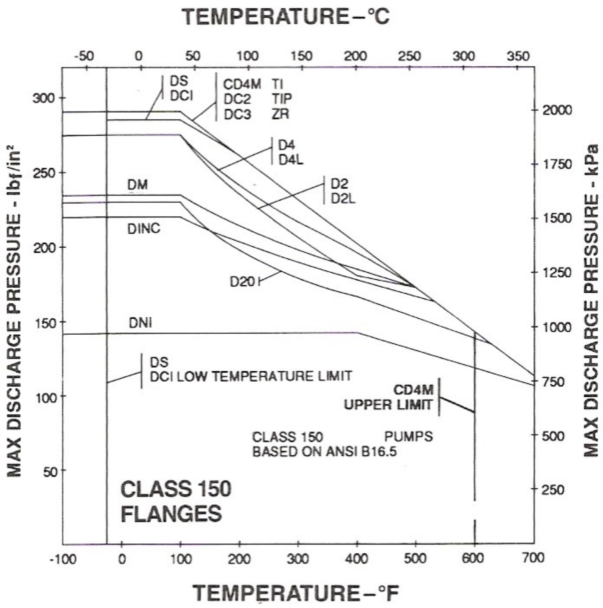
8. EXCESSIVE PUMP NOISE OR WITH THE SUCTION VALVE CLOSED.

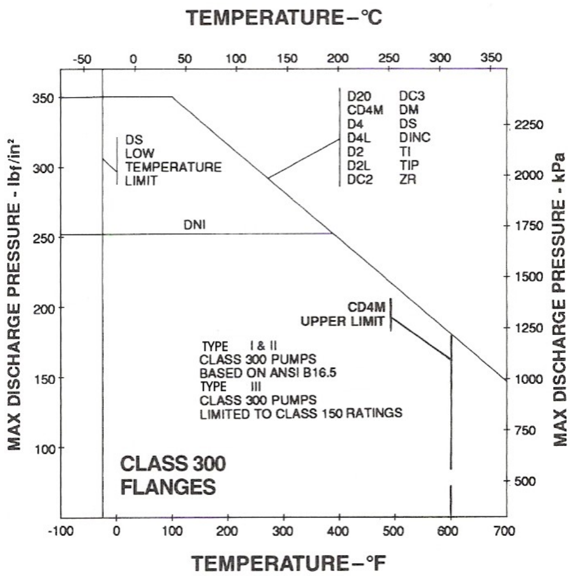
9. DO NOT OPERATE THE PUMP FOR AN EXTENDED PERIOD BELOW THE RECOMMENDED MINIMUM FLOW (Figure 20).

10. THE PUMP SHAFT MUST TURN CLOCKWISE WHEN VIEWED FROM THE MOTOR END. It is absolutely essential that the rotation of the motor be checked before installation of the coupling spacer and starting the pump. Incorrect rotation of the pump for even a short period of time can unscrew the impeller, which can cause severe damage.

FIGURE 2.1

Pressure-Temperature Limits by Alloy





Section 3 INSTALLATION RECOMMENDATIONS

PIPING CONNECTION-SUCTION/DISCHARGE

All piping must be independently supported, accurately aligned and preferable connected to the pump by a short length of flexible piping. The pump should not have to support the weight of the pipe or compensate for misalignment. It should be possible to install suction and discharge bolds through mating flanges without pulling or prying either of the flanges. All piping must be tight. Pumps may air-bind if air is allowed to leak into the piping.

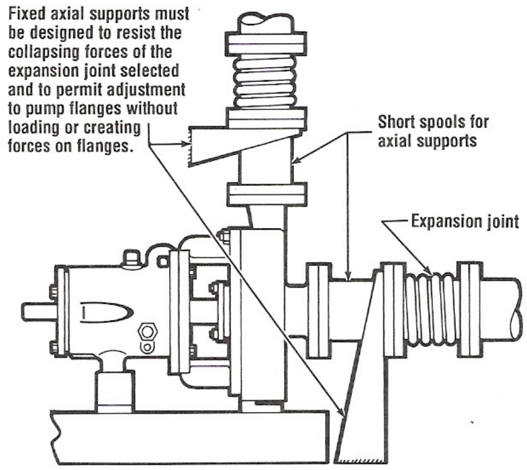
⚠ WARNING

Piping Forces: Take care during installation and operation to minimize pipe forces and/or moments on the pump casing.

Many bellows type joints have an effective area larger than the pipe area. The force resulting from application of system pressure over the effective area when combined with other live and dead loads must not exceed the values given by the joints manufacturer. If the combined forces and moments are greater than the specified values, a piping system as shown in Figure 3-1 must be used.

FIGURE 3-1

Pump Installation Using Expansion Joints.



Suction Piping

To avoid NPSH and suction problems, suction pipe sizes must be at least as large as the pump suction connection. Never use pipe or fittings on the suction that are smaller in diameter than the pump suction size.

FIGURE 3-2 illustrates the ideal piping configuration with a minimum of 10 pipe diameters between the source and the pump suction. In most cases, horizontal reducers should be eccentric and mounted with the flat side up as shown in figure 3-3 with a maximum of one pipe size reduction. Never mount eccentric reducers with the flat side down. Horizontally mounted concentric reducers should not be used if there is any possibility of entrained air in the process fluid.

Vertically mounted concentric reducers are acceptable. In applications where the fluid is completely deaerated and free of any vapor or suspended solids, concentric reducers are preferable to eccentric reducers.

FIGURE 3-2

Good Piping Practice

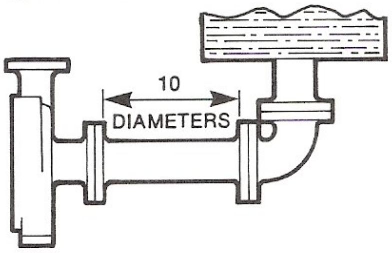
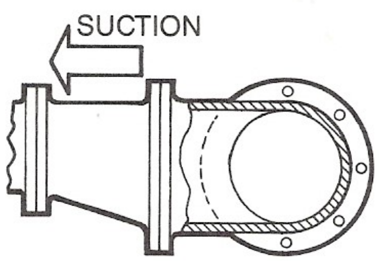


FIGURE 3-3

Good Piping Practice



Avoid the use of valves and strainers in the suction line. Start up strainers must be removed shortly after start up. When the pump is installed below the source of supply, a valve should be installed in the suction line to isolate the pump and to permit pump inspection and maintenance. However, never place a valve directly on the suction nozzle of the pump.

Refer to the Centrifugal Pump IOM Section of the Hydraulic Institute Standards for additional recommendations on suction piping.

Suction pressure limits for DPUMPS pumps with reverse vane impellers are given in figure 3-4. The curves show maximum allowable suction pressure at various specific gravities. Note that Class 300 flanges may be necessary. Note also that for front vane open impellers the suction pressure is limited only by the pressure/temperature curves shown in Figure 2-1.

⚠ WARNING

The pressure temperature ratings shown in FIGURE 2-1 must not be exceeded. Suction pressure is limited only by the pressure temperature ratings, for pump sizes 10x8-14, 8x6-16A, 10x8-16 and 10x8-16H up through 2.0 specific gravity. Consult factory for specific gravity greater than 2.0

Discharge Piping

Install a valve in the discharge line. This valve is required for regulating flow and/or to isolate the pump for inspection and maintenance.

⚠ WARNING

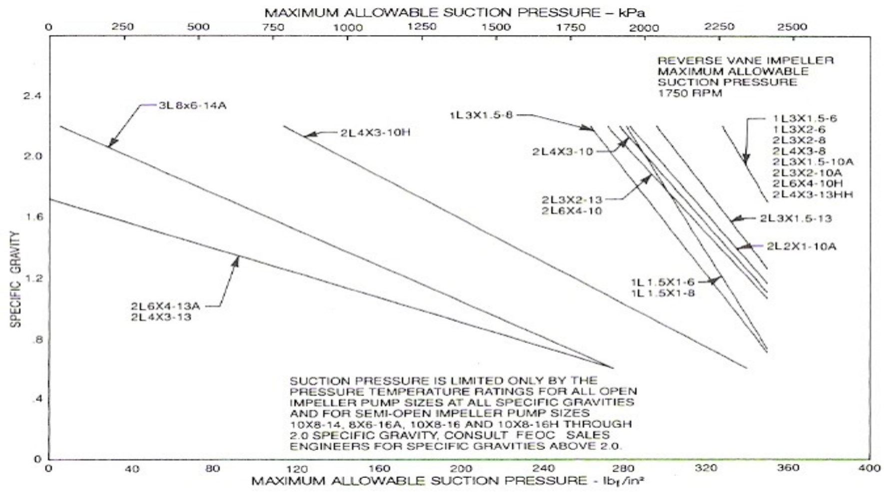
When fluid velocity in the pipe is high, for example, 10 f/s (3 m/s) or higher, a rapidly closing discharge valve can cause a damaging pressure surge. A dampening arrangement should be provided in the piping.

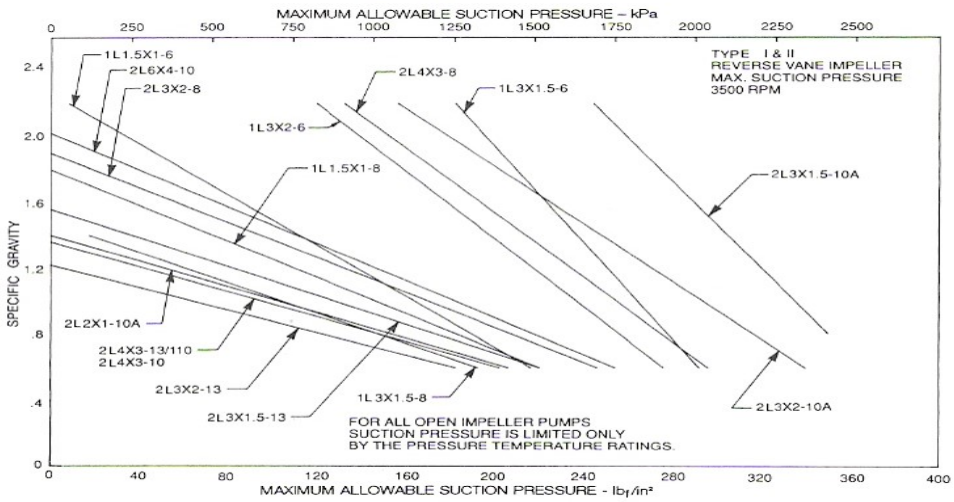
Pump and Shaft Alignment Check

After connecting piping, rotate the pump drive shaft clockwise (view from motor end) by hand several complete revolutions to be sure there is no binding and that all parts are free. Recheck shaft alignment. If piping caused unit to be out of alignment, correct piping to relieve strain on the pump.

FIGURE 3-4

Suction pressure limits



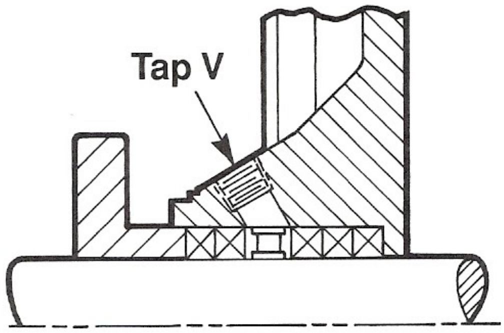


PIPING CONNECTION – SEAL/PACKING SUPPORT SYSTEM

If the pump has a seal support system, it is mandatory that this system be fully installed and operational before the pump is started.

If packing is used:
Packing Lubrication – Water, when compatible with the pumpage, should be introduced into Tap V (Figure 3-5) at pressure 10 to 15 lb_f/in^2 (69 to 103kPa) above the stuffing box pressure. The gland should be adjusted to give a flow rate of 20 to 30 drops per minute for clean fluid.

FIGURE 3-5



Grease lubrication, when compatible with the pumpage, may be used. In non-abrasive applications the pumpage itself may be sufficient to lubricate the packing. Again, introduced into Tap V.

PIPING CONNECTION – HEATING/COOLING FLUID FOR JACKETED COVER/CASTING

The piping connections for jacketed covers and casings are shown below. The flow rate of the cooling water (less than 90°F (32°C) should be at least 2 gpm (0.13 l/s).

FIGURE 3-6

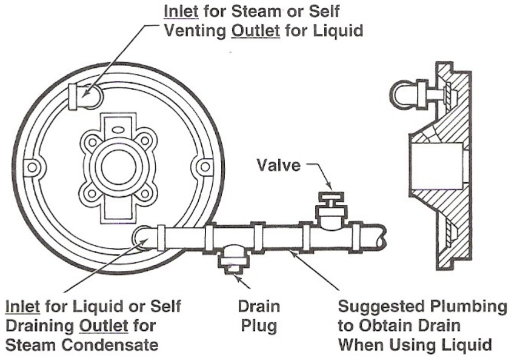
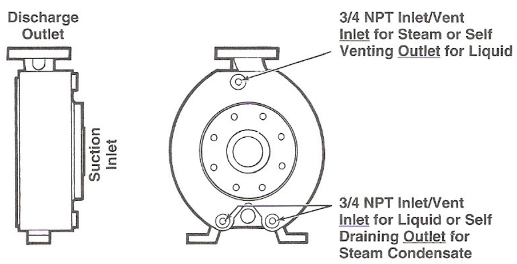


FIGURE 3-7



Section 4 OPERATION

ROTATION CHECK

It is absolutely essential that the rotation of the motor be checked before connecting the shaft coupling. Incorrect rotation of the pump, for even a short time, can dislodge and damage the impeller, casing, shaft and shaft seal. All DPUMPS turn clockwise as viewed from the motor end. A direction arrow is cast on the front of the casing as shown in Figure 4-1. Make sure the motor rotates in the same direction.

PRE START-UP CHECKS

Prior to starting the pump it is essential that the following checks are made. These checks are all described in detail in the Maintenance Section of this booklet.

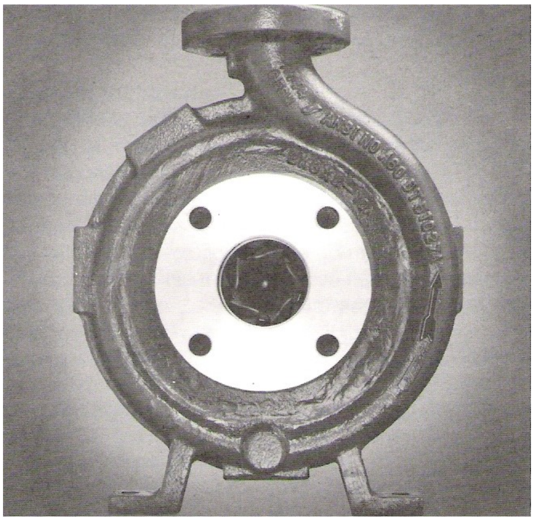
- Pump and Motor properly secured to the baseplate.
- All fasteners tightened.
- Coupling guard in place and not rubbing.
- Rotation check, see above instructions.

THIS IS ABSOLUTELY ESSENTIAL.

- Impeller clearance setting (see appendix A and B).
- Shaft seal properly installed.
- Seal support system operational.
- Bearing lubrication.
- Bearing housing cooling system operational.
- Heating/cooling for jacketed casing/cover operational.
- Pump instrumentation is operational.
- Pump is primed.
- Rotation of shaft by hand.

As final step in preparation for operation, it is important to rotate the shaft by hand to be certain that all rotating parts move freely, and that there are no foreign objects in the pump casings.

FIGURE 4-1



START-UP CONSIDERATIONS

ENSURING PROPER NPSH$_A$

Net Positive Suction Head – Available (NPSH$_A$) is the measure of the energy in a liquid above the vapor pressure. It is used to determine the likelihood that a fluid will vaporize in the pump. It is critical because a centrifugal pump is designed to pump a liquid, not a vapor.
Vaporization in a pump will result in damage to the pump, deterioration of the Total Differential Head (TDH), and possibly a complete stopping of pumping.

Net Positive Suction Head – Required (NPSH$_R$) is the decrease of fluid energy between the inlet of the pump, and the point of lowest pressure in the pump. This decrease occurs because of friction losses and fluid accelerations in the inlet region of the pump, and particularly accelerations as the fluid enters the impeller vanes. The value for $NPSH_R$ for the specific pump you have purchased is given in the pump data sheet, and on the pump performance curve.

For a pump to operate properly the $NPSH_A$ must be greater than the $NPSH_R$. Good practice dictates that this margin should be at least 5 ft (1.5 m) or 20%, whichever is greater.

Ensuring that $NPSH_A$ is larger than $NPSH_R$ by the suggested margin will greatly enhance pump performance and reliability. It will also reduce the likelihood of cavitation, which can severely damage the pump.

MINIMUM FLOW

Minimum continuous stable flow is the lowest flow at which the pump can operate and still conform to the bearing life, shaft deflection and bearing housing vibration limits of ANSI/ASME B73.1 2001. Pumps may be operated at lower flows, but it must be recognized that the pump may not conform to one or mote of these limits. For example, vibration may exceed the limit set by the ASME standard. The size of the pump, the energy absorbed, and the liquid pumped are some of the considerations in determining the minimum flow.

Typically, limitations of 10% of the capacity at the best efficiency point (BEP) should be specified as the minimum flow. However, FEOC has determined that several pumps must be limited to higher minimum flows to provide optimum service. The following are the recommended minimum flows for these specific pumps:

	60 Hz		50 Hz	
Pump Size	RPM	Minimum flow (% of BEP)	RPM	Minimum flow (% of BEP)
3x2-6	3500	25%	2900	21%
1.5x1-8	3500	20%	2900	20%
3x1.5-8	3500	20%	2900	20%
3x2-8	3500	25%	2900	21%
4x3-8	3500	25%	2900	21%
2x1-10	3500	25%	2900	25%
3x1.5-10	3500	25%	2900	25%
3x2-10	3500	33%	2900	28%
4x3-10	3500	33%	2900	28%
6x4-10	3500	50%	2900	42%
3x1.5-13	3500	30%	2900	30%
3x2-13	3500	50%	2900	42%
4x3-13	3500	50%	2900	42%
6x4-13	1750	50%	1450	42%
ALL GROUP 3 PUMPS	1750	50%	1450	50%
ALL OTHER SIZES	ANY	15%	ANY	15%

All DPUMPS also have a "Minimum Thermal Flow". This is defined as the minimum flow that will not cause an excessive temperature rise. Minimum Thermal Flow is application dependent. For more information please contact your nearest DPUMP Distributor or call Comercializadora FEOC S.A. de C.V. Engineering Department.

STARTING THE PUMP AND ADJUSTING FLOW

1. Open the suction valve to full open position. It is very important to leave the suction valve open while the pump is operating. Any throttling or adjusting of flow must be done through the discharge valve. Partially closing the suction valve can create serious NPSH and pump performance problems.

⚠ DANGER

Never operate pump with both the suction and discharge valves closed. This could cause an explosion.

2. A standard centrifugal pump will not move liquid unless the pump is primed. A pump is said to be "primed" when the casing and the suction piping are completely filled with liquid. Open discharge valve a slight amount. This will allow any entrapped air to escape and will normally allow the pump to prime, if the suction source is above the pump. When a condition exists where the suction pressure may drop below the pump's capability, it is advisable to add a low pressure control device to shut the pump down when the pressure drops below a predetermined minimum.
3. All cooling, heating, and flush lines must be started and regulated.
4. Start the driver (typically, the electric motor).
5. Slowly open the discharge valve until the desired flow is reached, keeping in mind the minimum flow restrictions listed above.

⚠ DANGER

It is important that the discharge valve be opened within a short interval after starting the driver. Failure to do this could cause a dangerous build up of heat, and possibly an explosion.

6. Reduced capacity.
   Avoid running a centrifugal pump at drastically reduced capacities or with discharge valve closed for extended periods of time. This can cause severe temperature rise and the liquid in the pump may reach its boiling point. If this occurs, the mechanical seal will be exposed to vapor, with no lubrication, and may score or seize to the stationary parts. Continued running under there conditions when the suction valve is also closed, can create and explosive condition due to the confined vapor at high pressure and temperature.
   Thermostats may be used to safeguard against over heating by shutting down the pump at a predetermined temperature.
   Safeguards should also be taken against possible operation with a closed discharge valve, such as installing a bypass back to the suction source. The size of the bypass line and the required bypass flow rate is a function of the input horsepower and the allowable temperature rise.

7. Reduced Head
   Note that when discharge head drops, the pump's flow rate usually increases rapidly. Check motor for temperature rise as this may cause overload. If overloading occurs, throttle the discharge.

8. Surging Condition
   A rapidly closing discharge valve can cause a damaging pressure surge. A dampening arrangement should be provided in the piping.

OPERATION IN SUB-FREEZING CONDITIONS

When using the pump in sub-freezing conditions where the pump is periodically idle, the pump should be properly drained or protected with thermal devices which will deep the liquid in the pump from freezing.

SHUTDOWN CONSIDERATIONS

When the pump is being shutdown, the procedure should be the reverse of the start-up procedure. First, slowly close the discharge valve, shutdown the driver, then close the suction valve. Remember, closing the suction valve while the pump is running is a safety hazard and could seriously damage the pump and other equipment.

TROUBLESHOOTING

The following is a guide to troubleshooting problems with DPUMPS. Common problems are analyzed and solutions are offered. Obviously, it is impossible to cover every possible scenario. If you are having a problem that is not covered by one of the examples, then you may want to contact your local DPUMPS Sales Engineer or Distributor/Representative for assistance.

PROBLEM	POSSIBLE CAUSE	RECOMMENDED REMEDY
Problem #1 Pump not reaching design flow rate	1.1 Insufficient NPSH. (Noise may not be present.)	Recalculate NPSH available. It must be greater than the NPSH required by pump at desired flow. If not, redesign suction piping, holding number of elbows and number of planes to a minimum to avoid adverse flow rotation as it approaches the impeller.
	1.2 System head greater than anticipated.	Reduce system head by increasing pipe size and/ or reducing number of fittings. Increase impeller diameter. NOTE: Increasing impeller diameter may require use of a larger motor.
	1.3 Entrained air. Air leaf from atmosphere on suction side.	1. Check suction line gaskets and threads for tightness. 2. If vortex formation is observed in suction tank, install vortex breaker. 3. Check for minimum submergence.
	1.4 Entrained gas from process.	Process generated gases may require larger pumps.
	1.5 Speed too low.	Check motor speed against design speed.
	1.6 Impeller clearance too large.	Reset impeller clearance.
	1.7 Plugged impeller, suction line or casing which may be due to a product or large solids.	1. Reduce solids in the process fluid when possible. 2. Consider larger pump.
	1.8 Wet end parts (casing cover, impeller) worn, corroded or missing	Replace part or parts.
Problem #2 Pump not reaching design head (TDH).	2.1 Refer to possible causes under Problem # 1.0	Refer to remedies listed under Problem #1.0 and #3.0
Problem #3 No discharge of flow with pump running.	3.1 No properly primed.	Repeat priming operation, recheck instructions. If pump has run dry, disassemble and inspect the pump before operation.

PROBLEM	POSSIBLE CAUSE	RECOMMENDED REMEDY
Problem #3 No discharge of flow with pump running.	3.2 Entrained air. Air leak from atmosphere on suction side.	Refer to recommended remedy under Problem #1.0, Item #1.3.
	3.3 Plugged impeller, suction line or casing which may be due to a fibrous product or large solids.	Refer to recommended remedy under Problem #1.0, Item #1.9.
	3.5 Damaged pump shaft, impeller.	Replace damaged parts.
Problem #4.0 Pump operates for short period, then loses prime.	4.1 Insufficient NPSH.	Refer to recommended remedy under Problem #1.0, Item #1.1
	4.2 Entrained air. Air leak from atmosphere on suction side.	Refer to recommended remedy under Problem #1.0, Item #1.3.
Problem #5.0 Excessive noise from wet end.	5.1 Cavitation – insufficient NPSH available.	Refer to recommended remedy under Problem #1.0, Item #1.1
	5.2 Abnormal fluid rotation due to complex suction piping.	Redesign suction piping, holder number of elbows and number of planes to a minimum to avoid adverse fluid rotation as it approaches the impeller.
	5.3 Impeller rubbing.	1. Check and reset impeller clearance. 2. Check outboard bearing assembly for axial end play.
	5.4 Damaged pump shaft, impeller.	Replace damaged parts.
Problem #6 Excessive noise from power end.	6.1 Bearing contamination appearing on the raceways as scoring, pitting, scratching, or rusting caused by adverse environment and entrance of abrasive contaminants from atmosphere.	1. Work with clean tools in clean surroundings. 2. Remove all outside dirt form housing before exposing bearings. 3. Handle with clean dry hands. 4. Treat a used bearing as carefully as new one. 5. Use clean solvent and flushing oil. 6. Protect disassembled bearing from dirt and moisture. 7. Keep bearings wrapped in paper or clean cloth while not in use. 8. Clean inside of housing before replacing bearings. 9. Check oil seals and replace as required. 10. Check all plugs and tapped openings to make sure that they are tight.

PROBLEM	POSSIBLE CAUSE	RECOMMENDED REMEDY
Problem #6 Excessive noise from power end.	6.2 Brinelling of bearing identified by indentation on the ball races, usually caused by incorrectly applied forces in assembling the bearing or by shock loading such as hitting the bearing or drive shaft with a hammer.	When mounting the bearing on the driver shaft use a proper size ring and apply the pressure against the inner ring only. Be sure when mounting a bearing to apply the mounting pressure slowly and evenly.
	6.3 False brinelling of bearing identified again by either axial or circumferential indentations usually caused by vibration of the balls between the races in a stationary bearing.	1. Correct the source of vibration. 2. Where bearings are oil lubricated and employed in units that may be out of service for extended periods, the drive shafts should be turned over periodically to relubricate all bearing surfaces at intervals of one-to-three months.
	6.4 Thrust overload on bearing identified by flaking ball path on one side of the outer race or in the case of maximum capacity bearings, may appear as a spalling of the races in the vicinity of the loading slot. These thrust failures are caused by improper mounting of the bearing or excessive thrust loads.	1. Follow correct mounting procedures for bearings.
	6.5 Misalignment identified by fracture of ball retainer or a wide ball path on the inner race and a narrower cocked ball path on the outer race. Misalignment is caused by poor mounting practices or defective drive shaft. For example, bearing not square with the centerline or possibly a bent shaft due to improper handling.	Handle parts carefully and follow recommended mounting procedures. Check all parts for proper fit and alignment.

PROBLEM	POSSIBLE CAUSE	RECOMMENDED REMEDY
Cont: Problem #6 Excessive noise from power end.	6.6 Bearing damaged by electric arcing identified as electro-etching of both inner and outer ring as a pitting or cratering. Electrical arcing is caused by a static electrical charge eminating from belt drives, electrical leakage or short circuiting.	1. Where current shunting through the bearing cannot be corrected, a shunt in the form of a slip ring assembly should be incorporated. 2. Check all wiring, insulation and rotor windings to be sure that they are sound and all connections are properly made. 3. Where pumps are belt driven, consider the elimination of static charges by proper grounding or consider belt material that is less generative.
	6.7 Bearing damage due to improper lubrication, identified by one or more of the following: 1. Abnormal bearing temperature rise. 2. A stiff cracked grease appearance. 3. A brown or bluish discoloration of the bearing races.	1. Be sure the lubricant is clean. 2. Be sure proper amount of lubricant is used. The constant level oiler supplied with DPUMPS pumps will maintain the proper oil level if it is installed and operating properly. In the case of greased lubricated bearings, be sure that there is space adjacent to the bearing into which it rid itself of excessive lubricant, otherwise the bearing may overheat and fail prematurely. 3. Be sure the proper grade of lubricant is used.

Section 5 MAINTENANCE

PREVENTIVE MAINTENANCE

The following sections of this manual give instructions on how to perform a complete maintenance overhaul. However, it is also important to periodically repeat the "Pre start-up checks" listed on page 11. These checks will help extend pump life as well as the length of time between major overhauls.

NEED FOR MAINTENANCE RECORDS

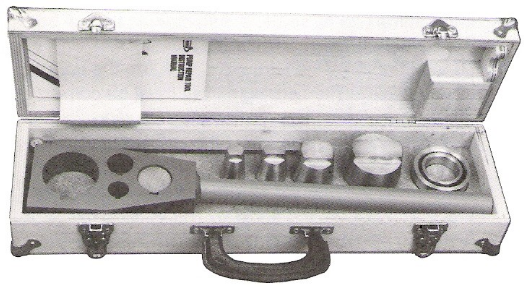
A procedure for keeping accurate maintenance records is a critical part of any program to improve pump reliability. There are many variables that can contribute to pump failures. Often long term and repetitive problems can only be solved by analyzing these variables through pump maintenance records.

NEED FOR CLEANLINESS

One of the major causes of pump failure is the presence of contaminants in the bearing housing. This contamination can be in the form of moisture, dust, dirt and other solid particles such as metal chips. Contamination can also be harmful to the mechanical seal (especially the seal faces) as well as other parts of the pumps. For example, dirt in the impeller threads could cause the impeller to not be seated properly against the shaft. This, in turn, could cause a series of other problems. For these reasons, it is very important that proper cleanliness be maintained. Some guidelines are listed below.

After draining the oil from the bearing housing, periodically send it out for analysis. If it is contaminated, determine the cause and correct. The work area should be clean and free from dust, dirt, oil, grease, etc. Hands and gloves should be clean. Only clean towels, rags, and tools should be used. This tool kit includes a handy impeller wrench, which simplifies installation and removal of the impeller. It also contains "nose cones" which protect shaft threads and make it easy to install the mechanical seal.

FIGURE 5-1
DPUMPS Tool Kit



DISASSEMBLY

Refer to the parts list shown in Figures 5-24, 5-25, 5-26, 6-6, 7-1 and 8-1 for item number references used throughout this section.

1. Before performing any maintenance, disconnect the driver from its power supply and lock it off line.

⚠ DANGER

Lock out power to driver to prevent personal injury.

2. Close the discharge and suction valves, and drain all liquid from the pump.

3. Close all valves on auxiliary equipment and piping, then disconnect all auxiliary piping.

4. Decontaminate the pump as necessary.

⚠ DANGER

If DPUMPS contain dangerous chemicals, it is important to follow plant safety guidelines to avoid personal injury or death.

5. Remove the coupling guard.
6. Remove the spacer from the coupling.
7. Remove casing fasteners (#115A).
8. Remove the fastener holding the bearing housing foot to the base plate.
9. Move the power end, rear cover, and seal chamber assembly away from the casing. Discard the casing/cover gasket (#107).

⚠ CAUTION

The power end and rear cover assembly is heavy. It is important to follow plant safety guidelines when lifting it.

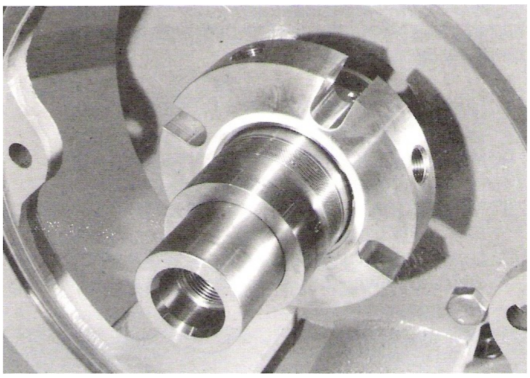
10. Transport the assembly to the maintenance shop.
11. Remove the coupling hub from the pump shaft (#105).
12. Using the shaft key (#130), mount the impeller wrench from the "DPUMPS Tool Kit" (Figure 5-1) to the end of the shaft. With the wrench handle pointing to the left when viewed from the impeller end, grasp the impeller (#103) firmly with both hands (wear heavy gloves), by turning the impeller in the clockwise direction move the wrench handle to the 11:00 o'clock position and then spin the impeller quickly in a counterclockwise direction so that the wrench makes a sudden impact with a hard surface on the bench. After several raps, the impeller should be free. Unscrew the impeller and remove from the shaft. Discard the impeller gasket (#104).

⚠ DANGER

Do not apply heat to the impeller. If liquid is entrapped in the hub, an explosion could occur.

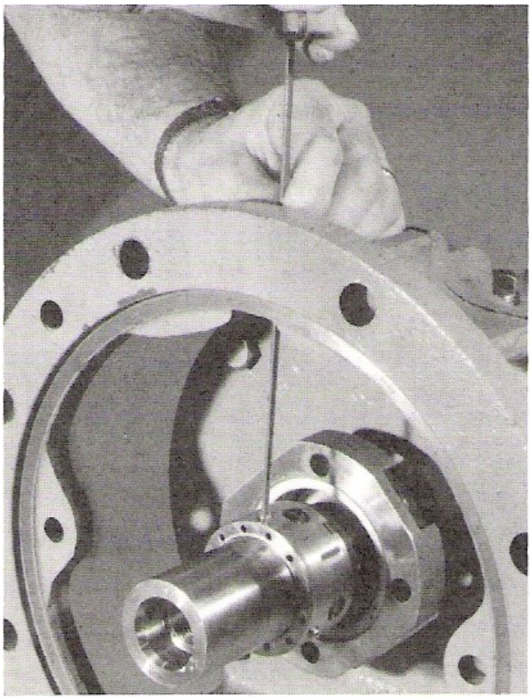
13. Remove the seal or packing gland nuts (#111A).
14. Remove the tow cap screws (#140) which attach the rear cover plate to the adapter. Carefully remove the rear cover plate (#106).
15. If a cartridge type mechanical seal (#153) is used (Figure 5-2), loosen the set screws which lock the unit to the shaft and remove the complete seal assembly. If you plan to reuse the seal, the spacing clips or tabs should be reinstalled prior to loosening the set screws. This will ensure that the proper seal compression is maintained.

FIGURE 5-2



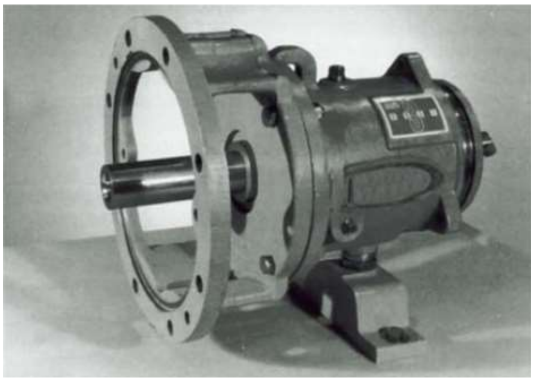
16. If a component type inside mechanical seal (#153) is used, loosen the set screws on the rotating unit and remove it from the shaft, see Figure 5-2. Then pull the gland (#190) and stationary seat off the shaft. Remove the stationary seat from the gland. Discard all O-rings and gaskets.

FIGURE 5-3



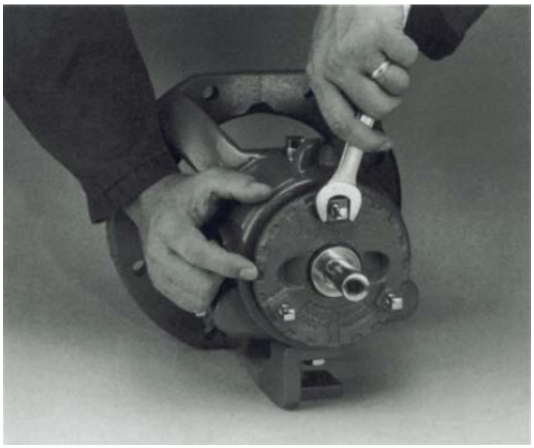
17. If a component type outside mechanical seal is used, remove the gland and the stationary seat. Remove the stationary seat from the gland. Loosen the set screws in the rotating unit and remove it. Discard all O-rings and gaskets.
18. If packing (#113) is used, remove it and the seal cage (lantern ring) (#112). Remove the gland (#110).
19. If the pump has a hook type sleeve (#177) it can now be removed. Unit now appears as shown in Figure 5-4.

FIGURE 5-4



20. If the power end is oil lubricated, remove the drain plug (#134) and drain the oil from the bearing housing (#119).
21. If the pump has lip seals, a deflector (#114) will be present. Remove it.
22. Loosen the three set screws (#201A) on the bearing carrier (#201). The bearing carrier must be completely unscrewed from the bearing housing.
Note: Do not pry against the shaft.
The face of the bearing carrier has three square lugs that protrude form the surface. The bearing carrier is turned by using an open end wrench on one of the square lugs as shown in Figure 5-5.

FIGURE 5-5

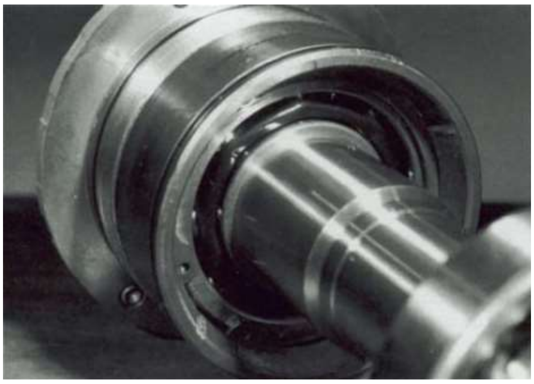


23. Because the O-rings (#201B) will cause some resistance in removing the bearing carrier assembly from the housing, hold the bearing carrier flange firmly and with slight rotation, pull it out of the bearing housing. The bearing carrier assembly with the shaft an bearings should come free. This unit will appear as shown in Figure 5-6. Further disassembly is not required unless the bearings are to be replaced.

FIGURE 5-6

24. Remove the snap ring (#201C) (Figure 5-7) on Type 1 and 2 pumps, or the bearing retainer (#201D) on Type 3 pumps.

FIGURE 5-7



Note: Type 1 and 2 pumps equipped with duplex angular contact bearings use a bearing retainer (#201) instead of the snap ring. Remove the carrier form bearing.

25. The bearing locknut (#124) and lockwasher (#125) may now be removed from the shaft (#105). Discard the lockwasher.

26. An arbor or hydraulic press may be used to remove the bearings (#120 and #121) from the shaft. It is extremely important to apply even pressure to the inner bearing race only. Never apply pressure to the outer race as this exerts load on the balls and causes damage.

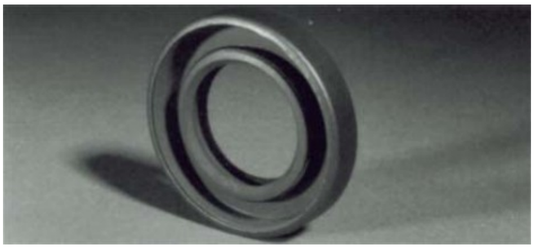
⚠ CAUTION

Applying pressure to the race could permanently damage the bearings.

27. On type 2 and 3 pumps, the bearing housing (#119) must be separated from the bearing housing adapter (#108). This is accomplished by removing the capscrews (#139) which thread into the bearing housing. The adapter O-ring (#131) should be discarded.

28. If lip seals (#118) and (#129) (Figure 5-8) are used, they should be removed from the bearing housing and adapter and discarded.

FIGURE 5-8



29. If bearing isolators are used, please contact to a Distributor.

30. If magnetic seals are used, maintain the seals as specified by the manufacturer.

31. The sight cage (#200) should be removed from the bearing housing.

FIGURE 5-9

CLEANING/INSPECTION

All parts should now be thoroughly cleaned and inspected. New bearings, O-rings, gaskets, and lip seals should be used. Any parts that show wear or corrosion should be replaced with new genuine DPUMP parts.

⚠ WARNING

It is important that only non-flammable, non-contaminated cleaning fluids are used. These fluids must comply with plant safety and environmental guidelines.

ASSEMBLY

It is very important that all pipe threads be sealed properly. PTFE tape provides a very reliable seal over a wide range of fluids, but it has a serious shortcoming if not used properly. If, during application to the threads, the tape is wrapped over the end of the male thread, strings of the tape will be formed off when threaded into the female fitting. This string can then tear away and lodge in the piping system. If this occurs in the seal flush system, small orifices can become blocked effectively shutting off flow. For this reason we do not recommend the use of PTFE tape as a thread sealant.

FEOC recommends the use of alternative sealants such as sealant paste with PTFE.

POWER END ASSEMBLY

Bearing Installation

Mounting of bearings on shafts must be done in a clean environment. Bearing and power end life can be drastically reduced if even very small foreign particles work their way into the bearings.

Bearings should be removed from their protective packaging only immediately before assembly to limit exposure contamination. After removing the packaging they should only come in contact with clean hands, fixtures, tools and work surfaces.

The chart shown in figure 5-10 gives the SKF part numbers for bearings in DPUMPS. Note that the term “inboard bearing” refers to the bearing nearest to the casing. “Outboard bearing” refers to the bearing nearest to the motor.

1. Install the inboard bearing (#120) on the shaft (105).
The inboard bearing must be positioned against the shoulder as shown in figure 5-10.

Both bearings have a slight interference fit which requires that they be pressed on the shaft with an arbor or hydraulic press. A chart giving bearing fits is shown in Figure 35. Even force should be applied to the inner race only. Never press on the outer race, as the force will damage the balls and races. An alternate method of installing bearings is to heat the bearings to 200°F (93°C) in an oven or induction heater. Then place them quickly in position on the shaft.

⚠ CAUTION

Never heat the bearings above 230°F (110°C). To do so will likely cause the bearing fits to permanently change, leading to early failure.

FIGURE 5-10

Type	Type of Bearings	Inboard Single Row, Deep Groove	Outboard Double Row, Angular Contact, Deep Groove	Optional Outboard Duplex Angular Contact
1L	Oil bath/mist – Open[1]	6207C3	5306-AC3	7306-BECBY
	Greased for life – Double Shielded[2]	6207-2ZC3	5306-A2Z	NA[5]
	Sealed for life – Double Sealed[4]	6207-2RSIC3	5306-A2RS	NA[5]
2L	Oil bath/mist – Open[1]	6310-C3	5310-AHC3	7310-BECBY
	Greased for life – Double Shielded[2]	6310-2ZC3	5310-A2ZC3	NA[5]
	Sealed for life – Double Sealed[4]	6310-2RSIC3	5310-A2RS	NA[5]
3L	Oil bath/mist – Open[1]	6314-C3	5314-AC3	7314-BECBY
	Greased for life – Double Shielded[2]	6314-2ZC3	5314-A2ZC3	NA[5]
	Sealed for life – Double Sealed[4]	6314-2RS1C3	5314-A2ZRS1C3	NA[5]

1 These bearings are open on both sides. They are lubricated by oil bath or oil mist.

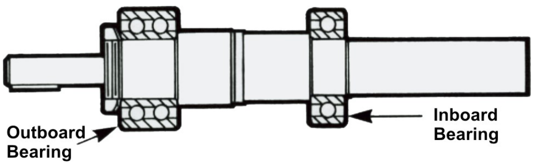
2 These bearings are shielded on both sides. They come pre-greased by the bearing manufacturer. The user does not need to regrease these bearings. The shields do not actually contact the bearing race, so no heat is generated.

3 These bearings are sealed on both sides. They come pre-greased by the bearing manufacturer. The user does not need to regrease these bearings. The seals physically contact and rub against the bearing race, which generates heat. These bearings are not recommended at speeds above 1750 RPM.

4 Regreasable – Single Shielded bearings are not available in the duplex configuration; however, open oil bath-type bearings can be used for the regreasable configuration. These bearings must be pre-greased during assembly. Lubrication fittings are provided, to allow the user to periodically replenish, as recommended by the bearing and/or grease manufacturer

5 Not available.

FIGURE 5-11



2. Place the snap ring (#201C for 1L and 2L type std.) or the bearing retainer (#201D for 3L type and 1L and 2L type with outboard duplex angular contact bearing) onto the outboard end of the shaft and slide down to the inboard bearing. Note the proper orientation of the bearing retainer or snap ring must be assured in this step. The flat side of the snap ring and the small side of the retainer must face away from the inboard bearing.

3. Using clean gloves, install the outboard bearing (#121) firmly against the shoulder as shown in Figure 5-11. If hot bearing mounting techniques are used, steps must be taken to ensure the outboard bearing is firmly positioned against the shaft shoulder. The outboard bearing, while still hot. is to be positioned against the shaft shoulder. After the bearing has cooled below 100°F (38°C) the bearing should be pressed against the shaft shoulder. An approximate press force needed to seat the bearing is listed in Figure 5-11. This value may be used if the press has load measuring capability.

⚠ CAUTION

It must be understood that fixtures and equipment used to press the bearing must be designed so no load is ever transmitted through the bearing balls. This would damage the bearing.

The locknut (#124) and lockwasher (#125) should be installed. The locknut should be torqued to the value shown in Figure 5-12. At this point the lock washer tang must be bent into the locknut.

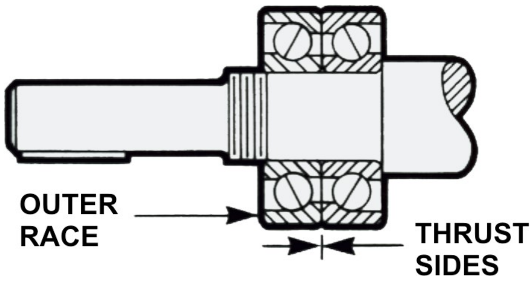
FIGURE 5-12

Pump Type	Press Force Lb_f (N)	Locknut Torque $ft.lb_f$ (N.m)
1L	1300 (5,780)	20+5/-0 (27+4/0)
2L	2500 (11,100)	40 +5/-0 (54 +7/-0)
3L	4500 (20,000)	70 +5/-0 (95 +7/0)

4. If the outboard bearing is cold pressed against the shaft shoulder, it should be secured with the lockwasher and locknut torqued with the "locknut torque" value listed in Figure 5-12. The lockwasher tang must then be bent into the locknut.

5. Duplex angular contact bearings must be mounted back to back with the wider thrust sides of the outer races in contact with each other as shown in Figure 5-13. Only bearings designed for universal matching, identified by the suffix "BECB", should be used. **Note:** A special shaft is required when using duplex angular contact bearings.

FIGURE 5-13



Lip Seals
If lip seals were used, install new lip seals in the bearing carrier (#201) and the housing (#119) (Group 1) or the adapter (#108) (Group 2 and 3). The lip seals (#118 and #129) are double lip style, the cavity between the lips should be 1/2 to 2/3 filled with grease.

Labyrinth seals
Follow the installation instructions provided by the manufacturer.

Magnetic seals
Follow the installation instructions provided by the manufacturer.

Bearing Carrier/Power end assembly

6. Install new O-rings (#201 B) onto the bearing carrier. Be sure to use the correct size O-rings. Slide the bearing carrier (#201) over the outboard bearing (#121).

7. On type 1L and 2L pumps, if standard outboard bearings are used, slide the snap ring (#201C) in place with its flat! side against the outboard bearing and snap it into its groove in the bearing carrier.

⚠ WARNING

Never compress the snap ring unless it is positioned around the shaft and between the bearings. In this configuration, it is contained therefore if it should slip off the compression tool it is unlikely to cause serious injury.

8. On Group 1 and 2 pumps, if duplex angular contact bearings are used, slide the bearing retainer (#201 D) in place, install, and tighten the head capscrews (#201E).

9. On Group 3 pumps slide the bearing retainer (#201D) against the outboard bearing and install and tighten the head capscrews (#201 E).

10. The shaft, bearings, and bearing carrier assembly (See FIGURE 5-6) can now be installed into the bearing housing (#119). The bearing carrier (#201) should be lubricated with oil on the O-rings and threads before installing the assembly into the bearing housing. Thread the bearing carrier into the bearing housing by turning it clockwise to engage the threads. Thread the carrier into the housing until the carrier flange is approximately 1/8 in (3 mm) from the housing. Install the set screws (#201A) loosely.

11. Install a sight gage (#200) into the bearing housing.

12. Install a drain plug (#134) into the bearing housing.

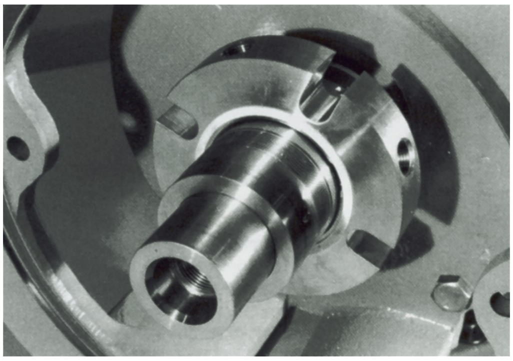
13. On Group 2 and 3 pumps, assemble the bearing housing adapter (#108) to the bearing housing (#119). Be sure to install a new O-ring (#131). Thread the cap screws (#139) through the adapter and into the tapped holes in the bearing housing.

14. If the pump has lip seals, install the deflector (#114).

15. If the pump is equipped with a hook type sleeve (#177), slip it into place over the end of the shaft (#105).

WET END ASSEMBLY
Cartridge Mechanical Seal
Seal installation
Slide the cartridge seal (#153) onto the shaft using a seal guide until it lightly touches the bearing housing (#119) or adapter (#108). See FIGURE 5-14.

FIGURE 5-14



Cover installation
Install the cover (#106) to the bearing housing (Group 1) or tile bearing housing adapter (Group 2 and 3) by using the cap screws (#140). Now install the cartridge seal gland to cover (#106) using studs (#111) and nuts (#111A).

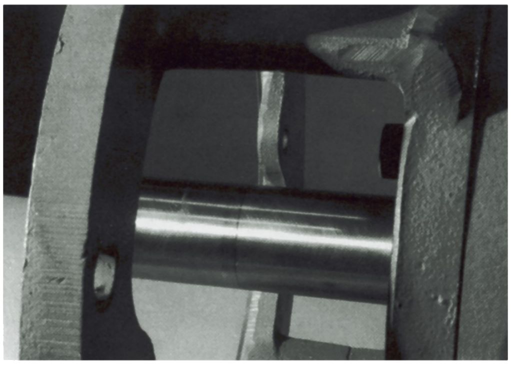
Impeller installation and clearance setting
Install the impeller (#103) as instructed in **Appendix A**, if reverse vane, or **Appendix B**, if a front vane open style impeller (See FIGURE 5-17).

Lock seal in place
Tighten set screws on the seal to lock the rotating unit to the shaft. Finally, remove centering clips from the seal.

Component type mechanical seal
Determination of seal location
In order to properly set a component seal it is necessary to first locate the shaft in its final axial position. This is accomplished in the following manner.

Install the cover (#106) to the bearing housing (1L type) or the bearing housing adapter (2L and 3L type) by using the cap screws (#140). Install the impeller (#103) as instructed in **Appendix A**, if reverse vane, or **Appendix B**, if a front vane open style impeller. Put blueing on the shaft in the area near the face of the seal chamber (cover #106). Scribe a mark on the shaft at the face of the seal chamber (See FIGURE 5-15). Now the location of the seal can be determined by referring to the seal drawing supplied by the seal manufacturer.

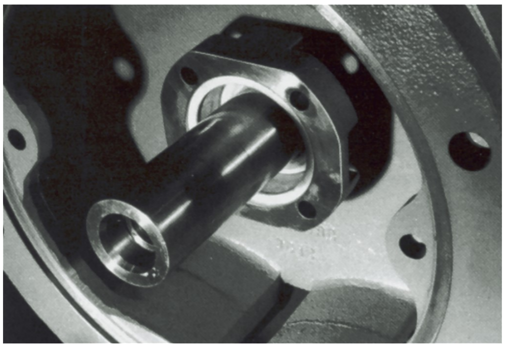
FIGURE 5-15



Impeller/cover removal
Remove the impeller following instructions given in the "Disassembly" section on Page 18. Remove the rear cover following instructions given in the "Disassembly" section on Page 18.

Gland installation
Install the gland (#190) and stationary seal components following the seal manufacturers instructions. Slide the gland and stationary seal components onto the shaft until it lightly touches the bearing housing or adapter. Install the gland gasket (#190G) into the gland. See FIGURE 5-16.

FIGURE 5-16



Seal installation
Install the rotating unit onto the shaft (or sleeve) using a seal guide following the seal manufacturers instructions. See FIGURE 5-17.

FIGURE 5-17

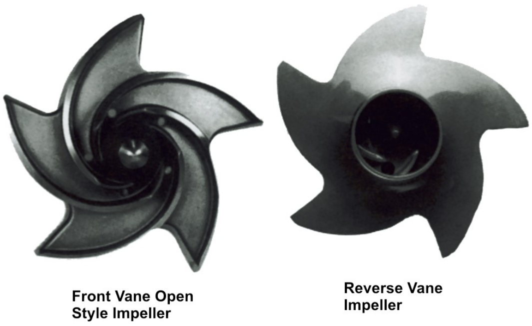
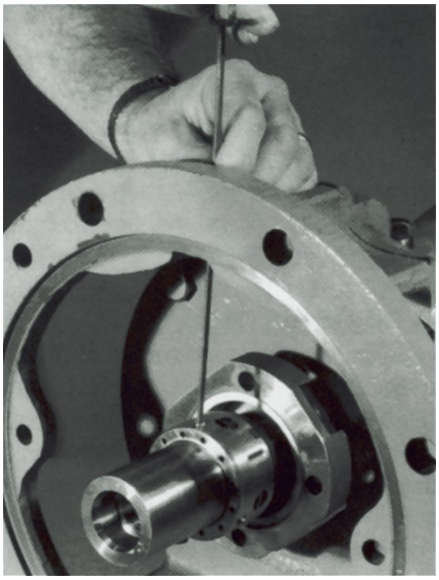
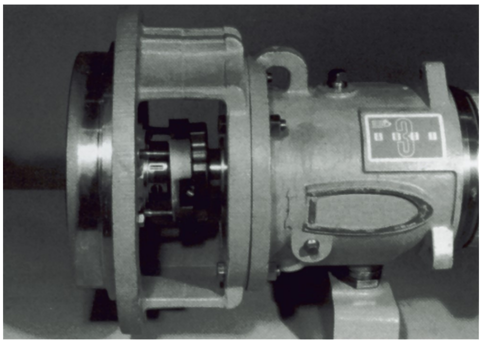


FIGURE 5-18



Rear cover installation
Install the rear cover plate (#106) to the bearing housing (1L type) or the bearing housing adapter (2L and 3L type) by using the cap screws (#140). Now, install the gland (#190) to the rear cover plate (#106) using studs (#111) and nuts (#111 A). See FIGURE 5-19

FIGURE 5-19



Impeller final installation
Install the impeller (#103) as instructed in **Appendix A**, if reverse vane, or **Appendix B**, if a front vane open style impeller. Remember that the impeller clearance is already set. It cannot be changed at this point without resetting the seal.

Packing and packing gland
Gland installation
Slip gland over shaft and slide back to the bearing housing.

Rear cover plate installation
Install the rear cover plate (#106) to the bearing housing (1L type) or the bearing housing adapter (2L and 3L type) by using the cap screws (#140).

Impeller installation and clearance setting
Install the impeller (#103) as instructed in **Appendix A**, if reverse vane, or **Appendix B**, if a front vane open style impeller. Low-Flo impeller clearances are set off the casing, just like the standard front vane open style impeller.

Packing installation
Install the packing rings (#113) and seal cage halves (#112) into the stuffing box as shown in FIGURE 3-5. Always stagger the end gaps 90° to ensure a better seal. To speed installation of each ring, have an assistant turn the pump shaft in one direction. This movement of the shaft will tend to draw the rings ¡into the stuffing box. Now, attach the gland (#110) to the cover using studs (#111) and nuts (#111A). Lightly snug up the gland. Final adjustments must be made after the pump has begun operation.

BEARING LUBRICATION

Oil bath

The standard bearing housing bearings are oil bath lubricated and are not lubricated by FEOC. Before operating the pump, fill the bearing housing to the center of the oil sight glass with the proper type oil. The oil level in the bearing housing must be maintained at ±1/8 in (±3 mm) from the center of the sight glass. The bearing housing oil level must be within the circumference of the center hole to ensure adequate lubrication of the bearings.
See FIGURE 5-20 for recommended lubricants. DO NOT USE DETERGENT OILS. The oil must be free of water, sediment, resin, soaps, acid and fillers of any kind. It should contain rust and oxidation inhibitors. The proper oil viscosity is determined by the bearing housing operating temperature as given in FIGURE 5-21.

To add oil to the housing, clean and then remove the vent plug (#135) at the top of the bearing housing, pour in oil until it is visually half way up in the sight glass (#200).

As stated above, proper oil level is the center of the "bull's eye" sight glass (#200) (See FIGURE 5-9).

In many pumping applications lubricating oil becomes contaminated before it loses its lubricating qualities or breaks down. For this reason it is recommended that the first oil change take place after approximately 160 hours of operation, at which time, the used oil should be examined carefully for contaminants. During the initial operating period monitor the bearing housing operating temperature. Record the external bearing housing temperature. See FIGURE 5-22 for maximum acceptable temperatures. The normal oil change interval is based on temperature and is shown in FIGURE 5-22.

FIGURE 5-20

Recommended Lubricants

Mineral Oil	Quality mineral oil with rust and oxidation inhibitors. Mobil DTE Heavy/Medium ISO VG 68
Synthetic	Royal Purple or Conoco SYNCON 68. Some synthetic lubricants require Viton O-rings.

FIGURE 5-21

Oil Viscosity Grades

Maximum Oil Temperature	**ISO Viscosity Grade**	**Minimum Viscosity Index**
Up to 160°F (71°C)	46	95
160-175°F (71-80°C)	68	95
175-200°F (80-94°C)	100	95

FIGURE 5-22

Maximum External Housing Temperatures

Lubrication	**Temperature**
Oil bath	180°F* (82°C)
Oil mist	180°F* (82°C)

*Synthetic oil and grease will allow higher temperatures.

FIGURE 5-23

Relubrication Intervals*

Lubricant	**Under 160°F (71°C)**	**160-175°F (71-80°C)**	**175-200 °F (80-94°C)**
Mineral Oil	6 mo	3 mo	1.5 mo
Synthetic Oil*	18 mo	18 mo	18 mo

*Assuming good maintenance and operation practices, and no contamination.

⚠ CAUTION

Do not fill the housing with oil when prelubricated bearings are used. The oil will leach the grease out of the bearings and the life of the bearings may be drastically reduced.

Double shielded or double sealed bearings
These bearings are packed with grease by the bearing manufacturer and should not be re-lubricated. The life for these bearings is greatly affected by their operating temperature and pump speed. However, the shielded bearing typically operates cooler, thus extending its life.

REINSTALLATION

The pump is now ready to be returned to service. It should be reinstalled as described in the installation section.

SPARE PARTS

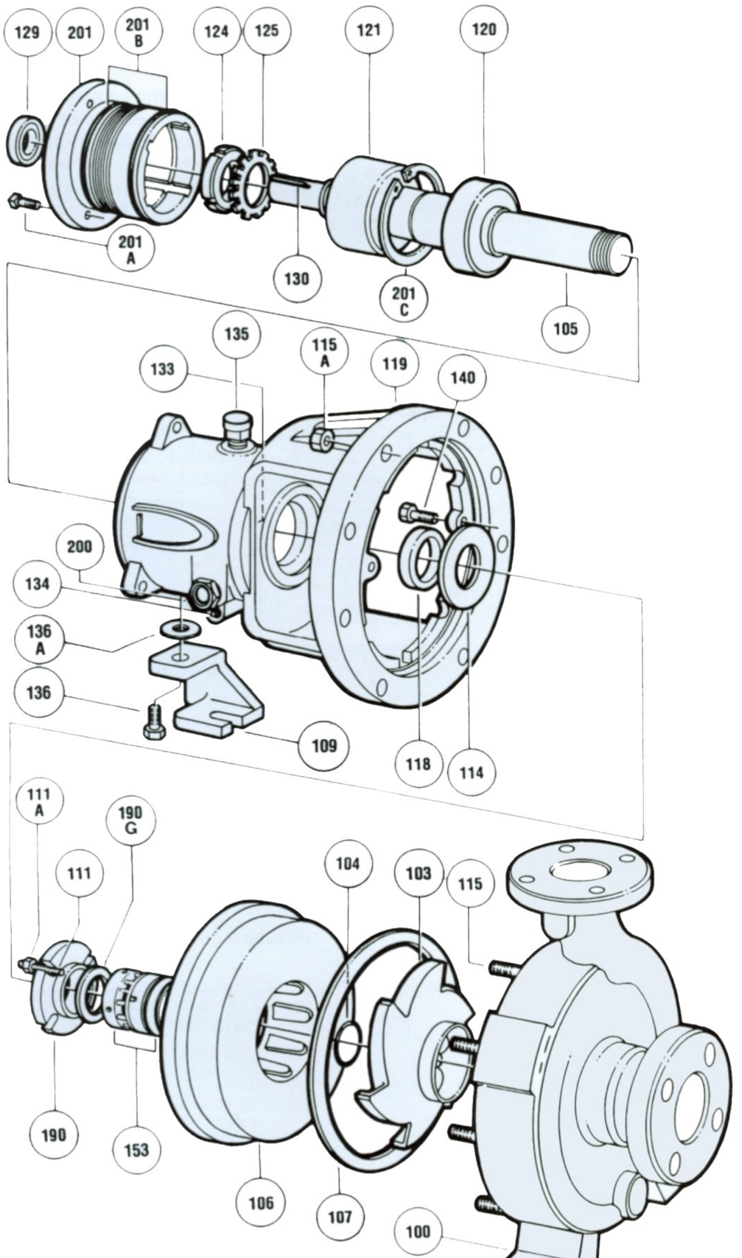
RECOMMENDED SPARE PARTS-STANDARD PUMP

The decision on what spare parts to stock varies greatly depending on many factors such as the criticality of the application, the time required to buy and receive new spares, the erosive/corrosive nature of the application, and the cost of the spare part. Figures 5-24, 5-25, 5-26 give the parts list for a typical pump.

HOW TO ORDER SPARE PARTS

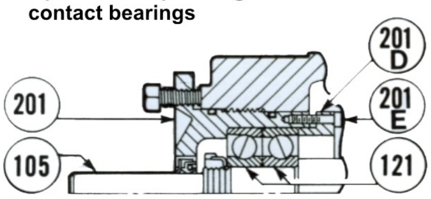
Spare parts can be ordered from the local Sales Engineer, or from Distributor or Representative. The pump size and type can be found on the name plate on the bearing housing. You will also need to provide the item number, description, and alloy for the part(s) you wish to order.

FIGURE 5-24
1L TYPE



ITEM	DESCRIPTION	
100	CASING	
103	IMPELLER	
104	IMPELLER GASKET	
105	SHAFT	
106	REAR COVER PLATE	
107	REAR COVER GASKET	
108	BEARING HOUSING ADAPTER	
109	BEARING HOUSING FOOT	
110	GLAND-PACKING	OPT.
111	STUD-GLAND	
112	PACKING SEAL CAGE HALVES	OPT.
113	PACKING	OPT.
114	DEFLECTOR INBOARD	
115	STUD-CASING	
118	OIL SEAL INBOARD	
119	BEARING HOUSING	
120	BEARING INBOARD	
121	BEARING OUTBOARD	
124	LOCKNUT-BEARING	
125	LOCKWASHER-BEARING	
129	OIL SEAL OUTBOARD	
130	KEY-SHAFT/COUPLING	
133	OILER (NOT SHOWN)	
134	BEARING HOUSING DRAIN PLUG	
135	BEARING HOUSING VENT PLUG	
136	CAPSCREW-FOOT	
140	CAPSCREW-COVER/ADAPTER	
153	MECHANICAL SEAL	
177	HOOK SLEEVE	OPT.
190	GLAND-MECHANICAL SEAL	
190G	GLAND GASKET	
200	SIGHT GAGE-BEARING HOUSING	
201	BEARING CARRIER	
201A	SET SCREW-BEARING HOUSING	
201B	O'RING-BEARING CARRIER	
201C	BEARING CARRIER RETAINER	
201D	CLAMP RING BEARIN HOUSING	OPT.
201E	SOC-CAPSCREW CLAMP	OPT.

Option for duplex angular contact bearings



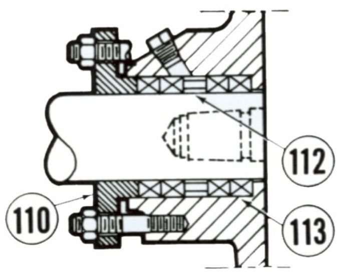
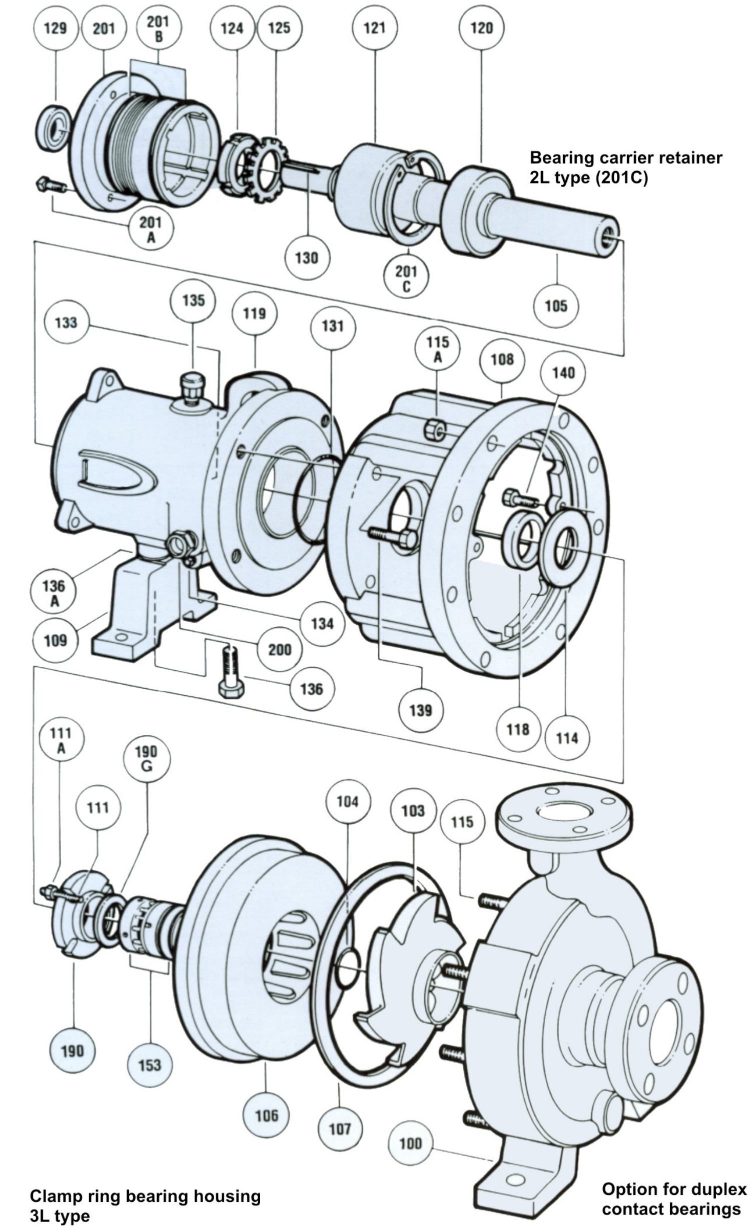
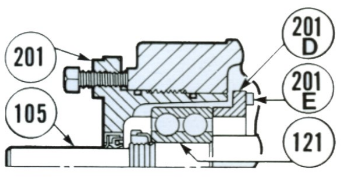


FIGURE 5-25
2L TYPE

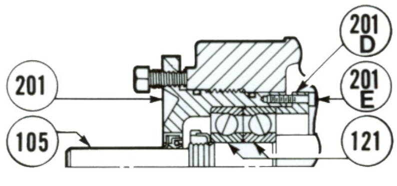


ITEM	DESCRIPTION	
100	CASING	
103	IMPELLER	
104	IMPELLER GASKET	
105	SHAFT	
106	REAR COVER PLATE	
107	REAR COVER GASKET	
108	BEARING HOUSING ADAPTER	
109	BEARING HOUSING FOOT	
110	GLAND-PACKING	OPT.
111	STUD-GLAND	
112	PACKING SEAL CAGE HALVES	OPT.
113	PACKING	OPT.
114	DEFLECTOR INBOARD	
115	STUD-CASING	
118	OIL SEAL INBOARD	
119	BEARING HOUSING	
120	BEARING INBOARD	
121	BEARING OUTBOARD	
124	LOCKNUT-BEARING	
125	LOCKWASHER-BEARING	
129	OIL SEAL OUTBOARD	
130	KEY-SHAFT/COUPLING	
131	O'RING-ADAPTER	
133	OILER (NOT SHOWN)	
134	BEARING HOUSING DRAIN PLUG	
135	BEARING HOUSING VENT PLUG	
136	CAPSCREW-FOOT	
139	CAPSCREW-BEARING HOUSING	
140	CAPSCREW-COVER/ADAPTER	
153	MECHANICAL SEAL	
177	HOOK SLEEVE	OPT.
190	GLAND-MECHANICAL SEAL	
190G	GLAND GASKET	
200	SIGHT GAGE-BEARING HOUSING	
201	BEARING CARRIER	
201A	SET SCREW-BEARING HOUSING	
201B	O'RING-BEARING CARRIER	
201C	BEARING CARRIER RETAINER	
201D	CLAMP RING BEARIN HOUSING	OPT.
201E	SOC-CAPSCREW CLAMP	OPT.

Clamp ring bearing housing
3L type



Option for duplex angular contact bearings



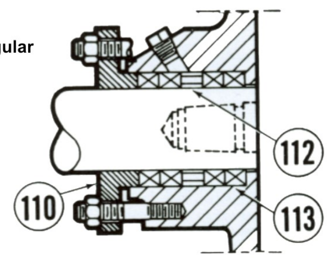
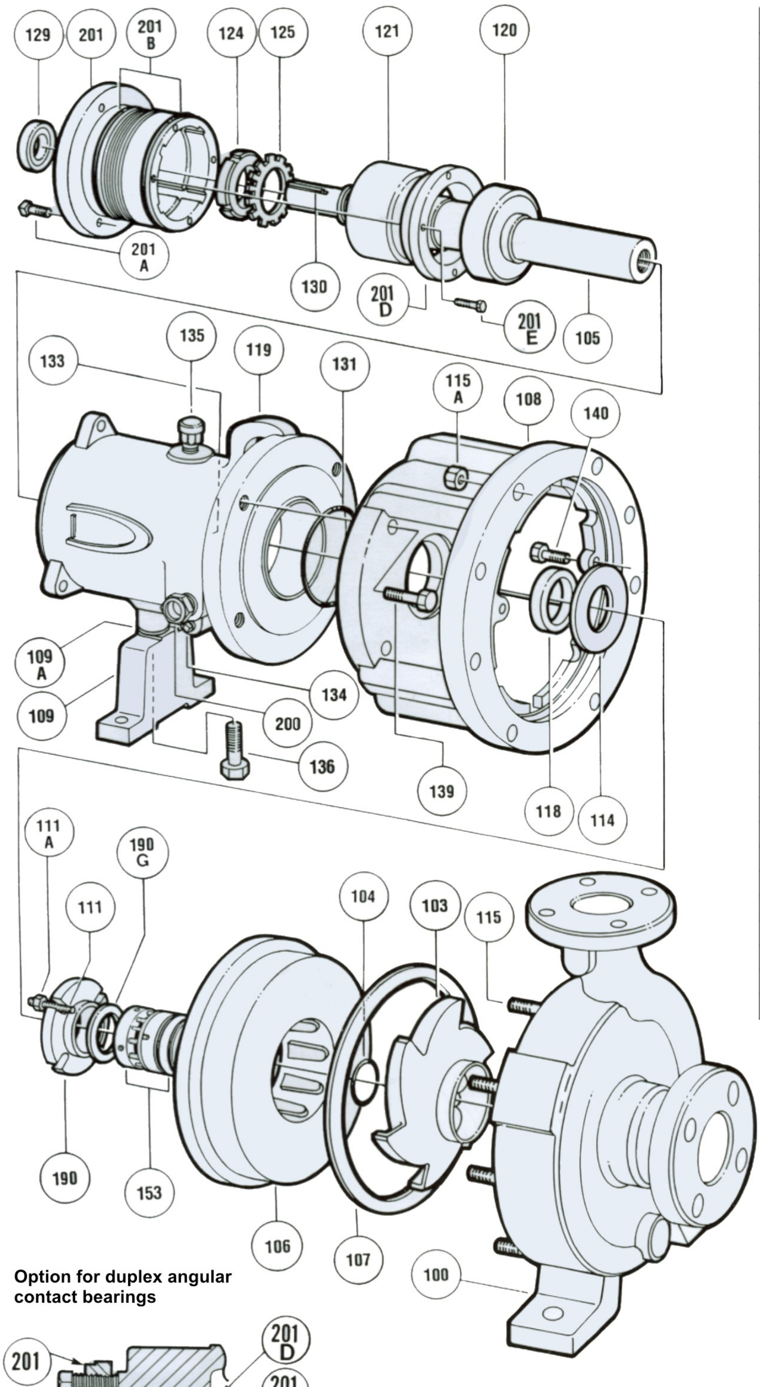
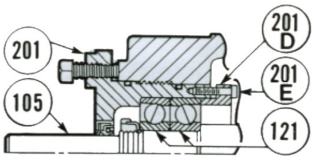


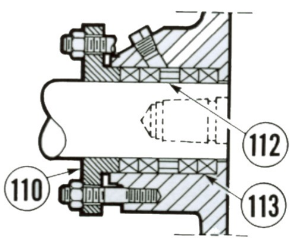
FIGURE 5-26
3L TYPE



ITEM	DESCRIPTION	
100	CASING	
103	IMPELLER	
104	IMPELLER GASKET	
105	SHAFT	
106	REAR COVER PLATE	
107	REAR COVER GASKET	
108	BEARING HOUSING ADAPTER	
109	BEARING HOUSING FOOT	
110	GLAND-PACKING	OPT.
111	STUD-GLAND	
112	PACKING SEAL CAGE HALVES	OPT.
113	PACKING	OPT.
114	DEFLECTOR INBOARD	
115	STUD-CASING	
118	OIL SEAL INBOARD	
119	BEARING HOUSING	
120	BEARING INBOARD	
121	BEARING OUTBOARD	
124	LOCKNUT-BEARING	
125	LOCKWASHER-BEARING	
129	OIL SEAL OUTBOARD	
130	KEY-SHAFT/COUPLING	
131	O'RING-ADAPTER	
133	OILER (NOT SHOWN)	
134	BEARING HOUSING DRAIN PLUG	
135	BEARING HOUSING VENT PLUG	
136	CAPSCREW-FOOT	
139	CAPSCREW-BEARING HOUSING	
140	CAPSCREW-COVER/ADAPTER	
153	MECHANICAL SEAL	
177	HOOK SLEEVE	OPT.
190	GLAND-MECHANICAL SEAL	
190G	GLAND GASKET	
200	SIGHT GAGE-BEARING HOUSING	
201	BEARING CARRIER	
201A	SET SCREW-BEARING HOUSING	
201B	O'RING-BEARING CARRIER	
201C	BEARING CARRIER RETAINER	
201D	CLAMP RING BEARIN HOUSING	
201E	SOC-CAPSCREW CLAMP	

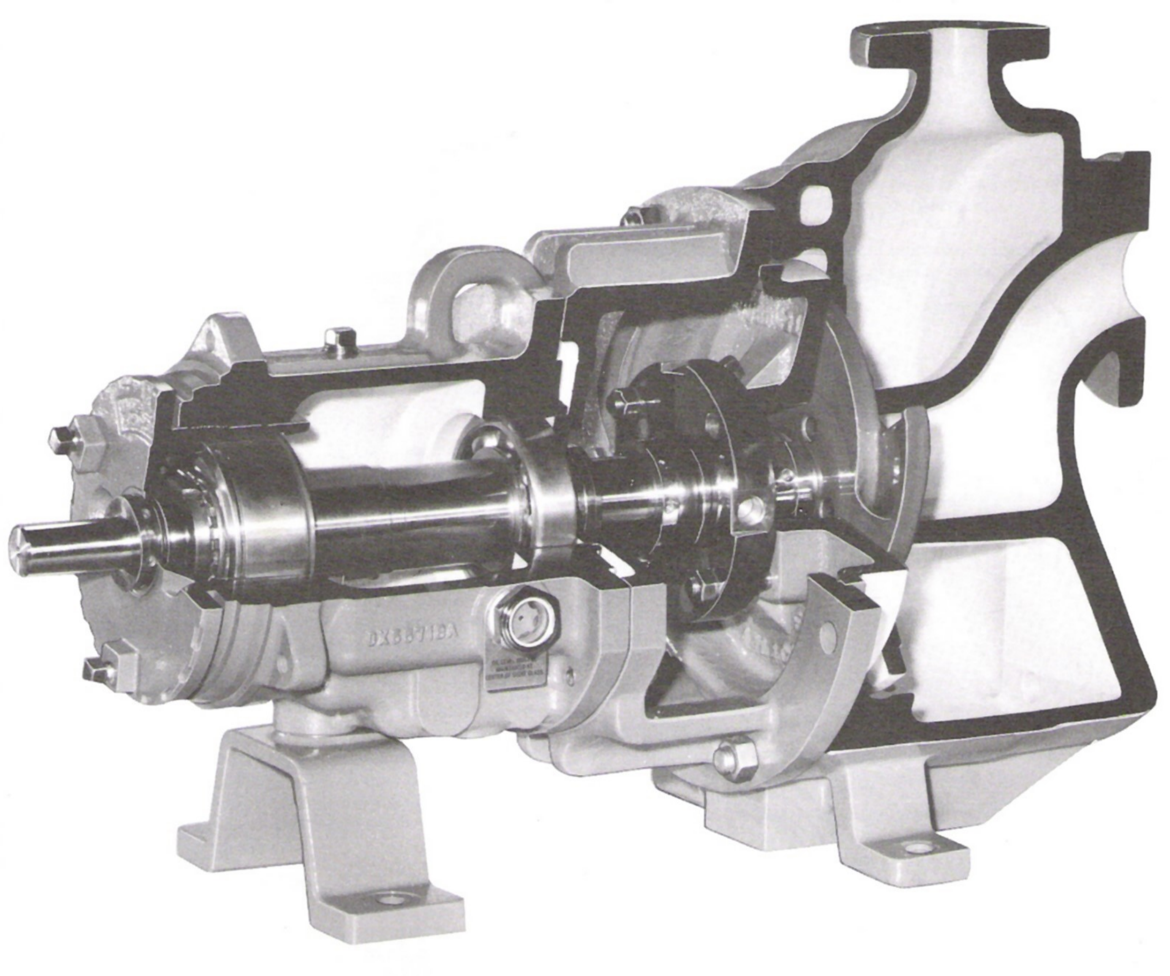
Option for duplex angular contact bearings





Section 6 SELF-PRIMING PUMP

Self-priming pumps combine the best design features of Standard pumps with efficient self-priming casings. These "specific purpose" wet end parts fit the basic building block philosophy in that they utilize the standard pump components from the impeller on back to the bearing housing. The self-priming casings were designed to pump from liquid sources which do not flow naturally to the pump's suction, such as from sups or from the tops of thank cars.



PUMP INSTALLATION AND OPERATION

Installation of the self-priming pump is perhaps more critical than any other of the DPUMPS. The suction piping must be as short as possible and be as close to the diameter of the pump's suction nozzle as is practical.

The pump works by removing the air contained in the suction piping. Once removed, it operates exactly the same as flooded suction Standard pump. The longer the suction pipe, the greater the volume of air that has to be removed. The larger the diameter of the pipe, the greater the volume of air. The suction piping and the seal chamber/stuffing box must be airtight, for any leak will destroy the partial vacuum which is created by the impeller. This vacuum is what allows the liquid to enter the pump.

Initial priming liquid must be added to the pump casing until the liquid level has reached the bottom of the suction nozzle (See FIGURE 6-1). Once the initial prime is in place, the pump will automatically replenish itself and additional priming liquid might have to be added to make up for evaporation losses. Another important dimension to check is the minimum submergence of the suction pipe into the sump, "S" as shown in FIGURE 6-1. See FIGURE 6-4 for the acceptable minimum values of "S".

The priming cycle begins pump operation. When the pump is turned on, the spinning impeller quickly moves the priming liquid out of the suction nozzle creating a partial vacuum in the suction line. The sump liquid begins to rise in the suction line, or the liquid in the tank car begins its ascent up the dip tube (See FIGURE 6-4). The liquid passes from the impeller and back into the casing where any entrained air is vented out the discharge nozzle. There must be a way for this air to vent. Our typical recommendation is to provide a small diameter air bleed line from discharge pipe to sump if the air is not able to freely vent out the discharge pipe as shown in FIGURE 6-3. The liquid falls to the bottom of the priming chamber with the volute.
The liquid then returns to the impeller where it is mixed with air from the suction piping. This process may take anywhere from 15 seconds to several minutes depending upon the amount of air to be removed.

FIGURE 6-1

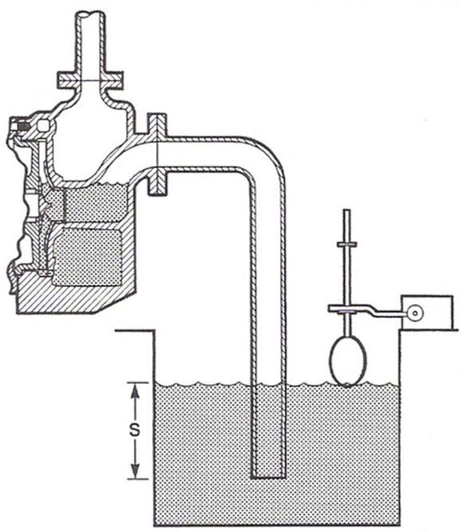


FIGURE 6-2

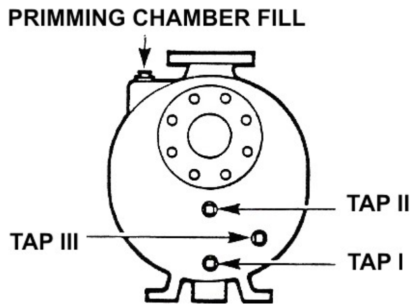
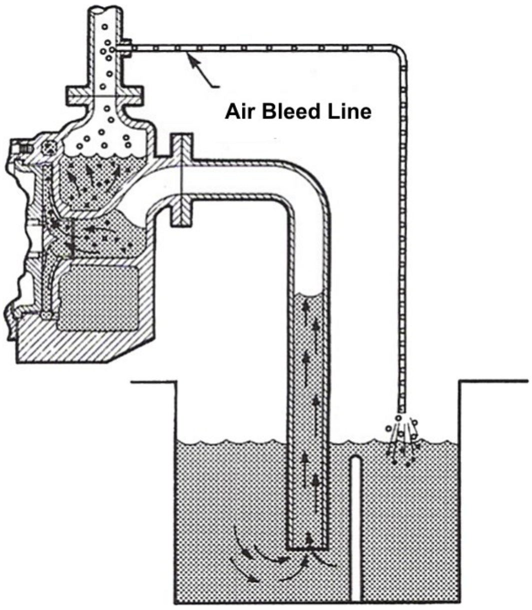
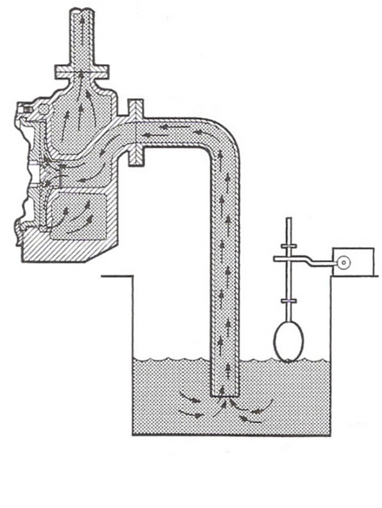


FIGURE 6-3



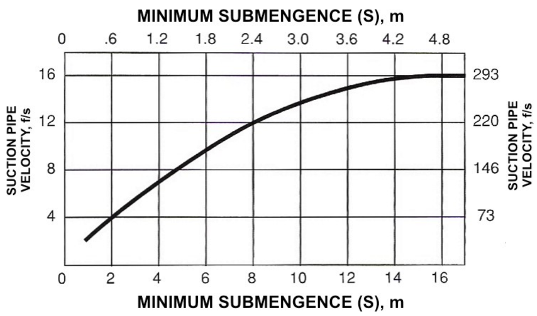
Normal operation commences as soon as the suction piping and the priming chamber are void of air (See FIGURE 6-4). Liquid from the impeller then passes through the discharge passage and into the priming chamber. At the same time, liquid from the impeller also passes through the bypass slot in the bottom of the casing and into the priming chamber. These two flows join and pass out of the priming chamber through the discharge nozzle located at the top of the chamber.

FIGURE 6-4



Shut down occurs when the pump is turned off either by a float switch in the sump or manually by the pump operator. The liquid in the discharge piping falls back into the priming chamber and washes back through the impeller and suction nozzle. The backwash creates a siphon effect in the casing and suction nozzle until the liquid falls below the nozzle level and the siphon is broken The inertia of the liquid flowing backwards pulls the level of the priming chamber to a lower level than achieved with the initial fill. Though the level is lower, there is still sufficient liquid in the priming chamber to allow the pump to reprime itself during the next pumping cycle.

FIGURE 6-5

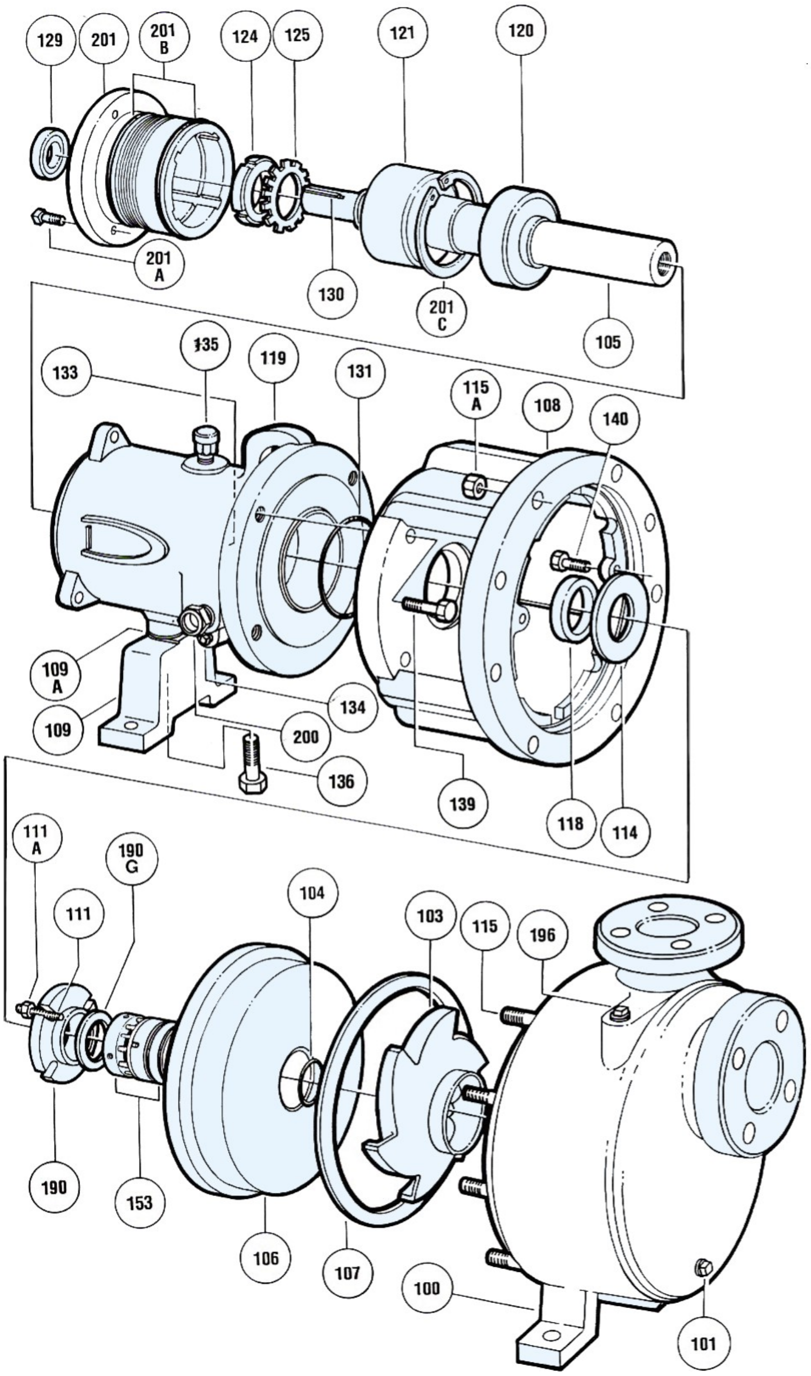


It is usually recommended that a bypass line be installed from the casing Tap III (See FIGURE 6-2) to the seal camber or the gland. The purpose of this line is to keep the seal faces wet during the priming cycle.

When possible, it is recommended that the suction piping be sloped slightly downward to the casing suction flange. This will ensure that no priming fluid is lost down the suction line while the pump is priming.

SPARE PARTS

The parts diagram is the same as the DPUMP standard with the exception of the special casing. The pump shown below is a 2L type. Refer to FIGURE 5-23 to see 1L pump, or to see the duplex angular contact bearing option.



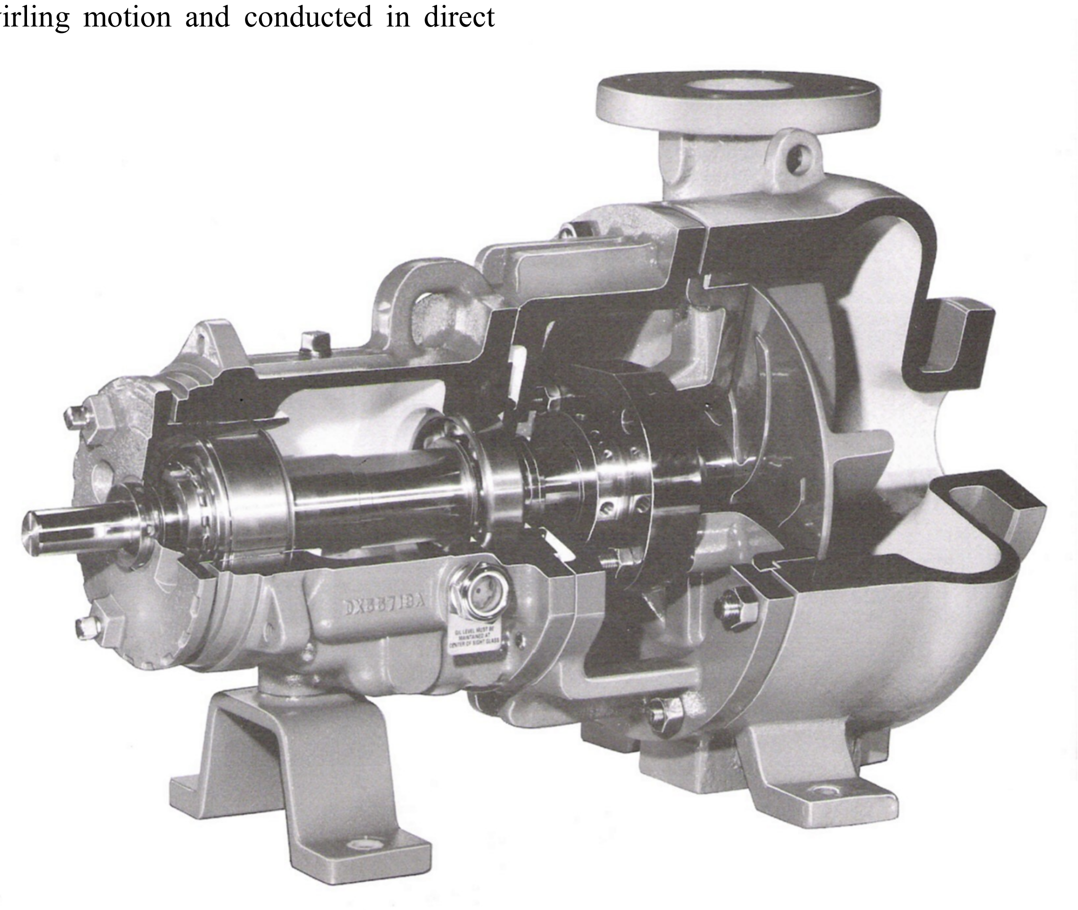
ITEM	DESCRIPTION	
100	CASING	
103	IMPELLER	
104	IMPELLER GASKET	
105	SHAFT	
106	REAR COVER PLATE	
107	REAR COVER GASKET	
108	BEARING HOUSING ADAPTER	
109	BEARING HOUSING FOOT	
111	STUD-GLAND	
114	DEFLECTOR INBOARD	
115	STUD-CASING	
118	OIL SEAL INBOARD	
119	BEARING HOUSING	
120	BEARING INBOARD	
121	BEARING OUTBOARD	
124	LOCKNUT-BEARING	
125	LOCKWASHER-BEARING	
129	OIL SEAL OUTBOARD	
130	KEY-SHAFT/COUPLING	
131	O'RING-ADAPTER	
133	OILER (NOT SHOWN)	
134	BEARING HOUSING DRAIN PLUG	
135	BEARING HOUSING VENT PLUG	
136	CAPSCREW-FOOT	
139	CAPSCREW-BEARING HOUSING	
140	CAPSCREW-COVER/ADAPTER	
153	MECHANICAL SEAL	
177	HOOK SLEEVE	OPT.
190	GLAND-MECHANICAL SEAL	
190G	GLAND GASKET	
200	SIGHT GAGE-BEARING HOUSING	
201	BEARING CARRIER	
201A	SET SCREW-BEARING HOUSING	
201B	O'RING-BEARING CARRIER	
201C	BEARING CARRIER RETAINER	
201D	CLAMP RING BEARIN HOUSING	
201E	SOC-CAPSCREW CLAMP	

Section 7 VORTEX TYPE PUMP

The impeller vortex type is an open-vane design that has the shroud attached to the rear of the vanes. The impeller is located a distance of two inches or so from the suction face of the casing. When the impeller spins, it sets up a vortex within the casing. This swirling liquid is fed from the center via the suction nozzle and exits tangentially from the vortex through the discharge nozzle.

Very little of any solids that may be contained in the liquid actually touch the impeller. Rather, they are swept up in the swirling motion and conducted in direct fashion to the discharge nozzle. The discharge nozzle is placed at a tangent to the swirling flow so that the fluid flows smoothly out of the pump. Top, center-line discharge is not desirable as the extra bends in the discharge nozzle necessary to locate the flange in the center would disrupt the flow and increase the possibility of wearing out the casing.

Except for the impeller and casing, all other parts are identical to the DPUMP standard.

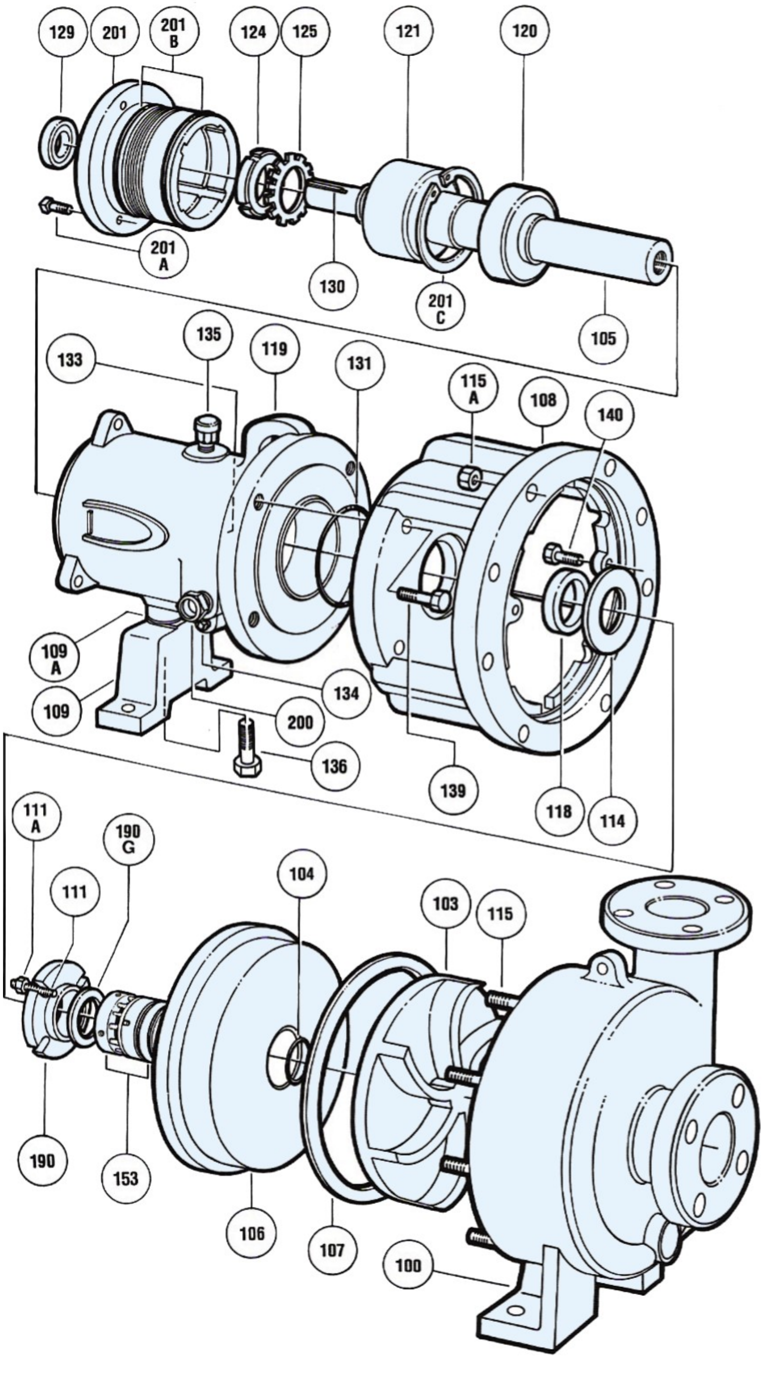


SETTING THE IMPELLER

The impeller is set off of the rear cover plate, just like the reverse vane impeller on the DPUMP standard. Refer to **Appendix A** for instructions on setting the impeller.

SPARE PARTS

The parts diagram is the same as the DPUMP standard with the exception of the casing and impeller. The pump shown below is a 2L type. Refer to FIGURE 5-23 to see a 1L type pump, or to see the duplex angular contact bearing option.



ITEM	DESCRIPTION	
100	CASING	
103	IMPELLER	
104	IMPELLER GASKET	
105	SHAFT	
106	REAR COVER PLATE	
107	REAR COVER GASKET	
108	BEARING HOUSING ADAPTER	
109	BEARING HOUSING FOOT	
110	GLAND-PACKING	OPT.
111	STUD-GLAND	
112	PACKING SEAL CAGE HALVES	OPT.
113	PACKING	OPT.
114	DEFLECTOR INBOARD	
115	STUD-CASING	
118	OIL SEAL INBOARD	
119	BEARING HOUSING	
120	BEARING INBOARD	
121	BEARING OUTBOARD	
124	LOCKNUT-BEARING	
125	LOCKWASHER-BEARING	
129	OIL SEAL OUTBOARD	
130	KEY-SHAFT/COUPLING	
131	O'RING-ADAPTER	
133	OILER (NOT SHOWN)	
134	BEARING HOUSING DRAIN PLUG	
135	BEARING HOUSING VENT PLUG	
136	CAPSCREW-FOOT	
139	CAPSCREW-BEARING HOUSING	
140	CAPSCREW-COVER/ADAPTER	
153	MECHANICAL SEAL	
177	HOOK SLEEVE	OPT.
190	GLAND-MECHANICAL SEAL	
190G	GLAND GASKET	
200	SIGHT GAGE-BEARING HOUSING	
201	BEARING CARRIER	
201A	SET SCREW-BEARING HOUSING	
201B	O'RING-BEARING CARRIER	
201C	BEARING CARRIER RETAINER	
201D	CLAMP RING BEARIN HOUSING	
201E	SOC-CAPSCREW CLAMP	

Section 8 LOW FLOW PUMP

The DPUMP low flow type has a special design casing and impeller which allows it to work very reliably at low flows. The pump has an impeller with radial vanes that twist around the hub, and a circular, concentric casing. This design ensures that, at lo flows, no significant hydraulic radial forces are transmitted to the shaft. Minimum flow on this pump is "Minimum Thermal Flow". This is defined as the minimum flow that will not cause an excessive temperature rise.

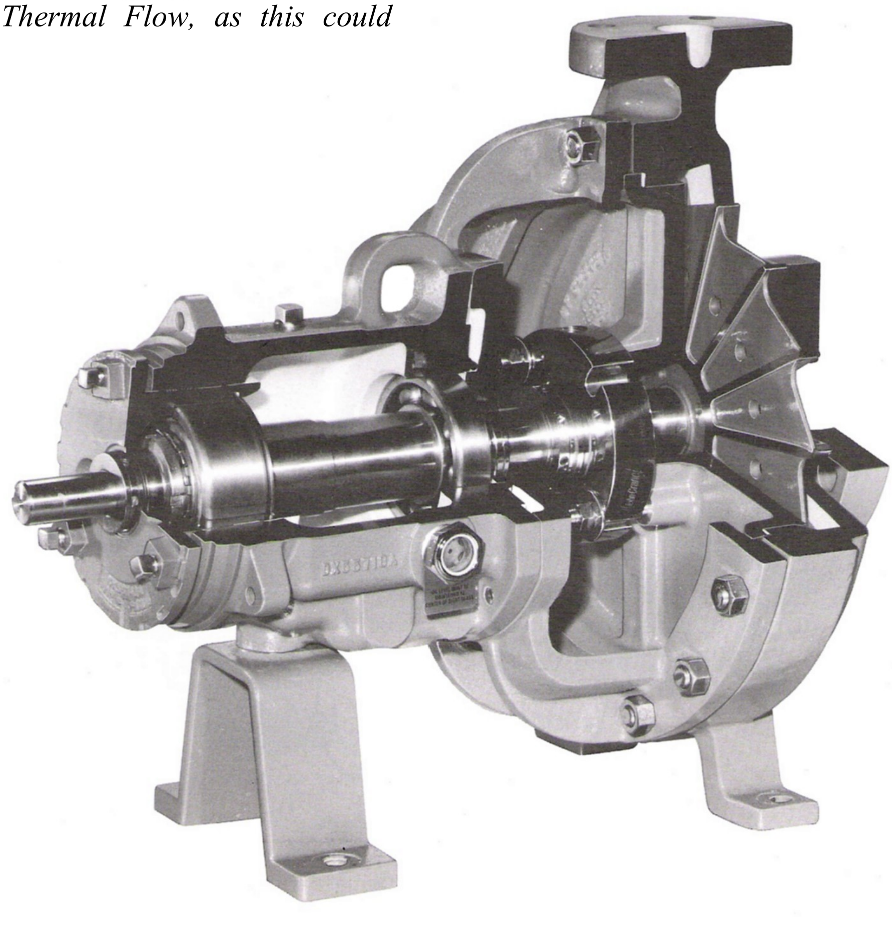
⚠ WARNING

Do not operate the Low Flow pump below Minimum Thermal Flow, as this could cause an excessive temperature rise. Contact your Distributor for determination of Minimum Thermal flow.

Only the impeller and casing are special, all other parts are standard parts. **Note**: The adapter on the 13 in pump is the standard adapter but with 16 holes drilled in it for attachment to the casing.

SETTING THE IMPELLER

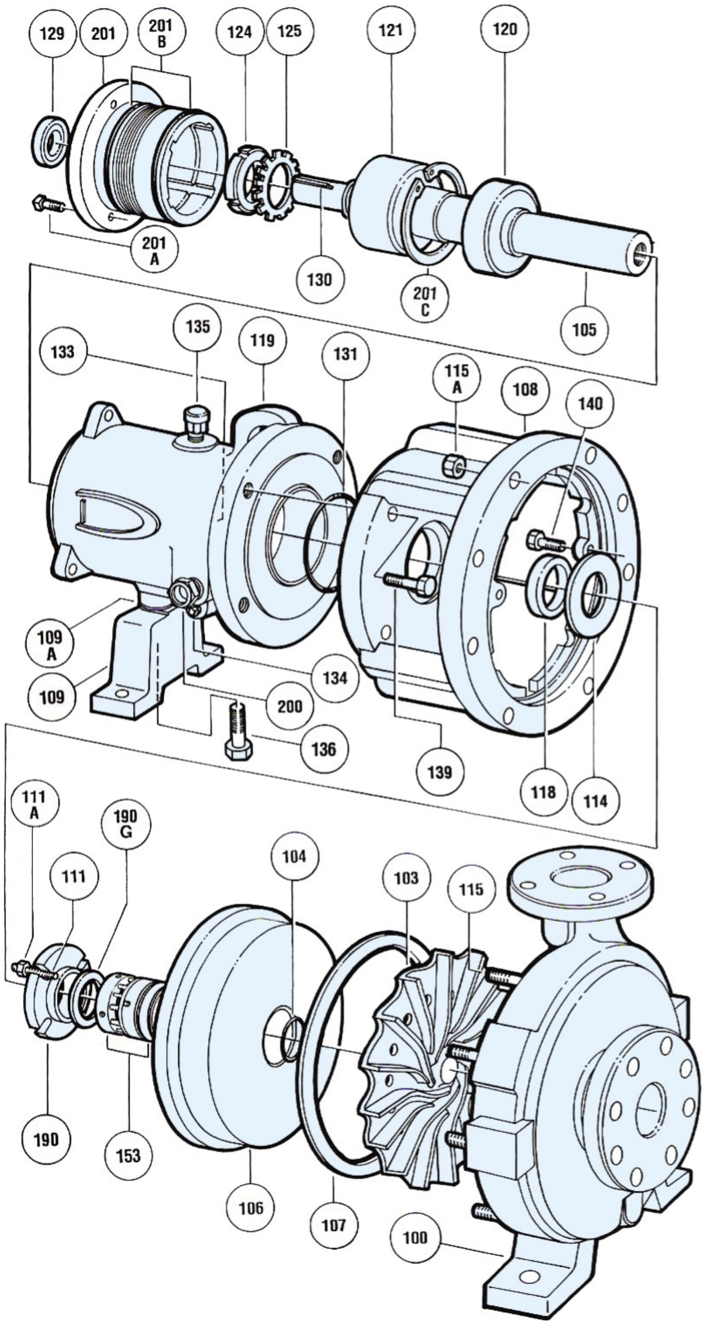
The impeller for this pump is set off the casing, just like the standard front vane open style impeller. Refer to **Appendix B** for instructions on how to install, remove, and set this impeller.



SPARE PARTS

The parts diagram is the same as the DPUMP standard with the exception of the casing and impeller. The pump shown below is a 2L type pump.

Refer to FIGURE 5-23 to see a 1L type pump, or to see the duplex angular contact bearing option.



ITEM	DESCRIPTION	
100	CASING	
103	IMPELLER	
104	IMPELLER GASKET	
105	SHAFT	
106	REAR COVER PLATE	
107	REAR COVER GASKET	
108	BEARING HOUSING ADAPTER	
109	BEARING HOUSING FOOT	
110	GLAND-PACKING	OPT.
111	STUD-GLAND	
112	PACKING SEAL CAGE HALVES	OPT.
113	PACKING	OPT.
114	DEFLECTOR INBOARD	
115	STUD-CASING	
118	OIL SEAL INBOARD	
119	BEARING HOUSING	
120	BEARING INBOARD	
121	BEARING OUTBOARD	
124	LOCKNUT-BEARING	
125	LOCKWASHER-BEARING	
129	OIL SEAL OUTBOARD	
130	KEY-SHAFT/COUPLING	
131	O'RING-ADAPTER	
133	OILER (NOT SHOWN)	
134	BEARING HOUSING DRAIN PLUG	
135	BEARING HOUSING VENT PLUG	
136	CAPSCREW-FOOT	
139	CAPSCREW-BEARING HOUSING	
140	CAPSCREW-COVER/ADAPTER	
153	MECHANICAL SEAL	
177	HOOK SLEEVE	OPT.
190	GLAND-MECHANICAL SEAL	
190G	GLAND GASKET	
200	SIGHT GAGE-BEARING HOUSING	
201	BEARING CARRIER	
201A	SET SCREW-BEARING HOUSING	
201B	O'RING-BEARING CARRIER	
201C	BEARING CARRIER RETAINER	
201D	CLAMP RING BEARIN HOUSING	
201E	SOC-CAPSCREW CLAMP	

APPENDIX A

INSTALLATION/CLEARANCE SETTING FOR REVERSE VANE IMPELLER

Install the impeller (#103) by screwing it onto the shaft (use heavy gloves) until it firmly seats against the shaft shoulder.

WARNING

The impeller could have sharp edges which could cause an injury. It is very important to wear heavy gloves.

Tighten the impeller with the impeller wrench from the DPUMP tool kit. To do this, grasp the impeller in both hands and, with the impeller wrench handle to the left (viewed from the impeller end of the shaft) (FIGURE A-1), spin the impeller forcefully in a clockwise direction to impact the impeller wrench handle on the work surface to the right (FIGURE A-2).

FIGURE A-1

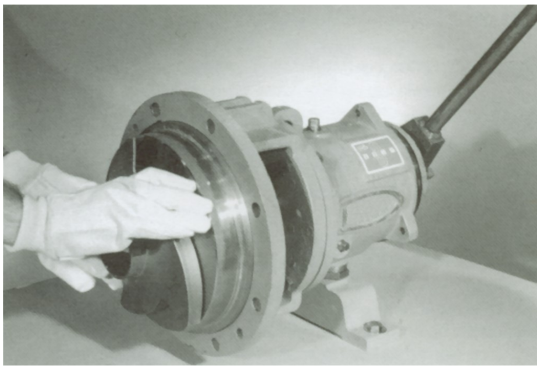


FIGURE A-2

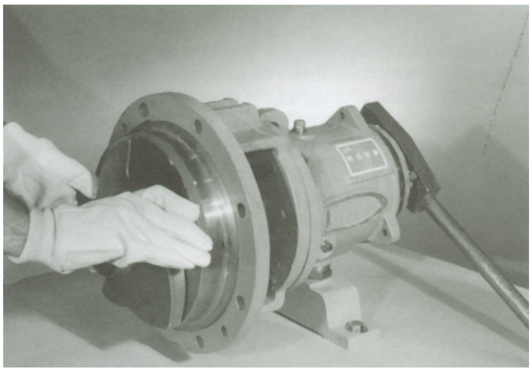
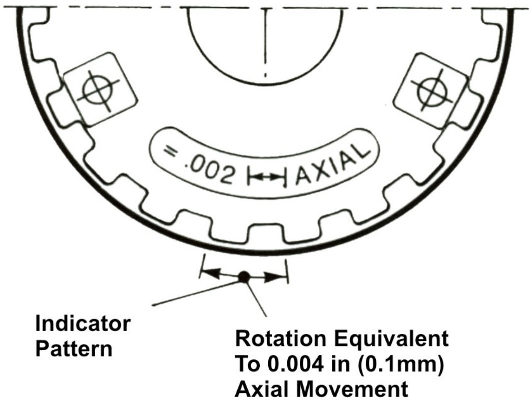


FIGURE A-3



CAUTION

Do not attempt to tighten the impeller on the shaft by hitting the impeller with a hammer or any other object or by inserting a pry bar between the impeller vanes. Serious damage to the impeller may result from such actions.

Now set the impeller clearance by loosening the set screws (#201A) and rotating the bearing carrier (#201) to obtain the proper clearance. Turn the bearing carrier counterclockwise until the impeller comes into light rubbing contact with the rear cover. Rotating the shaft at the same time will accurately determine this zero setting. Now, rotate the bearing carrier clockwise to get the proper clearance. Refer to FIGURE A-4 for the proper impeller clearance. Rotating the bearing carrier the width of one of the indicator patterns cast into the bearing carrier moves the impeller axially 0.004 in (0.1 mm). (See FIGURE A-3)

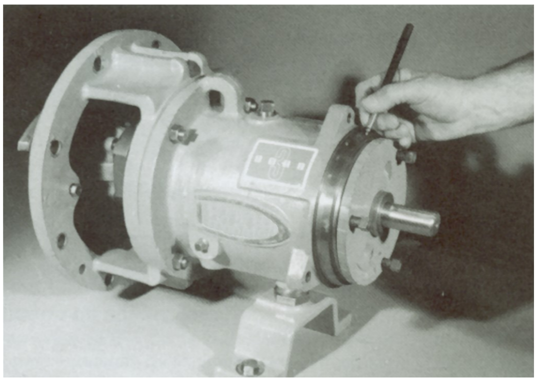
Determine how far to rotate the bearing carrier by dividing the desired impeller clearance by 0.004 (one indicator pattern). Tightening the set screws (#201A) will cause the impeller to move 0.002 in (0.05 mm) closer to the rear cover because of the internal looseness in the bearing carrier threads. This must be considered when setting the impeller clearance. Rotate the bearing carrier clockwise the required amount to get the desired clearance to the cover. Lastly, tighten the set screws (#201A) to lock the bearing carrier in place.

FIGURE A-4
Impeller Clearance Settings

Temperature - °F (°C)	Clearance to cover – in (mm)
<200 (93)	0.018 ± 0.003 (0.46 ± 0.08)
250 (121)	0.021 (0.53)
300 (149)	0.024 (0.61)
350 (176)	0.027 (0.69)
400 (204)	0.030 (0.76)
450 (232)	0.033 (0.84)
>500 (260)	0.036 (0.98)

Notes
1. For 3 x 1.5-13 and 3x2-13 at 3500 rpm add 0.003 in (0.08 mm).
2. Rotation of bearing carrier from center of one lug to center of next results in axial shaft movement of 0.004 in (0.1 mm).
3. Reverse vane impeller set to cover, open impeller to casing.

FIGURE A-5



Example: For an impeller setting of 0.020 in (0.5 mm) off the rear cover plate it is necessary to add 0.002 in (0.05 mm) for the movement caused by tightening the set screws; therefore, an adjustment of 0.022 in (0.56 mm) is needed. First, turn the bearing carrier counterclockwise until the impeller comes into light rubbing contact with the rear cover. Now rotate the bearing carrier clockwise 5-1/2 indicator patterns to get the 0.022 in (0.56 mm) clearance (0.004 x 5¬1/2 = 0.022). FEOC suggests that a fell tip pen be used to mark an initial reference point on the bearing housing and the bearing carrier as shown in FIGURE A-5. Then make a second mark on the bearing carrier 5-1/2 indicator patterns counterclockwise from the initial reference point. Now rotate the bearing carrier clockwise until the second mark on the bearing carrier lines up with the initial reference point mark on the bearing housing. The impeller is now set correctly.

APPENDIX B

INSTALLATION/CLEARANCE SETTING FOR FRONT VANE OPEN IMPELLER

Install the impeller (#103) by screwing it onto the shaft (use heavy gloves) until it firmly seats against the shaft shoulder.

⚠ WARNING

The impeller could have sharp edges which could cause an injury. It is very important to wear heavy gloves.

Tighten the impeller with the impeller wrench from the DPUMP tool kit. To do this, grasp the impeller in both hands and, with the impeller wrench handle to the left (viewed from the impeller end of the shaft) (FIGURE B-1), spin the impeller forcefully in a clockwise direction to impact the impeller wrench handle on the work surface to the right (FIGURE B-2).

FIGURE B-1

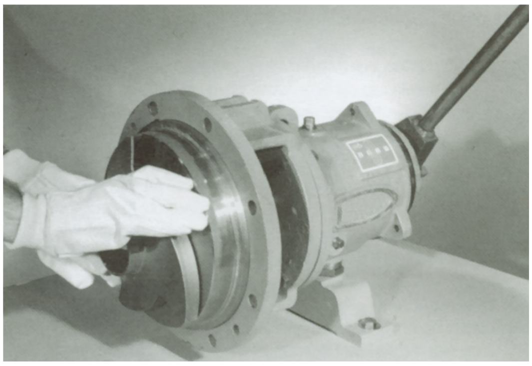
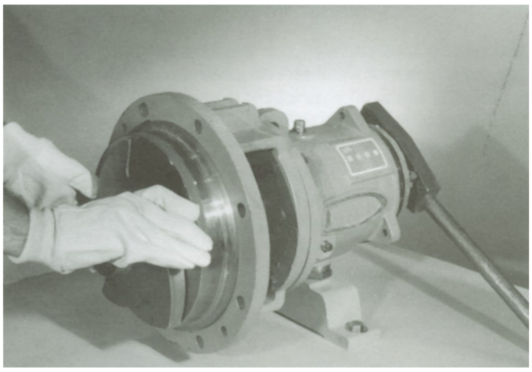


FIGURE B-2



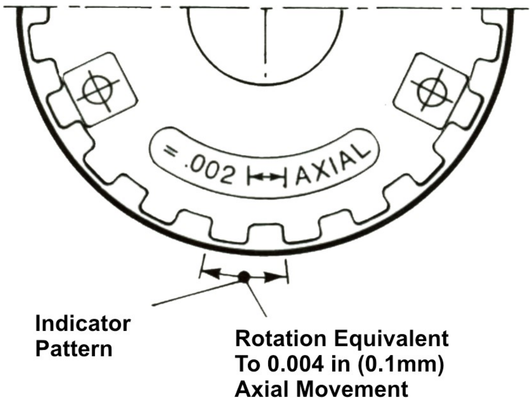
⚠ CAUTION

Do not attempt to tighten the impeller on the shaft by hitting the impeller with a hammer or any other object or by inserting a pry bar between the impeller vanes. Serious damage to the impeller may result from such actions.

Like all front vane open style impellers, the semi-open impeller clearance must be set off the casing. The casing must be present to accurately set the impeller clearance. (Realizing that this can be very difficult, strongly promotes the use of reverse vane impellers, which do not require the presence of the casing to be properly set.)

Attach the power end/rear cover plate assembly to the casing. Now set the impeller clearance by loosening the set screws (#201A) and rotating the bearing carrier (#201) to obtain the proper clearance. Turn the bearing carrier clockwise until the impeller comes into light rubbing contact with the casing. Rotating the shaft al the same time will accurately determine this zero setting. Now, rotate the bearing carrier counterclockwise to get the proper clearance. Refer to FIGURE B-4 for the proper impeller clearance. Rotating the bearing carrier the width of one of the indicator patterns cast into the bearing carrier moves the impeller axially 0.004 in (0.1 mm). (See FIGURE B-3)

FIGURE B-3



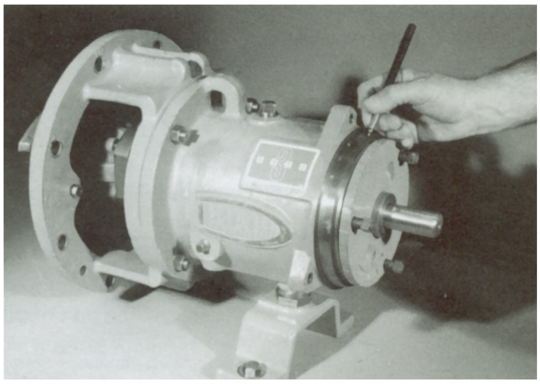
Determine how far to rotate the bearing carrier by dividing the desired impeller clearance by 0.004 in (0.1 mm) (one indicator pattern). Tightening the set screws (#201A) will cause the impeller to move 0.002 in (0.05 mm) away from the casing because of the internal looseness in the bearing carrier threads. This must be considered when setting the impeller clearance. Rotate the bearing carrier counterclockwise the required amount to get the desired clearance to the casing. Lastly, tighten the set screws (#201A) to lock the bearing carrier in place.

FIGURE B-4
Impeller Clearance Settings

Temperature - °F (°C)	Clearance to cover – in (mm)
<200 (93)	0.018 ± 0.003 (0.46 ± 0.08)
250 (121)	0.021 (0.53)
300 (149)	0.024 (0.61)
350 (176)	0.027 (0.69)
400 (204)	0.030 (0.76)
450 (232)	0.033 (0.84)
>500 (260)	0.036 (0.98)

Notes
1. For 3 x 1.5-13 and 3x2-13 at 3500 rpm add 0.003 in (0.08 mm).
2. Rotation of bearing carrier from center of one lug to center of next results in axial shaft movement of 0.004 in (0.1 mm).
3. Reverse vane impeller set to cover, open impeller to casing.

FIGURE B-5



Example: For an impeller setting of 0.020 in (0.5 mm) off the casing, it is necessary to subtract 0.002 in (0.05 mm) for the movement caused by tightening the set screws; Therefore an adjustment or 0.018 in (0.46 mm) is needed. First, turn the bearing carrier clockwise until the impeller comes into light rubbing contact with the casing. Now rotate the bearing carrier counterclockwise 4-1/2 indicator patterns lo gel the 0.018 in (0.46 mm) clearance (0.004 x 4-1/2 = 0.018). FEOC suggests that a felt tip pen be used to mark an initial reference point on the bearing housing and the bearing carrier as shown in FIGURE B-5. Then make a second mark on the bearing carrier 4-1/2 indicator patterns clockwise from the initial reference point. Now rotate the bearing carrier counterclockwise until the second mark on the bearing carrier lines up with the initial reference point mark on the bearing housing. Al that point, the setting will be 0.018 in (0.46 mm). Tightening the set screws will cause a 0.002 in (0.05 mm) draw of the bearing carrier threads, which will give the final setting or 0.020 in (0.5 mm).

APPENDIX C YOUR DPUMP EQUIPMENT DATA

IDENTIFICATION DATA	**Item**	
	Pump Size	
	Serial Number	
	Purchase Date	
	Service	
ALLOY	Casing	
	Rear cover plate	
	Impeller	
	Shaft	
	Hook Sleeve	
SERVICE	Fluid	
	Temperature	
	Specific Gravity	
	Viscosity	
	Flow	
	Inlet pressure	
	Discharge pressure	
	TDH	
	NPSHa	
	NPSHr	
INSTALLATION	Mechanical Seal Brand	
	Mechanical Seal Type	
	Mechanical Seal Materials	
	Power Drive	
	RPM	
	Base	
	Coupling	

NOTES

PUMPS

DISTRIBUTOR DATA