

MAINTENANCE AND TROUBLESHOOTING

VERTICAL TURBINE PUMPS



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TROUBLE SHOOTING INSTRUCTIONS

VERTICAL TURBINE PUMPS

OPEN LINE SHAFT CONSTRUCTION

PUMP MODEL: _____

SERIAL NO: _____

PO NO: _____

Trouble Indicators and Possible Causes

Trouble Source	Probable Cause	Remedy
Insufficient Pressure	1. Speed too slow	Check motor for correct voltage, speed, hp. Replace motor if necessary.
	2. Improper impeller trim	Remove pump and replace Impeller
	3. Impeller loose	Pull Pump and Tighten Impeller
	4. Cavitation	Increase pump submergence, lower pumped liquid temperature, check sump for compliance with HI recommendations, redesign sump if necessary
	5. Wear rings worn	Pull pump and inspect for bent shaft, straighten bent shaft, replace wear ring, remove any abrasive material, adjust Impeller setting per Peerless recommendations
	6. Leak in the discharge piping system	Plug leaks or change pipe section
	7. Leaking column joints or bowl castings	Change column gasket or "O" ring, tighten all boltings and nuts to recommended torque ratings, replace or repair leaky castings
	8. Wrong rotation	Check pump for CCW rotation when viewed from top of motor. If necessary reverse motor rotation by swapping two leads in the motor terminal box
Insufficient Capacity	1. Speed too slow	Check motor for correct voltage, speed, hp. Replace motor if necessary.
	2. Improper impeller trim	Remove pump and replace Impeller
	3. Impeller loose	<i>Pull Pump and Tighten Impeller</i>
	4. Impeller or bowl partially plugged	Disassemble pump, inspect and remove foreign material, reassemble and set impeller with correct lateral settings
	5. Leaking joints	Change column gasket or "O" ring, tighten all boltings and nuts to recommended torque ratings, replace or repair leaky castings
	6. Strainer partially clogged	Remove strainer from pump, inspect and clean
	7. Suction valve throttled	Check for Fully Open position or Partially Closed position
	8. Low water level in sump	Increase min water level in sump
	9. Wrong rotation	Check pump for CCW rotation when viewed from top of motor. If necessary reverse motor rotation by swapping two leads in the motor terminal box
	10. Total Pump Head is too high	Check Discharge piping for friction losses. Larger piping may correct problem.
No Liquid Delivered	1. Pump suction broken (water level below bell inlet)	Increase min water level in sump, refer to min water level requirements of individual pump
	2. Suction valve closed	Open suction valve
	3. Impeller plugged	Disassemble pump, inspect and remove foreign material, reassemble and set impeller with correct lateral settings
	4. Strainer clogged	Remove strainer from pump, inspect and clean
	5. Wrong rotation	Check pump for CCW rotation when viewed from top of motor. If necessary reverse motor rotation by swapping two leads in the motor terminal box
	6. Shaft broken or unscrewed	Replace broken shaft, retighten couplings.
	7. Impeller loose	<i>Pull Pump and Tighten Impeller</i>

Trouble Source	Probable Cause	Remedy
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Using Too Much Power

- | | |
|--|--|
| 1. Speed too high | Check motor for correct speed, Replace motor if necessary. |
| 2. Improper impeller adjustment | Adjust Impeller lateral setting per Peerless recommendations |
| 3. Improper impeller trim | Change Impeller or reduce Impeller diameter |
| 4. Pump out of alignment or shaft bent | Check for overall pump concentricity, remove and straighten bent shaft, consider replacing bent shaft |
| 5. Mechanical binding | |
| 6. Packing rings adjusted too tight | Loosen packing rings to release gland pressure. Ensure adequate lubrication flow per Peerless Pump recommendations |
| 7. Damaged Impeller | Pull pump, Inspect and replace impeller if damaged |

Vibration

- | | |
|--|--|
| 1. Motor imbalance | Field balance motor |
| 2. Motor bearings not properly seated | Inspect and replace as required |
| 3. Motor drive coupling out of balance | Field balance coupling |
| 4. Misalignment of pump, casting, discharge head, column, or bowls | Check for overall pump concentricity, remove and straighten bent shaft, consider replacing bent shaft |
| 5. Discharge head misaligned by improper mounting or pipe strain | Reduce pipe strain, ensure pipe strain does not exceed limits recommended by Peerless Pump |
| 6. Bent shafting | Remove and straighten bent shaft, consider replacing bent shaft |
| 7. Worn pump bearings | Pull pump and inspect for bent shaft, straighten bent shaft, replace wear ring, remove any abrasive material, adjust Impeller setting per Peerless recommendations |
| 8. Clogged impeller or foreign material in pump | Disassemble pump, inspect and remove foreign material, reassemble and set impeller with correct lateral settings |
| 9. Improper impeller balance | Remove Impellers and balance per Peerless Pump recommendations |
| 10. Vortex problems in sump | Adding of baffels or flow direction devices can reduce this. |
| 11. Resonance – system frequency at or near pump speed | Stiffening or softening the system can be accomplished by many different methods. |

Abnormal Noise

- | | |
|--|--|
| 1. Motor noise | |
| 2. Pump bearings running dry | Check for minimum submergence, ensure min water level is above the centerline of first stage impeller |
| 3. Broken column bearing retainers | Remove and replace bearing retainers, consider replacing bearings |
| 4. Broken shaft or shaft enclosing tube | Disassemble pump and replace |
| 5. Impeller dragging on bowl case | Adjust Impeller setting per Peerless recommendations |
| 6. Cavitation due to low submergence or operation beyond maximum capacity rating | Increase submergence |
| 7. Foreign material in pump | Disassemble pump, inspect and remove foreign material, reassemble and set impeller with correct lateral settings |

TROUBLE SHOOTING GUIDE FOR VERTICAL PUMPS

Running

1. The pump should be shut down at once, and the trouble corrected (refer to Table 1 - Fault Finding Chart), if the pump is running at rated speed and any of the following defects occur:
 - a) No liquid delivered.
 - b) Not enough liquid delivered.
 - c) Not enough pressure.
 - d) Loss of liquid after starting.
 - e) Vibration.
 - f) Motor runs hot.
 - g) Cavitation (noise).
 - h) Pump bearing overheat.

2. While the pump is running a periodic inspection should be made of:
 - a) Bearing housing temperature.
 - b) With soft packed stuffing box, check that there is sufficient leakage to lubricate the packing.
 - c) With mechanical seal fitted check that there is no leakage from stuffing box.
 - d) Suction gauge reading (if fitted).
 - e) Discharge gauge reading (if fitted).

Stopping

1. Slowly close delivery valve and shut down driving unit in accordance with manufacturers' instructions.

2. Shut off external sealing liquid supply, if specified, to relieve stuffing box pressure.

3. Successful operation of the pumps depends on accurate alignment. It is recommended to recheck the alignment after preliminary running.

Faults and Remedial Action (Table 1)

POTENTIAL FAULT OR DEFECT:						
No liquid delivered.						
Insufficient liquid delivered.						
Liquid delivered at low pressure.						
Loss of liquid after starting.						
Pump bearings run hotter than normal.						
Motor runs hotter than normal.						
Excessive noise from pump cavitation.						
Excessive vibration.						
PROBABLE CAUSES						
*						Pump not primed.
*	*	*				Speed too low.
				*	*	Speed too high.
	*	*				Air leak in mechanical seal.
		*	*		*	Air or gas in liquid.
	*	*		*		Discharge head too high (above rating).
*	*	*		*	*	Not enough NPSHa.
	*	*		*		Viscosity of liquid greater than rating
				*		Liquid density higher than rating.
*	*	*		*	*	Insufficient submergence.
*	*				*	Impeller blocked.
*	*	*				Wrong direction of rotation.
	*	*				Excessive impeller clearance.
	*	*			*	Damaged impeller.
				*		Rotor binding.
				*		Defects in motor.
				*		Voltage and/or frequency lower than rating.
			*			Lubricating grease or dirty oil or contaminated.
					*	Foundation not rigid.
			*	*	*	Misalignment of pump and driver.
			*			Bearing worn
			*		*	Rotor out of balance.
			*	*	*	Shaft bent.
	*					Impeller too small.

MAINTENANCE INSTRUCTIONS

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IMPORTANT SAFETY PRECAUTIONS

Pump parts, tools, and rigging equipment used in installing pumps are heavy and may easily cause personal injury if dropped or carelessly handled. The normal precautions and safety rules associated with the erection of heavy machinery, use of power equipment, manual lifting, and handling of tools must be observed in the installation of this pump.

Do not work under a heavy suspended object unless there is a positive support under it to stop its fall in event of sling or hoist failure. Disregard of this warning could result in grave personal injury.



Before opening the conduit box of an electric motor, be certain that the current to the motor is shut off and the breakers are locked out. An electrical shock from contact with live motor leads can be fatal.

The motor canopy (cover) must be in place when the pump is in operation. If exposed, rotating parts below this cover could cause grave personal injury.

Petroleum-based cleaning solvents are flammable. Smoking by personnel in the vicinity of these solvents is extremely hazardous and must not be permitted. Also, in many areas, the use of these contaminating and hazardous solvents is illegal. Consult the local EPA/Air Quality officials for instructions.

The pumps described in this manual should not be installed in any manner except as specified herein, and must not be operated at speeds, capacities, pressures, or temperatures other than those specified on this the order.

These pumps must not be used to pump any fluid other than those specified for the order.

Violation of this warning will void the manufacturer's warranty and may result in serious property damage or grave personal injury.

SUGGESTED MAINTENANCE SCHEDULE

Date	Activity	Maintenance Frequency*	Signature
Pump			
	Check pump packing for adequate leakage	Daily	
	Check and lubricate pump packing as needed	Monthly	
	Check pump discharge flow and head to ensure operation within acceptable range	Annually	
	Replace packing when leakage cannot be controlled by tightening the packing gland	As Needed	
Motor (see specific manufacturer instructions)			
	Check oil level and refill as needed	Weekly	
	Inspect oil in reservoirs for condensation; flush and refill if condensation is present	Monthly	
	Check vibration monitors to ensure operation within acceptable limits	Monthly	
	Lubricate bearings	Quarterly	
	Change oil	Annually	
	Test resistance of winding insulation per IEEE-43 instructions (DANGER – USE EXTREME CAUTION!)	As required by IEEE	

*FREQUENCY DETERMINED BY CONDITIONS OF OPERATION.

ABRASION AND CORROSION

Definitions

Corrosion means “eating away by degrees by chemical action”. Abrasion is “the process of rubbing or wearing away by friction”. A pump’s performance can be reduced and eventually destroyed by corrosion or abrasion—or a combination of the two, commonly called erosion, which means “a gradual wearing away”.

Corrosion alone

When metallic corrosion alone is adversely affecting pump performance, the solution is to select material that will corrode very slowly when in contact with the fluid being pumped. Protective coatings can also reduce corrosion in some applications.

Corrosion and Abrasion Working Together

Great difficulties arise when corrosion and abrasion are both present. All metals rely on a thin oxide film or “skin” to protect them against corrosive chemical agents in fluids. If a corrosive fluid contains hard abrasives—even in small amounts—then abrasion will eventually wipe away the protective skin and the metal will corrode, forming a new skin. As long as the abrasives are harder than the corroded skin, this process of wear and corrosion will continue until the metal is eroded away. Fluid velocity inside the pump affects this erosive cycle. Lowering internal velocity—by slowing the pump speed or over-sizing the pump for the design conditions—will reduce abrasion and slow down erosion.

Sand-Locked Pump:

If, for any reason, the pump is stopped while pumping water containing sand, the pump may become “sand-locked”. Sand-locking is the condition that occurs when the clearances between the impellers and bowls are packed with sand, which settles in the bowl unit after the pump stops rotating and the water drains back into the well.

If a sand-locked pump is restarted, severe damage may result.

If a pump is accidentally stopped while pumping sandy water, sand-locking may be overcome by the following procedure:

1. As soon as the pump shaft stops rotating, raise the impellers to their top position.
2. Alternately raise and lower the impeller a small amount to loosen the trapped sand.
3. Rotate the shaft alternately clockwise and counterclockwise by applying a wrench to the drive coupling. This too has the effect of loosening the sand, permitting it to fall back into the well.
4. If a separate water supply is available, flush the pump with clear water.

If all attempts to free the impellers fail, it will be necessary to pull the pump. The obstruction can then be cleared by back-flushing, or, if necessary, by disassembling the bowl unit.

Defense is the Best Offense

The best defense is your own experience on any given unit. Good records are a necessity. Each pump should be checked for vibration and amperage periodically. This information, along with the shutoff head, should be noted in the permanent record. Any changes should be cause for investigation. Any repairs should be noted with complete description of parts used, materials, and condition of the parts being replaced.

With this type of record, it is possible to keep track of improvements in performance and to be aware of what materials or actions brought them about. Without such information, it is impossible to be certain that a solution is correct for a particular application, and expensive parts could be lost. Defending against corrosion is a never-ceasing battle to extend the life of the equipment. Your Sterling-Peerless service center maintains detailed records and analyses on pump repairs to determine changes that will improve pump operating life.

CAVITATION

Cavitation occurs when the absolute pressure of a moving liquid is reduced to a value equal to (or below) the vapor pressure of the liquid. Small vacuum pockets or bubbles form, then collapse in the area where pressure increases in the impeller. The collapse of these vapor pockets is so rapid that it makes a rumbling or crackling noise—like rocks passing through the pump. The forces in the collapse are generally high enough to cause minute pockets of fatigue on metal surfaces adjacent to bubbles. This action may be progressive and under severe condition can cause serious pitting damage on the metal subject to cavitation attack.

Cavitation takes place along the impeller vane tips and vane surfaces, as shown in Fig. 1. Cavitation can cause the following problems:

- Reduced pump capacity
- Erratic power consumption
- Noisy operation
- Damage to impeller
- Pitting suction inlet vanes and impaired casting strength

Note: The same type of damage can result from recirculation caused by operating the pump away from the best efficiency point (BEP).

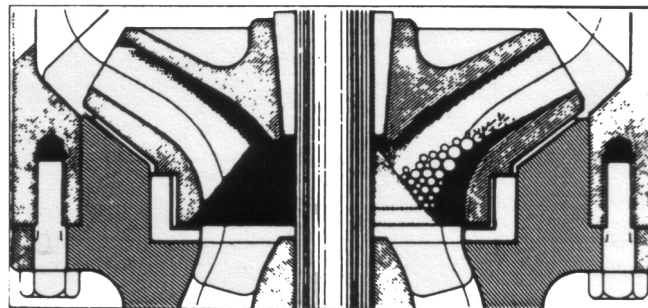


Figure 1. Cross-sectional view of cavitation.

How to Prevent Cavitation in Existing Installations

Cavitation can be avoided by providing sufficient net positive suction head (NPSH) for the pump. However, this may be an expensive correction in the field. An alternate solution is to reduce the NPSH requirement of the pump by one of the following methods:

- Evaluate system head condition, NPSH available, and, if possible, reduce pump capacity.
- Change impellers to obtain low NPSH design.
- Replace the pump assembly with a different model capable of operating with the system NPSH available.

Contact a Sterling-Peerless service center for assistance in evaluating your system NPSH and recommended solution. Frequently, Sterling-Peerless low NPSH impeller assemblies can be furnished to fit your existing vertical pumps

MOST EFFICIENT BEARING AND IMPELLER CLEARANCES

**All current vertical turbine pump models are represented,
and some obsolete models are also shown.**

B = DISTANCE FROM BOTTOM OF IMPELLER TO END OF SHAFT (SUCTION CASE)

C = DISTANCE FROM BOTTOM OF IMPELLER TO END OF SHAFT (SUCTION BELL)

D = DIAMETRICAL CLEARANCE BETWEEN SHAFT AND BEARINGS

E = DIAMETRICAL CLEARANCE BETWEEN IMPELLER SKIRT AND BOWL SIDE SEAL

(Dimensional references only; no guarantees implied. Information subject to change without notice.)

Size	Model	Shaft Dia.	B	C	D (max.)	D (min.)	E (max.)	E (min.)	Best Lateral
4	LE	0.75	5.19	-	0.006	0.005	0.010	0.006	0.125
6	HXB	0.88	4.56	-	0.007	0.006	0.012	0.008	0.125
6	LB	0.88	3.38	3.38	0.007	0.006	0.011	0.007	0.063
6	MA	0.88	6.56	3.69	0.007	0.006	0.015	0.010	0.125
7	HXB	1.00	5.63	-	0.007	0.006	0.012	0.008	0.125
7	LA	1.00	6.50	4.06	0.007	0.006	0.012	0.008	0.125
7	LB	1.00	7.00	7.00	0.007	0.006	0.018	0.012	0.125
8	HDX	1.19	6.38	-	0.007	0.006	0.018	0.012	0.063
8	HDX (w/o ring)	1.19	6.13	-	0.007	0.006	0.018	0.012	0.063
8	HXB	1.19	5.44	-	0.007	0.006	0.012	0.008	0.063
8	LB	1.19	4.38	4.38	0.007	0.006	0.012	0.008	0.125
8	MA	1.19	7.63	3.94	0.007	0.006	0.012	0.008	0.125
8	MFH	1.19	Keyed	-	0.007	0.006	-	-	0.012
9	LA	1.19	8.00	4.75	0.007	0.006	0.012	0.008	0.125
10	HH	1.50	8.88	8.88	0.007	0.006	0.012	0.008	0.125
10	HXB	1.50	8.25	4.81	0.007	0.006	0.012	0.008	0.188
10	LB	1.19	8.19	8.19	0.007	0.006	0.012	0.008	0.125
10	MA	1.19	8.00	4.31	0.007	0.006	0.012	0.008	0.125
10	MF	1.00	Keyed	Keyed	0.007	0.006	-	-	0.012
10	MFH	1.50	Keyed	Keyed	0.007	0.006	-	-	0.125
10	PL	1.19	Keyed	Keyed	0.007	0.006	-	-	0.125
11	MB	1.94	9.25	-	0.007	0.006	0.015	0.011	0.125
12	HD	1.94	8.88	-	0.009	0.006	0.012	0.008	0.125
12	HD (w/o ring)	1.94	8.63	-	0.009	0.006	0.012	0.008	0.125
12	HXB	1.50	9.75	2.25	0.009	0.006	0.012	0.008	0.125
12	HXH	1.94	8.44	8.44	0.009	0.006	0.012	0.008	0.063
12	LB	1.50	7.81	7.81	0.007	0.006	0.013	0.008	0.125
12	LD	1.50	7.06	7.06	0.011	0.009	0.015	0.010	0.188
12	LD (w/o ring)	1.50	6.75	6.75	0.011	0.009	0.015	0.010	0.188
12	LDT	1.50	7.13	7.13	0.011	0.009	0.015	0.010	0.125
12	LDT (w/o ring)	1.50	6.88	6.88	0.011	0.009	0.015	0.010	0.125
12	MB	1.50	9.38	3.13	0.007	0.006	0.015	0.011	0.188
12	MF	1.19	Keyed	Keyed	0.007	0.006	-	-	0.012
12	PL	1.19	Keyed	Keyed	0.007	0.006	-	-	MIDDLE
14	HH	1.69	9.00	9.00	0.007	0.006	0.015	0.011	0.063
14	HXB	1.94	9.72	3.44	0.008	0.007	0.016	0.010	0.125
14	LA	1.94	10.38	7.06	0.008	0.007	0.012	0.008	0.125
14	LC	1.94	9.56	9.56	0.008	0.007	0.012	0.008	0.125
14	LD	1.94	8.38	8.38	0.009	0.008	0.017	0.013	0.063

Size	Model	Shaft Dia.	B	C	D (max.)	D (min.)	E (max.)	E (min.)	Best Lateral
14	LD (w/o ring)	1.94	8.06	8.06	0.009	0.008	0.017	0.013	0.063
14	MD	1.94	9.88	7.50	0.010	0.007	0.016	0.010	0.125
14	MF	1.50	Keyed	Keyed	0.007	0.006	-	-	0.015
14	MFAH	1.50	Keyed	Keyed	0.007	0.006	-	-	0.015
14	PL	1.50	Keyed	Keyed	0.007	0.006	-	-	MIDDLE
15	LC	2.19	9.25	9.81	0.012	0.010	0.012	0.008	0.125
15	MA	2.19	9.81	-	0.012	0.010	0.015	0.011	0.125
16	HH	1.94	9.75	9.75	0.008	0.007	0.015	0.011	0.063
16	HXB	1.94	9.50	9.50	0.008	0.007	0.015	0.011	0.125
16	MC	1.94	9.75	9.75	0.008	0.007	0.018	0.012	0.063
16	MF	1.69	Keyed	Keyed	0.007	0.006	-	-	0.018
16	PL	1.50	Keyed	Keyed	0.007	0.006	-	-	MIDDLE
18	HH	2.19	Keyed	Keyed	0.012	0.010	0.019	0.012	0.063
18	HXB	1.94	8.38	8.38	0.008	0.007	0.015	0.011	0.063
18	MA	1.94	11.13	6.31	0.012	0.010	0.021	0.015	0.063
18	MF	1.94	Keyed	Keyed	0.010	0.007	-	-	0.018
18	MFAL	-	Keyed	Keyed	0.010	0.007	-	-	0.018
18	PL	1.50	Keyed	Keyed	0.007	0.006	-	-	MIDDLE
20	HH	2.19	Keyed	Keyed	0.013	0.010	0.019	0.015	0.063
20	HXB	2.19	10.56	10.56	0.013	0.010	0.018	0.014	0.063
20	MA	2.19	11.75	11.75	0.012	0.010	0.015	0.010	0.063
20	MF	1.69	Keyed	Keyed	0.007	0.006	-	-	0.020
20	MFAL	2.19	Keyed	Keyed	0.013	0.010	-	-	0.020
20	PL	1.50	Keyed	Keyed	0.007	0.006	-	-	MIDDLE
24	HH	2.44	Keyed	Keyed	0.013	0.010	0.019	0.015	0.031
24	HHOH	2.44	Keyed	Keyed	0.013	0.010	-	-	0.125
24	HXB	2.19	Keyed	Keyed	0.013	0.010	0.019	0.015	0.125
24	HXC	2.19	Keyed	Keyed	0.013	0.010	0.019	0.015	0.125
24	MA	2.44	Keyed	Keyed	0.013	0.010	0.018	0.014	0.063
24	MF	2.44	Keyed	Keyed	0.013	0.010	-	-	0.020
24	MFH	2.44	Keyed	Keyed	0.013	0.010	-	-	0.020
24	PL	1.69	Keyed	Keyed	0.007	0.006	-	-	MIDDLE
26	HH	2.94	Keyed	Keyed	0.013	0.010	0.019	0.015	0.125
26	HHOH	2.94	Keyed	Keyed	0.013	0.010	-	-	0.031
26	HXB	2.94	Keyed	Keyed	0.013	0.010	0.019	0.015	0.063
27	MA	2.94	Keyed	Keyed	0.013	0.010	0.020	0.016	0.063
28	HXB	2.94	Keyed	Keyed	0.013	0.010	0.021	0.017	0.031
30	HH	2.94	Keyed	Keyed	0.013	0.010	0.022	0.018	0.125
30	HHOH	2.94	Keyed	Keyed	0.013	0.010	-	-	0.031
30	LA	2.69	Keyed	Keyed	0.013	0.010	0.021	0.015	0.063
30	MF	1.69	Keyed	Keyed	0.007	0.006	-	-	0.026
30	MFAH	2.44	Keyed	Keyed	0.013	0.010	-	-	0.026
30	MFH	-	Keyed	Keyed	0.013	0.010	-	-	0.026
30	PL	2.19	Keyed	Keyed	0.013	0.010	-	-	MIDDLE
32	HXB	3.69	Keyed	Keyed	0.014	0.012	0.021	0.017	0.031
36	HH	3.69	Keyed	Keyed	0.014	0.012	0.025	0.015	0.125
36	HHOH	3.69	Keyed	Keyed	0.014	0.012	-	-	0.031
36	HXB	3.94	Keyed	Keyed	0.014	0.012	0.022	0.018	0.125
36	MA	3.69	Keyed	Keyed	0.014	0.012	0.018	0.014	0.125
36	MF	3.44	Keyed	Keyed	0.013	0.010	-	-	0.029
36	MFH	3.44	Keyed	Keyed	0.013	0.010	-	-	0.029
36	PL	2.44	Keyed	Keyed	0.013	0.010	-	-	MIDDLE
42	HH	-	Keyed	Keyed	0.014	0.012	0.025	0.015	0.125
42	HXB	3.94	Keyed	Keyed	0.014	0.012	0.022	0.018	0.125
42	MF	3.44	Keyed	Keyed	0.013	0.010	-	-	0.036
42	MFH	3.44	Keyed	Keyed	0.013	0.010	-	-	0.036

Size	Model	Shaft Dia.	B	C	D (max.)	D (min.)	E (max.)	E (min.)	Best Lateral
42	PL	2.44	Keyed	Keyed	0.013	0.010	-	-	MIDDLE
48	HH	3.94	Keyed	Keyed	0.016	0.012	0.028	0.019	0.125
48	HHOH	3.94	Keyed	Keyed	0.016	0.012	-	-	0.047
48	HXB	3.94	Keyed	Keyed	0.014	0.012	0.025	0.019	0.125
48	MF	3.44	Keyed	Keyed	0.013	0.010	-	-	0.042
48	PL	2.69	Keyed	Keyed	0.013	0.010	-	-	MIDDLE
54	MF	3.94	Keyed	Keyed	0.014	0.012	-	-	0.048
54	PL	3.19	Keyed	Keyed	0.013	0.010	-	-	MIDDLE
56	HH	4.25	Keyed	Keyed	-	-	-	-	0.063
56	HHOH	4.25	Keyed	Keyed	0.016	0.012	-	-	0.047
60	PL	3.94	Keyed	Keyed	0.014	0.012	-	-	MIDDLE
66	HH	-	Keyed	Keyed	-	-	-	-	0.063
66	MF	4.94	Keyed	Keyed	0.016	0.012	-	-	0.054

DISASSEMBLING THE PUMP

Do not attempt to lift the entire pump by the lifting lugs of the driver. These lugs and the bolts attaching the driver to the pump cannot support the weight of the entire pump.

Do not work under a heavy suspended object unless there is a positive support under it to stop its fall in the event of sling failure. Disregard of this warning could result in grave personal injury.



Clear a large area adjacent to the pump as a storage space for pump parts as they are disassembled. Arrange parallel timbers on the ground in the cleared area to support the pump column and shaft sections horizontally.

Disconnect the discharge piping from the discharge head. If the driver is equipped with an oil-cooling system, remove the external tubing or piping used for this purpose. On pumps equipped with an air-pressure water level testing system, remove the gauge and disconnect the tubing connection inside the discharge head. Some pumps have this connection below the base, in which case the tubing will be disconnected later.

Remove the electrical connection of the motor at the conduit box.

Before opening the conduit box of an electric motor, be certain that the current to the motor is shut off. An electrical shock from contact with live motor leads can be fatal.

Remove the driver from the discharge head in the following manner:

1. Remove the driver cover.
2. Remove the lock screws, the top shaft nut, the gib key, and the top drive coupling.
3. Remove the driver mounting screws.
4. Attach the hoist sling to the lifting lugs of the driver and lift it off the discharge head.
5. Place the driver on clean wooden blocks in the storage area.

Remove the top shaft seal ring from the pump shaft by sliding it up over the top.

Disassemble the packing. Remove the gland retaining bolts or nuts and the two gland clamps. Lift off the split gland. Pull out the packing rings, using a special packing removal tool or a hooked pointed wire.

If the packing assembly includes a lantern ring or a compression spring and a washer, or a bushing, remove these. Be sure to remove any packing rings that might be below the lantern ring.

If the packing container is a separate casting (not integral with the discharge head), remove the cap screws in the packing container flange, and lift off the packing container. Remove the gasket.

Remove the cap screws or nuts holding the discharge head to the sole plate or to the foundation. Attach the sling to the lifting ears of the discharge head, or through the hand-holes if the head is fabricated, and hoist the entire pump straight upward to bring the discharge head base to a comfortable working height. If the pump has an air line with a connection point below the base, disconnect the line at this time.

Follow the instructions given in the [FWP-1 Installation & Operating Instructions](#), in reverse order:

1. Remove the discharge head.
2. Remove the top column section using an elevator clamp.
3. Remove the bearing retainer.
4. Remove the top shaft section.
5. Remove other column sections, shaft sections, and bearing retainers in the same manner.
6. Pull the bowl unit from the well or sump.

IMPELLER CLEARANCE ADJUSTMENT

Lock out the electrical power source before working on the pump.

With the top drive coupling securely fastened to the motor rotor, check the gib key fit to the top shaft keyway. The key fit should be such that one can slide the key inside the shaft keyway by hand.

Rotate the top drive coupling until its keyway is aligned with the top shaft keyway. The key must fit snugly against the sides of the keyways, but must have a slight clearance with the bottom of each keyway. File the key, if necessary, with a smooth mill file to obtain the proper fit. Coat the gib key with anti-seize compound and install in keyway (see Fig. 2).

Prior to installing the brass adjusting nut, take a marking pen and scribe radial marks from all the drilled and tapped holes to the outside circumference. These marks will allow you to more easily locate the holes after the top adjusting nut is installed.

At this time, attempt to manually rotate the pump and motor counter-clockwise. No rotation should be possible if all the threaded line shaft is mated and the impeller is resting on the suction manifold. If any free rotation of the pump and motor can be made, it is an indication that the line shaft has come unscrewed. If possible, try to determine the location of the loose line shaft. If this is not possible, continue to rotate the pump and motor counter-clockwise until it stops.

On small pumps at short settings where the rotating element of the pump is relatively light, rotation of the shaft may be felt but some resistance would be encountered (shaft would not freely spin).

Install the brass adjusting nut on the top shaft and screw down until it makes light contact with the face of the top drive coupling. Do not tighten yet.

Measure the distance from the face of the motor top drive coupling to the top of the top shaft. **Record this measurement.**

Turn the adjusting nut in a right-hand rotation until the dimension that was recorded is increased by 3/16", or by the recommended impeller clearance as shown in the [IMPELLER CLEARANCES CHART](#). After the pump has operated for a minimum of one hour, or when the water is clear of foreign material, the impeller clearance can be reset if so desired, but this is not required for normal pump operation.

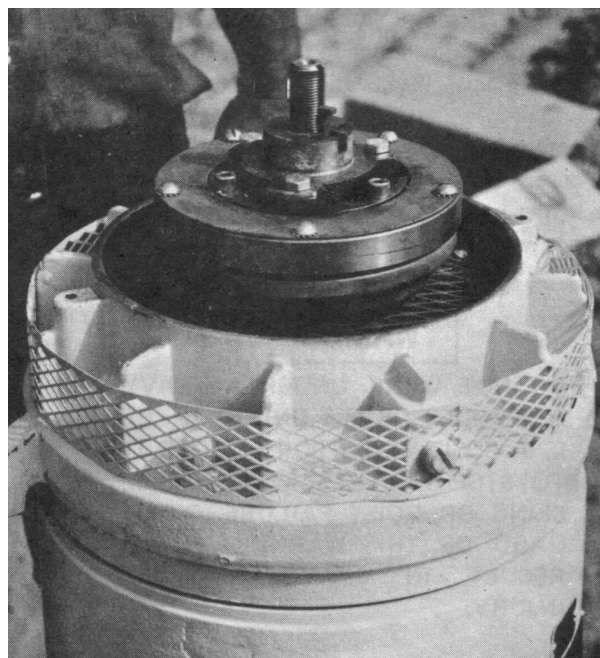


Figure 2. Gib key inserted into top shaft and top drive coupling.

A pump operating in a new well or sump can be run with its impellers in the mid-position, which is approximately 3/16 inch above the lateral bowl wear rings. This is to minimize the possibility of damage due to sand in the water. When the water is clear of sand, the impellers should be reset to the most efficient pumping position.

Verify free rotation of pump-motor shaft. It should rotate by hand freely. Align the holes in the adjusting nut with the radial marks indicating the location of the tapped holes in the top drive coupling.

Turn the nut slightly in either direction, if necessary, to align two of the holes 180° apart in the adjusting nut with the tapped holes in the top drive coupling.

Install the adjusting nut retaining bolts and tighten.

Replace the motor canopy prior to putting the pump in operation.

Note: The impellers must be adjusted before any attempt is made to start the pump.

After freedom of rotation is verified, the lock out on the electrical power should be removed and the pump is now ready for start-up.

The driver cover must be in place when the pump is in operation. Rotating parts below this cover could cause grave personal injury if exposed.

RECOMMENDED LUBRICANTS

(3600 RPM maximum; -20 to +120 degrees F.)

Manufacturer	Product
American Oil Co.	AMOCO Lithium Grease All- Weather
Atlantic Richfield Co.	ARCO Multipurpose Grease
Cato Oil & Grease Co.	Mystik JT-6
Cities Service Oil Co.	Citgo H-2
Continental Oil Co.	EP Conolith No. 1 (-20°F to +40°F) EP Conolith No. 2 (+40°F to +120°F)
Gulf Oil Co.	Gulfcrown No. 2 or Ep 2
E.F. Houghton & Co.	Cosmolube No. 2
Exxon	Lidok Ep2
Hydrotex	Deluxe No. M-33 Super Shield
Imperial Oil & Grease Co.	Molub-Alloy No. 1
Keystone Div., Pennwalt Corp.	80 X LT
Mobil Oil Corp.	Mobilux Ep No. 2
The Pennzoil Co.	Pennzoil 705 HDW
Phillips Petroleum Co.	Philube IB & RB
Shell Oil Co.	Alvania EP Grease or Alvania EP Grease 1 for prolonged ambient below 0 degrees F.
Sun Oil Co.	Sunaplex No. 2 EP Prestige 42
Texaco, Inc.	Novatex Grease No. 2
Union Oil Co.	Unoba Ep-2

PUMP PACKING

Packing failure

What causes packing to fail prematurely? Some of the common causes are improper flushes, incorrect clearances, wrong selection of packing, faulty installation and maintenance, abrasive or corrosive conditions, insufficient lubrication, and leakage.

Abrasives in the fluids being pumped can be kept out of the packing box by using a flushing system. There are, however, other sources of abrasives such as scale in the pipe solids that might be left when water evaporates. These are just as damaging as abrasives in the fluid itself.

Packing installation

Before installing the packing container in the discharge head, check the centering of the shaft at the packing box bore. The shaft should be centered within 1/64". If it is not within that tolerance, the cause of the misalignment needs to be determined and corrected.

Clean the bore and counterbore in the head. A thin coat of lubricant can be used in the bore and on the gasket to facilitate the assembly. Place the packing container ring gasket in place, then slide the packing container over the shaft and lower it until it is seated on the gasket. Install and tighten the cap screws provided.

The arrangement of the packing (see Fig. 3) depends on the size of the discharge head, the diameter of the top shaft, and the pressure developed by the pump. Consult the assembly drawing for the correct arrangement for the particular pump being installed. Note that some pumps require a lantern ring and a compression spring in addition to packing rings.

Eliminating pressure differentials as much as possible is another way of prolonging packing life, since leakage is directly proportional to pressure differences. One common way of accomplishing this is to use a throttle bearing below the packing and bleed off pressure through a bypass line.

Shaft runout also causes packing difficulties. Runout can be the result of a bent shaft, a shaft which flexes at high speeds, misalignment, or an unbalanced motor coupling.

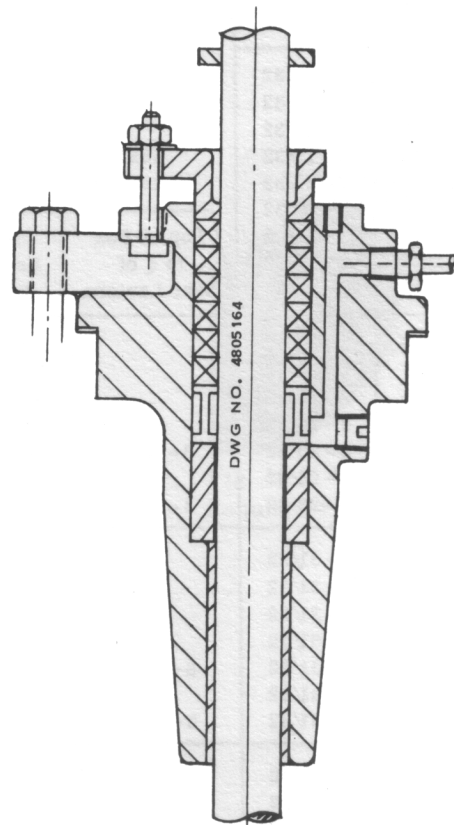


Figure 3. Typical packing container; consult assembly drawing for details on your particular packing arrangement.

Be sure the lantern ring (if used) is properly positioned; it should be in line with the drilling in the packing box.

To install a packing ring in the container, lubricate the ring on all sides and wrap it around the shaft, just above the container. Using your fingers, start the ring into the container. Be sure that the ends of the ring do not overlap. When the entire ring is worked flush with the top of the container, carefully and evenly tamp it down into place with your fingers. The gland or split gland may be used as a tamper for the topmost ring.

Install the required number of packing rings in this manner. Install packing rings with the gaps 180 degrees apart (on opposite sides of the shaft).

The last ring may have to be installed later, after a period of operation.

In packing arrangements which use springs, be sure not to omit the washer between the spring and the bottom packing ring.

Place the gland or split-gland in the packing container. Insert the gland retainer bolts in the slots in the packing container. If the gland is split, place a clamp over the end of each gland bolt so that it holds the two halves of the gland together. Install nuts on the gland bolts and turn them finger-tight only. Final adjustment of the packing gland is done after the pump is started.

If there is no shaft coupling between the motor and packing container, install the top shaft water deflector (“water slinger”) over the top shaft, and position it a short distance above the gland but well below the driver mounting surface of the discharge head. This water deflector is important, as it will help protect the driver from the spray if there is a major leakage through the packing.

On pumps furnished with a pressure-type lubricant fitting at the packing container, apply the lubricant with a lubricant gun until lubricant starts to come out around the gland. In addition to its lubrication value, the lubricant will help to limit the amount of fluid leakage.

Certain pumps which operate at relatively high pressures are equipped with a pressure by-pass. Connect the tubing provided for this purpose to the tube fitting in the side of the packing container. Route the other end of the tube back to the well or sump.

Packing maintenance:

On packing containers equipped with a zerk (grease) fitting, you can pump about five strokes of a grease gun into it. If the static water level in the pump is 50 feet or greater, it is recommended to use ten strokes of the grease gun. The grease installed at the time of pump start-up will provide lubrication to the bearings and packing rings until the water reaches the discharge head. There is no need to add additional grease while the pump is operational. If the pump remains idle for one month or longer, it is recommended that additional grease be added as described above.

It is critical to permit enough leakage to keep the packing container running cool. Check for overheating. If the pump runs hot and leakage begins to diminish, stop the pump and permit it to cool down.

Excessive tightening on the gland nuts is dangerous: the resulting inadequate leakage and lubrication not only burns the packing, but damages the shafts.

Maintain an adequate water flow to the packing but do not overpressurize. This will cause excessive leakage and over-tightening of the packing, thus damaging the packing and other pump components.

Make sure the gland nuts are only finger-tight. Allow the pump to run approximately 15 minutes. If the leakage rate is more than desired, slightly tighten the gland nuts. **The packing adjustment is made only with the pump running.** Before making another adjustment, allow the packing to equalize against the increased pressure and permit leakage to decrease gradually to a steady rate.

Pump packing must always leak slightly, but never to the extent of a spray.

New packing will run a little warmer for the first few hours until the packing has seated. Again, do not over-tighten the gland nuts. The resulting inadequate leakage and lubrication will burn the packing and damage the shafts.


When the packing has been compressed to the point that the gland is about to contact the upper face of the packing container, remove the gland, add one more packing ring, and re-adjust. If this fails to reduce leakage to the desired amount, remove all of the packing rings, and repack with new rings.

Packing removal:

Loosen and remove the gland nuts and washers.

Remove the two (2) gland halves.

Find the split in the first ring of packing and insert the cork screw end of the packing puller toward the end of the packing ring. Remove the ring by pulling upward and away from the split. Use the same method to remove the other rings.

If your pump is equipped with a lantern ring, this is easily removed by inserting two (2) metal rods with a bent hook (i.e., ) into the holes on the face of the lantern ring. Pull evenly on both rods so as not to cock the lantern ring in the bore of the entrance. Note: this rod can be made from metal wire coat hanger.

Thoroughly clean the outer and inner surfaces of the packing container bore. Inspect the shaft for wear or deep grooves.

Replacement packing:

If the replacement packing is in the form of a continuous coil or rope, it must be cut into rings before installing. This can be done by tightly wrapping one end of the packing material around the top shaft like one coil of a coil spring, and marking the coil with a sharp knife.

The ends should meet with little or no gap. The packing rings provide better sealing if the ends are cut on a 45° angle. After cutting on the mark, this length of packing may be used as a template for cutting all the other rings.

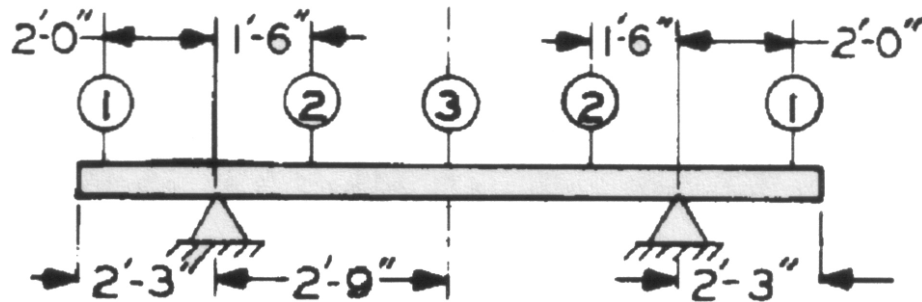
RUNOUT (ECCENTRICITY IN SHAFTS)

All shafting must be straight for proper pump operation. Provide a solid mounting for a dial indicator at the points labeled 1, 2, and 3 in Fig. 4. Place a shaft on the rollers or vee-blocks and rotate it slowly by hand while checking the eccentricity (run-out) at points 1, 2 and 3. Check all of the shaft sections in this manner.

Do not use any shaft section that exceeds the limits given in Fig. 4.

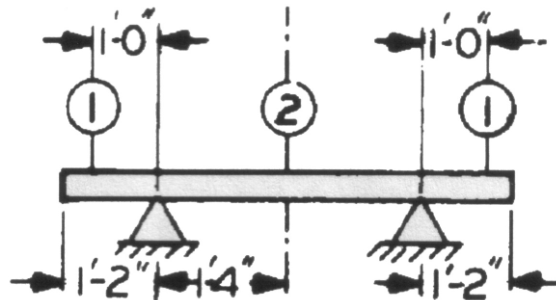
Rejected shaft sections may be straightened.

All re-straightened shaft sections must have a cleanup cut machined on both ends. Re-straightened shaft sections must be rechecked for eccentricity.



10 FOOT SHAFT SECTION

MAX. PERMISSIBLE RUN-OUT TOTAL INDICATOR READING (inches)		
LOCATION	5 FT.	10 FT.
①	.002	.004
②	.004	.004
③	----	.006



5 FOOT SHAFT SECTION

Figure 4. Verification of shaft straightness.

CARE OF VERTICAL PUMP SHAFTING

Proper selection of shaft materials, shaft finish under bearings, machining and straightening are vital functions of vertical pump manufacturing.

Vertical pump shafting materials are carefully selected for physical properties.

Shaft threads must be machined parallel and concentric, and shaft ends must be machined and faced perfectly square.

Shafts must be straightened to .0005 in./ft. total runout. Example: A ten-foot shaft cannot exceed .005 in. total runout.

Finally, careful handling of all shafting prior to and during assembly and installation is necessary to avoid bent shafting which will cause premature pump failure.

STARTING THE PUMP

Before attempting to start the pump, check the water level in the well or sump to be sure that the first impeller of the pump is submerged. **Do not operate the pump if the first impeller is above the standing water level. In this condition, the pump cannot be expected to pump water, and severe damage to the pump may result.**

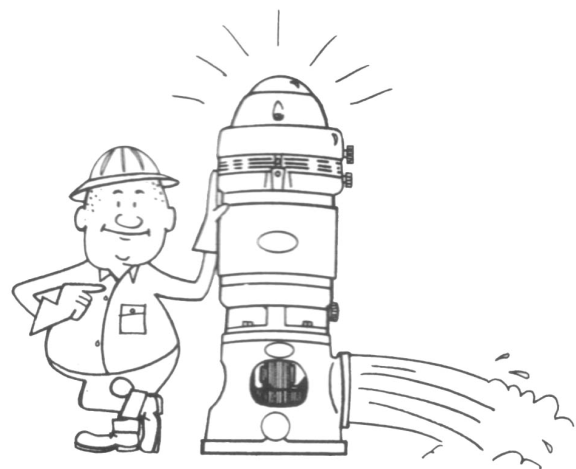
Before attempting to start the pump, check the readiness of the following items:

- Grease fitting at packing (if applicable)
- Lubrication of the driver
- Oil-cooling connections for the driver (if applicable)
- Wiring of electric motor (if applicable)
- Impeller adjustment
- Discharge piping connection
- Shut-off valve in discharge pipe – should be ¼ open

After the pump is started, check for any unusual noises and excessive vibration. If either is present, shut the pump down and investigate the cause of the problem.

If the pump is started with the check valve open and the pump is operating against the system head, slowly open the discharge valve until the pump is operating at its designed discharge pressure. If the system head was correctly calculated, the pump should operate at its design condition with the discharge valve completely open.

Operation of the pump away from its intended design conditions could have adverse effects on its efficiency and service life.



LONG-TERM STORAGE OF VERTICAL PUMPS

Preservation/packaging:

Coat exposed/extended section of impeller shaft, shaft coupling, column pipe coupling (or flange) and all exposed machine surfaces that are not painted. Coating shall be KENDCOTE – 60 or equal.

Coat column threads and inside couplings (or flange) faces with KENDCOTE – 60 or equal.

Coat column shafting if steel or 400 series stainless on all surfaces with KENDCOTE – 60 or equal.

Coat discharge head machined surfaces I.E. flange face and register surface for top column flange, motor and packing container with KENDCOTE – 60 or equal.

Apply KENDCOTE – 60 or equal to all machined surfaces of packing container if not installed.

Place packing rings in plastic bag and secure to pump discharge head.

Cover pump suction with cardboard or wood, do not seal air tight.

Cover equipment with a vented or breathable material to prohibit the build up of dust and dirt.

Notes:

Stainless steel 300 series or better components should not be painted and do not require the above preservation.

KENDCOTE – 60 is removed by using petroleum-based solvent.

Storage:

Store the equipment in as protected an area as is available. If the pump **is not** designed for water flush to the bearings, before placing the pump in service, remove the suction manifold. Remove and flush out all of the original grease. Install new grease in the bearings and reinstall the suction manifold.

TROUBLESHOOTING

<i>Trouble Indicators and Possible Causes</i>	
<p>Insufficient Pressure</p> <ol style="list-style-type: none"> 1. Speed too slow (check voltage) 2. Improper impeller trim 3. Impeller loose 4. Cavitation 5. Wear rings worn 6. Leak in the discharge piping system 7. Leaking column joints or bowl castings 8. Wrong rotation 	<p>Insufficient Capacity</p> <ol style="list-style-type: none"> 1. Speed too slow 2. Improper impeller trim 3. Impeller loose 4. Impeller or bowl partially plugged 5. Leaking joints 6. Strainer partially clogged 7. Suction valve throttled 8. Low water level in sump 9. Wrong rotation
<p>No Liquid Delivered</p> <ol style="list-style-type: none"> 1. Pump suction broken (water level below bell inlet) 2. Suction valve closed 3. Impeller plugged 4. Strainer clogged 5. Wrong rotation 6. Shaft broken or unscrewed 7. Impeller loose 	<p>Using Too Much Power</p> <ol style="list-style-type: none"> 1. Speed too high 2. Improper impeller adjustment 3. Improper impeller trim 4. Pump out of alignment or shaft bent 5. Mechanical binding 6. Packing rings adjusted too tight
<p>Vibration</p> <ol style="list-style-type: none"> 1. Motor imbalance – electrical 2. Motor bearings not properly seated 3. Motor drive coupling out of balance 4. Misalignment of pump, casting, discharge head, column, or bowls 5. Discharge head misaligned by improper mounting or pipe strain 6. Bent shafting 7. Worn pump bearings 8. Clogged impeller or foreign material in pump 9. Improper impeller balance 10. Vortex problems in sump 11. Resonance – system frequency at or near pump speed 	<p>Abnormal Noise</p> <ol style="list-style-type: none"> 1. Motor noise 2. Pump bearings running dry 3. Broken column bearing retainers 4. Broken shaft or shaft enclosing tube 5. Impeller dragging on bowl case 6. Cavitation due to low submergence or operation beyond maximum capacity rating 7. Foreign material in pump

TROUBLESHOOTING—VERTICAL MOTORS

Please refer to specific manufacturer instructions; these troubleshooting issues are provided as a guideline only. For additional technical assistance, please contact the motor manufacturer's representative or the nearest authorized motor service facility

While an electric motor is a reliable machine, lack of maintenance and defects in design, manufacturing, or workmanship can sometimes occur. None of the protective devices available will provide maintenance or solve built-in motor defects, so it is worthwhile to know when to suspect the motor. Fortunately, a motor will tend to exhibit some signs of distress prior to a complete and catastrophic failure, and while it does take experience to recognize many of these symptoms, the following summary of possible motor problems can help prevent failure.

Mechanical Failures and Probable Causes

Vibration

- Excessive motor or pump imbalance
- Misalignment or eccentricity of rotating parts
- Open bars in motor rotor
- Mounting unstable or uneven
- Faulty bearings (improperly seated, pitted from long periods of idleness, fatigued)
- Uneven motor air gap
- Operation of spring-loaded spherical roller bearing motors with insufficient thrust load
- Oil whip

Motor noise

- Worn bearings
- Loose iron
- Fan noise
- Vibration
- Bearing noise: Bearing noise is a normal phenomenon, but experience

will tell when noise exceeds acceptable levels. Such excessive noise should be recognized as a symptom of impending bearing failure.

Motor drive coupling problems

- The most common complaint is failure of cap screws that hold the couplings. Motors are shipped with specially hardened cap screws which require proper values of torque when tightened to prevent shearing, but over-tightening puts excessive stress on the cap screw fasteners. Replacement cap screws should be SAE Grade 5 or the equivalent.
- Unbalanced drive coupling.

Oil Leaks

- Over-filling
- Foaming because of improper oil
- Leaks at fittings
- Cracked castings (rare)

Motor Bearing Failures

- Plate bearing failures: failure of oil film because of excessive thrust, rusting during storage, lack of cooling water.
- Sleeve bearing failures: rusting during storage, improper lubricants.
- Ball and roller bearing failure other than normal wear.
 - Improper, contaminated or deteriorated lubricant
 - Excessive loading
 - False brinelling during storage
 - Rusting
 - Misalignment
- Bearing overheating
 - Over-greased
 - Old grease
 - Overloading
 - Misalignment
- High temperature breakdown of lubricating oil.

VIBRATION

General

Almost all vertical pump vibration problems are reported as a vibrating motor regardless of the type of vibration. This occurs because the head and motor are the only parts observed by the user, and since the motor top is at the extremity, it exhibits the largest vibration amplitude. Vibrations below the pump base are seldom noted, nor do they seem damaging to the equipment. Normally on vertical pumps, below base and above base vibrations are isolated from each other by their stiff base configurations.

If a running pump is vibrating, feel by hand the motor-head, piping, and base to determine the maximum vibration amplitudes, including their locations and slopes from the maximum to nil. Usually the maximum is at the top of the motor, with amplitudes decreasing to near zero at the head or motor base. Sometimes a discharge pipe is vibrating more than the pump. Picturing the high amplitude locations and how the pump is vibrating aids in understanding the causes.

If a vibration analyzer is available, determine amplitudes on the motor and head in line and 90° to discharge (motor top and bottom, head top and bottom).

1. Slow down the pump. If it is an electric drive, just shut it off; if it is an engine drive, throttle it down. Be aware of how the vibration changes with speed.
 - If the vibration reduces gradually, it is a sign that unbalance, misalignment, or bent shafting is the cause.
 - If the vibration decreases immediately with the electrical power shutoff, the cause is electrical imbalance in the motor.
 - If the vibration disappears with only a small speed change, then the cause is probably a natural frequency or resonance problem. The unit is operating at or near the resonance frequency.
 - If the vibration is due to a resonance just below the operating speed, the vibration level will momentarily increase, then decrease quickly with unit slowdown. When a pump shudders in slowdown, the cause is generally passage through a resonance frequency. But do not jump to conclusions at this point; gather more data.
2. With the pump shut down, rotate the shaft by hand. If it is hard to rotate, the suspected causes are misalignment, bad fit, or a bent shaft. However, an easily rotated unit does not eliminate those causes, since small shafts can bend readily without load imposed on the bearings.
3. Disconnect the drive.
 - If the motor is a hollow-shaft, mark the position, remove the drive coupling, and note if the head shaft is centered. If not, misalignment has likely occurred due to mis-machining, a bent shaft, a bad fit between the motor and pump, excessive pipe strain on the head, or conduit strain on the motor.
 - On a solid-shaft motor, mark the position, disconnect the coupling, and note if the adjusting nut leans heavily to one side.

4. Run the drive disconnected.
 - Repeat the sequence detailed in the paragraph (1) on checking how vibration varies with motor speed and record the results.
 - If the vibration is the same, then only the motor-head area is likely to be involved. An unbalanced motor is the prime candidate.
 - If the vibration disappears, the cause is probably in the parts removed.
 - If a vibration analyzer is available, obtain amplitudes and frequency as before, shut off the unit, and again note vibration change with speed. Remember, only the head and motor are now involved in the vibration.
5. Check the operating history of the pump. When did the vibration begin? If the pump has always vibrated, the likely causes are misalignment, unbalance, or resonance problems. If the vibration only started recently, check for a clogged impeller, worn bearings, worn rings, or a change in the piping or base. Carefully observing and analyzing the operational and physical clues will usually reveal the cause. Even if you are not able to pinpoint the cause, the data you collect will help a qualified pump engineer to solve the problem and suggest corrective action.

Vibration Correction

Vibration correction should not be attempted without a Sterling-Peerless representative present.

Electric Motor

1. If you encounter “loose iron” or rotor eccentricity, contact the motor manufacturer and do not attempt repairs yourself.
2. Unbalance in the motor drive coupling.
 - a. Rotate the drive coupling on the hollow shaft and run the motor with the pump connected. Change locations until the minimum vibration point is located.
 - b. Field balance the hollow shaft for light balancing only, by trial and error adding washers under drive bolts. Start in line with a hollow shaft key and add a washer. If the vibration is less, you are in the right plane. Add more weight until it is smooth running or the vibration increases. If the vibration increases, change the bolt hole.
 - c. Using a vibration analyzer or balancer, weight may be added to or removed from the motor bearing shaft housing or the fan assembly until a proper balance is achieved.
 - d. Motor acceptability may be shop tested by running the motor on a thick rubber pad like those used in a NEMA motor vibration test.

Pump

Above-Base Discharge:

Check the easiest items first.

1. To check for a clogged impeller, run the pump and then let liquid backflush through the pump. This will not always work, however, since large debris and other pliable items will not necessarily flush out.
2. If you hear “metal hammering” noises that may indicate cavitation, check the intake for vortexes or swirls. Look over the installation plans for flow discontinuities since vortexes and swirls not visible at the water surface can still cause vibration. An example: a small propeller pump located just beyond a sharp step down in the sump floor in the suction approach of some large pumps. The small pump would run fine alone, but start the big pumps—and the small pump would lose performance and begin vibrating.
3. Look for off-center shaft conditions in housings, beginning with the motor.
 - a. Vertical hollow-shaft motor: Turn off the power and remove the drive coupling. If the shaft is not in the center of the motor hollow shaft, rotate the shaft 180 degrees. A bent shaft will follow rotation. Misalignment will cause the shaft to continue leaning in the same direction.
 - b. Vertical solid-shaft motor: Turn off the power and disconnect the motor/pump coupling. Take indicator readings on both the motor and pump shafts to determine if the cause is bent shafting or misalignment.
 - c. Continue checking for misalignment as you disassemble the pump.
4. Piping strain: Suction and discharge piping must be independently supported so that they do not impose a load on the discharge head. Any stress transmitted to the pump may cause misalignment and subsequent damage to the pump.
 - a. Unbolt the discharge flange and see where it goes. If the flange is in the correct position, all bolts will slip out by hand and you will be able to remove the gasket only by loosening the pump base bolts and wedging the assembly slightly apart.
 - b. To correct the assembly, leave the base bolts loose and bring the flanges together to about .060 inches parallel. Slip in the gasket and tighten the bolts evenly, using a “180 degrees apart” tightening pattern. Then tighten the base bolts.
 - c. Recheck the pump alignment.
5. Observe wear patterns.
 - a. If the bearing is worn on one side and the shaft is worn evenly, the pump housing is misaligned.
 - b. If the shaft is worn on one side and bearing wear is even, then check for a bent shaft or misalignment of the rotating parts. Debris or grease between shaft ends can cause misalignment.
6. Check for debris in pump housing joints which can cause misalignments.

Below-base Discharge:

Pumps with a below-base discharge often become misaligned when the discharge pipe is being attached.

1. On a flanged connection, unbolt the discharge flange and see where it goes. If the flange is in the correct position, the bolts will slip out by hand and the flange faces will be parallel and together, requiring slight wedging to remove the gasket. If necessary, realign the assembly as directed for above-base discharge (see paragraph 4b, above).
2. On flexible or semi-flexible joints, like those on bellows or Dresser-type couplings, use an indicator to measure movement from the rest position to running operation. If there is more than three mils of deflection per foot down from the pump base, a tie-bar arrangement should be added; if a tie-bar is already being used, it should be adjusted (see next paragraph). This procedure varies depending on the shaft size and pump construction, so if in doubt, contact Sterling-Peerless Pump Company.
3. Tie-bar adjustment: With the pump running, tighten or loosen one tie-bar slightly and check the result with a vibration meter on the pump motor. If improvement occurs, move to a lower amplitude and continue adjusting, alternating from side to side. Keep the sides relatively even with each move to a lower amplitude.
4. The lowest amplitude vibration indicates the least vibrational force, and so is the straightest shaft position. If correcting the discharge alignment does not lessen the vibration sufficiently, continue troubleshooting according to the guidelines in the section on above-base discharge pumps.

Resonance

All equipment has a natural frequency at which it will vibrate. Resonance vibration occurs when a pump is operated at a speed corresponding to this natural frequency.

The natural frequency of an installed pump varies with the foundation and piping, which create a system resonance.

Correction of vibration due to resonance requires a change in the spring rate or mass of the system to stiffen or weaken the pump or structures. A qualified pump vibration engineer can determine solutions based on data obtained from field investigations.

Acceptable Field Vibration Limits for Vertical Pumps

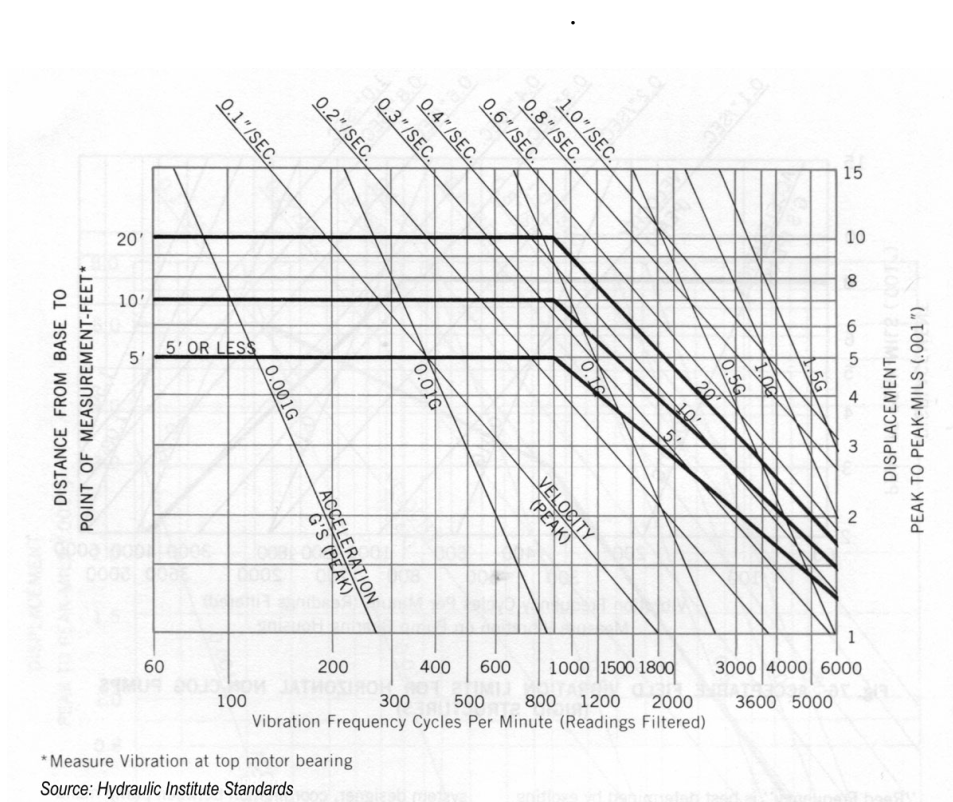


Figure 5. Acceptable vibration limits.

VORTEXING

“Something is wrong with the pump! It’s sucking in slugs of air.” This remark is frequently made when vortices form in flow patterns, causing loud rumbling noises.

A vortex is a whirlpool caused by a combination of factors such as sump design, inlet velocity, direction and flow, submergence, and the position of the

bowl assembly in the sump. Air entering the pump through these vortices causes noise and vibration, but not cavitation. Various methods can be used to prevent vortices. These include using suction umbrellas (Fig. 6), lowering the inlet velocities in the sump, increasing submergence, and relocating the pumps (see Fig. 7).

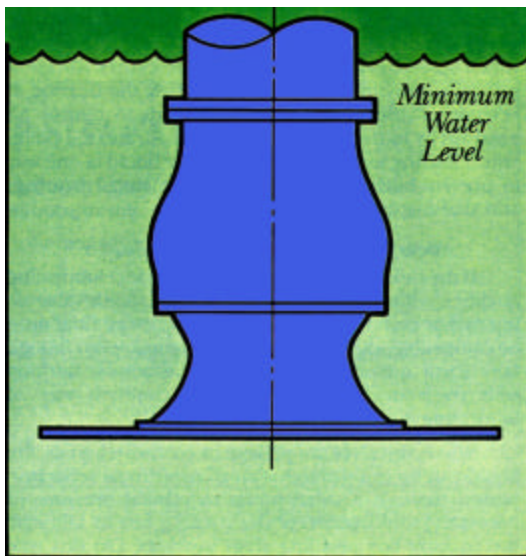


Figure 6. Add a suction umbrella.

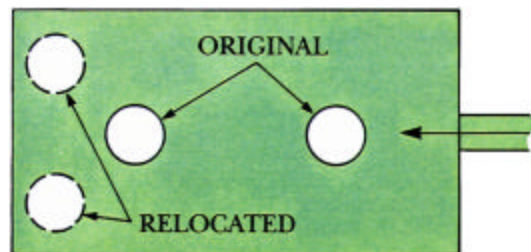


Figure 7. Relocate pumps at back wall, as indicated by dashed lines.

WEAR ANALYSIS: VERTICAL TURBINE PUMPS

Trouble Source	Probable Cause	Remedy
Uneven wear on bearings, uniform wear on shafts	Pump non-rotating parts misaligned	Check mounting and discharge pipe connection and check for dirt between column joints. Correct misalignment, replace bearings, and repair or replace shaft.
Uniform wear on bearings and shafts	Abrasive action	Replace parts. Consider changing materials or means of lubrication.
Uniform wear on bearings, uneven wear on shafts.	Shaft runout caused by bent shafts, shafts not butted in coupling, dirt or grease between shafts.	<ol style="list-style-type: none"> 1. Straighten shaft or replace, clean and assemble correctly. 2. Face parallel and concentric.
Wear on impeller skirts and/or bowl seal ring.	<ol style="list-style-type: none"> 1. Abrasive action or excess bearing wear allowing impeller skirts to function as bearing journal. 2. Impellers set too high. 	<ol style="list-style-type: none"> 1. Install new bearings and wear rings. Upgrade material if abrasion occurring. 2. Re-ring and adjust impellers correctly.
Impeller end seal wear.	Improper impeller adjustment. Impeller running on bottom.	Install "L"-shaped bowl wear rings. Adjust impeller setting per Sterling-Peerless's recommendations.
Wear on bowl vanes.	Abrasive action.	Coat bowls, upgrade material, or rubber line.
Wear on suction bell vanes.	Cavitation due to recirculation.	Correct condition or upgrade materials to extend life.
Impeller Wear Exit vanes and shrouds.	Abrasive action.	Replace impeller if excessive. Consider coating or upgrading material.
Pitting on entrance vanes of impeller.	Cavitation.	Correct condition or upgrade materials to extend life. See section on Cavitation.
Pitting on impellers and bowl casing.	Corrosion, erosion, or recirculation.	Investigate cost of different materials versus frequency of replacements. See section on Corrosion.
Bearing Failures Bearing Wear	Abrasive action.	Convert to fresh water flushing on bearings, or use pressure-grease or oil lubrication; or use bearings made of harder material.
Bearing seized or galling on shaft.	Running dry without lubrication.	Check lubrication, look for plugged suction or evidence of flashing.
Bearing failure or bearing seized.	High temperature failure.	Check with Sterling-Peerless for bearing temperature limits. Generally, <i>Bronze</i> - 175° F maximum in water. <i>Synthetics</i> - 125° F. <i>Carbon</i> - 300° F. <i>Rubber</i> - 125° F.
Excessive shaft wear.	Rubber bearings will swell in hydrocarbon, H ₂ S, and high temperature.	Change bearing material.
Shaft and Couplings Bent shaft.	Mishandling in transit or assembly.	Check straightness. Correct to .0005 in./ft. runout or replace.
Shaft coupling unscrewed.	Pump started in reverse rotation.	Shaft may be bent. Check shafts and couplings. Correct rotation.
Shaft coupling elongated (necked down).	<ol style="list-style-type: none"> 1. Motor started while pump is running in reverse. 2. Corrosion. 3. Pipe wrench fatigue on reused couplings. 4. Power being applied to shafts that are not butted in coupling. 	<ol style="list-style-type: none"> 1. Look for faulty check valve. Could also be momentary power failure or improper starting timers. 2. Replace couplings. 3. Replace couplings. 4. Check for galling on shaft ends.
Broken shaft.	<ol style="list-style-type: none"> 1. Can be caused by same reasons for coupling elongation. 2. Can also be caused by bearings seized due to lack of lubrication. 3. Foreign material locking impellers or galling wear rings. 4. Metal fatigue due to vibration. 5. Improper impeller adjustment or continuous upthrust conditions, causing impeller to drag. 	<ol style="list-style-type: none"> 1. Look for faulty check valve, momentary power failure or improper starting timers. 2. Same as above for bearing seizure. 3. Add strainers or screens. 4. Check alignment of pump components to eliminate vibration. 5. See section on Impeller Adjustment.
Impeller loose on shaft (rarely occurs).	<ol style="list-style-type: none"> 1. Repeated shock load by surge in discharge line (could knock top impeller loose). 2. Foreign material jamming impeller. 3. Differential expansion due to temperature. 4. Improper parts machining and assembly. 5. Torsional loading on submersible pumps. 	<ol style="list-style-type: none"> 1. Refit impeller. 2. Usually will break shaft or trip overloads before impeller comes loose. 3. Change to material with the same expansion factor. 4. Repair and refit. 5. Overcome by adding keyway to collet mounting.

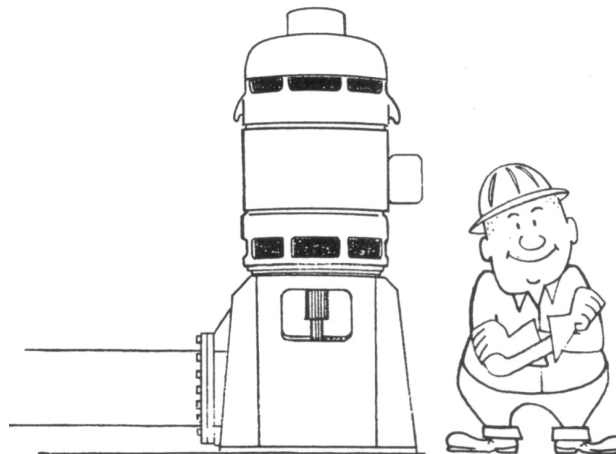
NOTICE:

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

WARRANTY:

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

In the event, notwithstanding the terms of this agreement, it is determined by a court of competent jurisdiction that an expressed warranty has been given by Seller to Purchaser with respect to the head, capacity or other like performance characteristics of said equipment, Seller's liability for breach of the same shall be limited to accepting return of such equipment F.O.B. plant of manufacture, refunding any amount paid thereon by Purchaser (less depreciation at the rate of 15% per year) if Purchaser has used equipment for more than thirty (30) days and canceling any balance still owing on the equipment. THIS WARRANTY IS EXPRESSLY IN LIEU OF OTHER WARRANTIES, EXPRESSED OR IMPLIED, AND SELLER SPECIFICALLY DISCLAIMS ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.



Rev. 9/14/02

TROUBLESHOOTING CENTRIFUGAL PUMPS

Purchasing well designed hardware does not bring automatic trouble free performance with it. The very best equipment will cause problems if it was not designed for your particular application. Here are a few of the more common selection problems we find with centrifugal pumps:

- Buying the same size pump as the one that came out of the application. That's O.K. If the old pump was the correct size, but the odds are that it was too big because of the safety factors that were added at the time of purchase. This will cause the pump to run off of its best efficiency point (B.E.P.) and you will spend a lot of production money for the additional power that is needed to run against a throttled discharge valve or orifice installed in the discharge piping.
- Buying to a standard, or making a decision based on efficiency, and believing that these two somehow relate to quality. Standards were written for packed pumps. When a mechanical seal is being used the shaft L3/D4 number is almost always too large. Efficiency is always gained at the expense of maintenance. Efficiency means tight tolerances and smooth passages that will eliminate reliable double volute designs and keep the maintenance department busy adjusting tight tolerances to maintain the efficiency you paid for.
- Series and parallel installation problems. We often find pumps installed in parallel, but no one knows it because the second pump was installed at a much later date and no one has bothered to trace the piping. Pumps in parallel require that they have the same diameter impeller and that they run at the same speed, or the larger pump will throttle the smaller one causing it to run off the best efficiency point, deflecting the shaft. The capacity should be looked at if the higher capacity pump might exceed the N.P.S.H. available.
- When pumps are installed in series the impellers must be the same width and they must run at the same speed or the higher capacity pump will either cavitate because the smaller capacity pump can not feed liquid at the proper capacity, or it will run throttled if it is feeding the smaller pump. In either case the larger of the two pumps will be adversely affected.
- Purchasing a larger pump because it will be needed in the future. Will raise the operating cost to unacceptable levels ($\text{Power} = \text{head} \times \text{capacity}$) as the pump is run against a throttled discharge valve. This inefficient use of power will translate to a higher heat environment for the seal along with all of the problems associated with shaft deflection.
- Using a variable speed motor to compensate for a pump curve that is not flat enough. Many boiler feed pumps require a flat curve so that the pump can put out varying capacities at a constant boiler pressure (head). We see this same need if we are pumping a varying amount of liquid to a very high constant height.
- Varying the speed of a pump is similar to changing the diameter of the impeller. If you look at a typical pump curve you will observe that the best efficiency point (B.E.P.) comes down with impeller size to form an angle with the base line (capacity line) of the graph. This means that if you vary the speed of the impeller,

TROUBLESHOOTING CENTRIFUGAL PUMPS

the pump always runs off the B.E.P. except in the case where the system curve intersects the pump curve, or in the case of an exponential system curve such as we find in a typical hot or cold water circulating system.

- Double ended pumps installed in a vertical position to save floor space. Makes seal replacement a nightmare unless you are using split or cartridge designs.
- Specifying a desired capacity without knowing the true system head. You can't guess with this one. Some one has to make the calculations and "walk the system". The present pump is not a reliable guide because we seldom know where it is pumping on its' curve. Chart recorders installed on both the suction and discharge side of the pump will give a more accurate reading of the present head if they are left on long enough to record the differences in flow. The trouble with this method is that it will also record a false head caused by a throttled valve, an orifice, or any other restriction that might be present in the piping.
- Requesting too low a required N.P.S.H. will cause you to end up with a different kind of cavitation problem. See another paper in this series for information about "Internal recirculation".
- Failure to request a "center line design" when pumping temperature exceeds 200°F (100°C) it will cause pipe strain that will translate to wear ring damage and excessive mechanical seal movement.
- The use of "inline" pumps to save floor space. Many of these designs are "close coupled" with the motor bearings carrying the radial and thrust loads. Because of typical L3/D4 numbers being very high, the wear rings act as "steady bearings" after the pump is converted to a mechanical seal. The pump should have been designed with a separate bearing case and a "C" or "D" frame adapter installed to connect a motor to the bearing case.
- Thrust bearings being retained by a simple snap ring. Beyond 65% of its rated efficiency most centrifugal pumps thrust towards the pump volute. The thin snap ring has to absorb all of this axial thrust and most of them can not do it very well .
- The mechanical seal has been installed in a packing stuffing box that is too narrow to allow free seal movement. If a mechanical seal was specified, the pump back plate should have been manufactured with a large diameter seal chamber. In most cases the stuffing box recirculation line should be installed from the bottom of this large seal chamber to the suction side of the pump or a low pressure point in the system. There are some exceptions to this, however:
 - If you are pumping at or close to vapor point.
 - If the entrained solids have a low specific gravity.
 - If you are using a Duriron pump that adjusts to the back plate.
 - If you are using a double suction pump where the stuffing boxes are at suction pressure.
- High temperature applications have several special needs:
 - A jacketed stuffing box that isolates the pumpage from the stuffing box contents by a carbon bushing to retard heat transfer.
 - A centerline design to compensate for thermal expansion.

TROUBLESHOOTING CENTRIFUGAL PUMPS

- A cartridge seal design that allows open impeller adjustment after the pump has come up to operating temperature.
- A stainless steel shaft to retard heat transfer to the bearings.
- A method of cooling the bearing oil, but never the bearings.
- A coupling that will compensate for axial expansion.