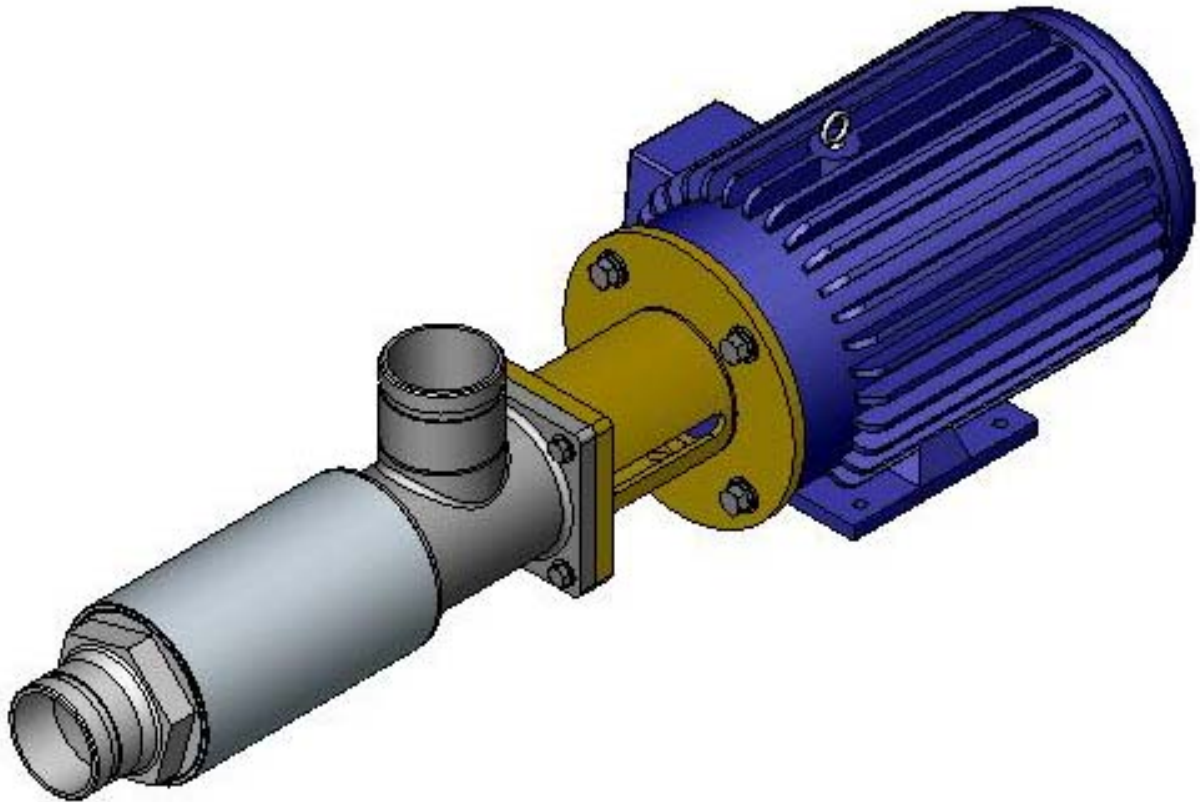




ENERGY RECOVERY, INC.



**INSTALLATION, OPERATION, & MAINTENANCE
MANUAL**

Series 8500-2400 PX Booster Pumps

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**Installation, Operation, & Maintenance Manual
Series 8500-2400 PX Booster Pumps**

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1.0 INTRODUCTION

This manual contains instructions for the installation, operation, and maintenance of the Energy Recovery, Inc. (ERI®) PX Booster Pumps for energy recovery in Sea Water Reverse Osmosis (SWRO) systems in conjunction with ERI's Pressure Exchanger® (PX®) technology. The PX Booster Pump boosts the pressure in the high pressure portion of an SWRO system to make up the small pressure losses that occur through the SWRO membranes, the PX units and the associated piping. The PX Booster Pump is designed to withstand a high inlet pressure in a corrosive seawater environment.

Please read this manual thoroughly before installation or operation and keep it for future reference. The instructions in this manual are intended for personnel with general training and experience in the operation and maintenance of fluid handling systems. PX and PX Booster Pump maintenance personnel are strongly encouraged to attend Factory Training courses offered by Energy Recovery, Inc. Energy Recovery, Inc. technical service personnel are available for assistance by telephone during the regular business hours of 08:00 to 17:00 Pacific Standard Time. Field service and system commissioning assistance are available.

Further information about PX Booster Pumps or other Energy Recovery, Inc. products or service can be found by contacting Energy Recovery, Inc. at:

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2.0 MATERIALS OF CONSTRUCTION AND QUALITY

ERI's commitment to quality starts with the fabrication and procurement of top quality materials made to extremely tight clearances. Every part is checked to ensure it meets all dimensional specifications during and after each stage of the manufacturing process. All wetted metal components in PX Booster Pumps are AL6XN® or equivalent stainless steel. Impellers and diffusers are fiber reinforced polymer. The mechanical seal has carbide contact/sealing faces. Seals are ethylene propylene (EPDM).

Assembled PX Booster Pump units are subjected to extensive testing in our wet test facility. Each PX Booster Pump is tested for efficiency, operating pressures, and flow rates. Each unit is tracked with a serial number and the testing records are maintained.

3.0 SAFETY, ARRIVAL AND INSPECTION

The PX Booster Pump has been designed to provide safe and reliable service. However, it is both a pressure vessel and a piece of industrial rotating machinery. Therefore, operations and maintenance personnel must exercise good judgment and proper safety practices to avoid

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damage to the equipment, to avoid damage to surrounding areas, and to prevent injury. It must be understood that the information contained in this manual does not relieve operation and maintenance personnel of the responsibility of exercising normal good judgment in the operation and care of this product and its components. The safety officer at the location where this equipment is installed must establish a safety program based on a thorough analysis of local industrial hazards. Proper installation and care of shutdown devices and over-pressure and over-flow protection equipment must be an essential part of any such program. In general, all personnel must be guided by all the basic rules of safety associated with high-pressure equipment and processes. Operation under conditions outside of those stated in Table 6-1 can result in damage to the PX Booster Pump.

NOTE

Energy Recovery, Inc. will not be liable for any project delay, damage or injury caused by the failure to comply with the procedures in this manual. This product must never be operated at flow rates, pressure or temperatures outside of those stated in Table 6-1, or used with liquids not approved by Energy Recovery, Inc.

The flags shown and defined below are used throughout this manual. They should be given special attention when they appear in the text.



These flags denote items that, if not strictly observed, can result in serious injury to personnel.



These flags denote items that, if not strictly observed, can result in damage or destruction to equipment.



These flags denote highlighted items.

Each PX Booster Pump should be inspected immediately upon arrival and any irregularities due to shipment should be reported to the carrier. PX Booster Pump units are securely packed with plugs in the fittings to protect the unit from damage during transportation. Care must be taken during unpacking and handling to avoid damage to the PX Booster Pump.



When handling and installing a PX Booster Pump, care should be taken to avoid dropping the unit or putting undue strain on the port fittings to avoid internal damage. Do not lift or support the PX Booster Pump by the port fittings.

Table 4-1 - Example Flow Rates and Pressures

STREAM	DESCRIPTION	FLOW RATE	PRESSURE PSI / BAR
A	Seawater supply	330	29 / 2.0
B	PX LP Inlet/ Seawater	195	29 / 2.0
C	Main HP Pump outlet	135	1000 / 69
D	PX HP Outlet/ Seawater	195	957 / 66
E	Booster Pump Outlet/ Seawater	195	1000 / 69
F	SWRO Feed Stream	330	1000 / 69
G	PX HP Inlet/ Reject	200	971 / 67
H	PX LP Outlet/ Reject	200	15 / 1.0
I	SWRO Product Water	130	5 / 0.3

In an SWRO system equipped with PX technology, the main pump is sized to equal the SWRO permeate flow plus a small amount of bearing lubrication flow, not the full SWRO feed flow. Therefore, PX technology significantly reduces flow through the main pump. This point is significant because a reduction in the size of the main pump results in lower operating costs. In a typical SWRO system equipped with PX technology, the main pump will provide 41% of the energy, the booster will provide 2% and the PX unit(s) will provide the remaining 57%. Since the PX energy recovery device uses no external power, the total power savings is 57% compared to a system with no energy recovery.

It is important to note that the PX unit(s) and associated boost pump are sized for 100% of the reject flow. The role and size of the main high-pressure pump is reduced to that of a “make-up pump” to compensate for the water that is exiting the SWRO system as permeate.

NOTE	ERI encourages plant designers and engineers to submit P&IDs to ERI for engineering review, especially for large or complex SWRO systems.
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5.0 INSTALLATION

The PX Booster Pump should be installed in a dry, sheltered location. Some type of drainage should be provided beneath the pump to allow standing water to drain when performing maintenance or repair. See installation drawings in Section 13.0 for pump dimensions, interface locations and minimum maintenance envelope requirements.

1. Place the PX Booster Pump in an appropriate location and mount the motor securely; making sure that the base of the unit is permanently supported.
2. Connect the inlet and outlet of the pump to the appropriate points. Proper piping, piping support, and motor mounts must be implemented to minimize external stresses on all piping fittings. Flexible couplings should be used for joining fittings and piping. See Section 13.0 for appropriate connection dimensions and specifications. PX Booster Pumps are shipped with the inlet oriented vertically upward. The inlet housing can be rotated either left or right to a horizontal orientation. Remove the four (4) bolts that connect the inlet housing to the yellow bell housing, rotate the pump head and replace the bolts. Torque bolts to 12 ft-lbs (16 N-m) as shown in Figure 7-4 below.

CAUTION

The PX Booster Pump is constructed from AL6XN or equivalent stainless steel. Inlet and discharge interconnecting lines should be constructed of suitable materials to avoid galvanic corrosion.

3. Connect the pump motor to a suitable electrical supply. See the motor plate or the inside cover of the motor electrical junction box for high and low voltage wiring diagrams. If no wiring diagram is evident on the motor, refer to Table 5-1. Connect a suitable ground to the pump motor.
4. The SWRO-PX system must include pressure gauges upstream and downstream of the PX Booster Pump and a high-pressure flow meter in the high-pressure circuit.

Table 5-1 – Motor Wiring

MOTOR MANUFACTURER		L1	L2	L3	JOIN
General Electric	High Voltage	1	2	3	4+7, 5+8, 6+9
	Low Voltage	1+7	2+8	3+9	4+5+6
Leeson	High Voltage	1+12	2+10	3+11	4+7, 5+8, 6+9
	Low Voltage	1+6+7+12	2+4+8+10	3+5+9+11	—

6.0 OPERATION

6.1 Specifications

The successful use of the PX Booster Pump depends on observing some basic operating conditions and precautions. The PX Booster Pump must be installed, operated and maintained in accordance with this manual and good industrial practice to assure safe operation and a long service life. Failure to observe these conditions and precautions can result in violation of the warranty, damage to the equipment, and/or harm to personnel.

6.1.1 System Performance Specifications

Table 6-1 provides a summary of system performance specifications. See Section 12.0 for flow and pressure curves.

Table 6-1 - System Performance Specifications

Parameter	Specification
Raw Water Temperature Range:	33-113°F (1-43°C)
Maximum Outlet Pressure:	1200 psi / 83 bar
Minimum Inlet Pressure:	15 psi / 1.0 bar
Design Flow Range: *	
HP-8503	30-110 gpm (7 – 25 m3/hr)
HP-8504	30-110 gpm (7 – 25 m3/hr)
HP-1253	40-190 gpm (9 – 43 m3/hr)
HP-1254	40-190 gpm (9 – 43 m3/hr)
HP-2402	80-300 gpm (18 – 68 m3/hr)
HP-2403	80-300 gpm (18 – 68 m3/hr)

* 60 Hz / 3450 rpm

6.1.2 Precautions and Conditions

The following precautions / conditions apply:

- Piping connections to the pump must be designed so as not to induce stress on the pump or motor.
- Ensure that all flexible connections are secure and tight before operating pump.
- Under no circumstances shall the inlet pressure or outlet pressure exceed 1,200 psig (83 bar).
- Ensure sufficient feed water supply. The PX Booster Pump should be thoroughly purged of air before startup. Operating the PX Booster Pump with feed pressures less than 15 psi may result in damage to PX Booster Pumps internal components. Never run pump dry.



Do not allow the high-pressure reject and/or seawater to exceed 1,200 psi (83 bar). If necessary, install a pressure switch and/or safety valve in the high-pressure line(s) to ensure the system does not exceed 1,200 psi (83 bar).



Allowable operating ranges for individual PX Booster Pumps are listed in Table 6-1. PX Booster Pumps are not designed to operate outside of these ranges.

6.1.4 Physical Characteristics

See Section 13.0 for weights and dimensions. Connections dimensions and requirements are provided in Table 6-2.

Table 6-2 - Connection Dimensions and Requirements

Utility	Connection	Maximum Pressure (psi / bar)
Inlet	3” Flexible Coupling	1,200 / 83
Discharge	3” Flexible Coupling	1,200 / 83

6.1.5 Utility Requirements

Power requirements are provided on the nameplate on the top of all PX Booster Pump motors. Horsepower requirements are provided in Table 6-3.

Table 6-3 – Motor Horsepower Requirements

HP-8503	HP-8504	HP-1253	HP-1254	HP-2402	HP-2403
5	7.5	10	15	15	20

6.1.6 Spare Parts

A listing of recommended ERI spare parts is provided in Table 6-4. O-ring kits are recommended for disassembly and inspection. Rebuilt kits provide impellers, stage assemblies and O-rings.

Table 6-4 - Recommended Spare Parts

DESCRIPTION	QTY	O-RING KIT PART NUMBER	REBUILD KIT PART NUMBER	MECHANICAL SEAL KIT
HP-8503	1	20005-02	20005-01*	20004-01
HP-8504	1	20006-02	20006-01*	20004-01
HP-1253	1	20007-02	20007-01*	20004-01
HP-1254	1	20008-02	20008-01*	20004-01
HP-2402	1	20009-02	20009-01*	20004-01
HP-2403	1	20010-02	20010-01*	20004-01

* Includes Impellers, Stage Assemblies and O-rings

NOTE

Only genuine ERI spare parts should be used in PX Booster Pumps. Use of parts other than those specified by ERI will void the warranty.

6.2 Startup Procedure

Refer to the PX Operations and Maintenance manual for detailed startup and shutdown instructions for the PX device.

1. Verify system is de-energized and un-pressurized.
2. Check tightness of all lines and fittings.
3. Supply feed water to the SWRO system and the PX unit's low-pressure inlet.
4. Verify that the inlet pressure to the PX Booster Pump is at least 15 psi as seen at the inlet of the main high-pressure pump. Verify that all air has been purged from the system. The pump cannot be run dry for even a few seconds. Damage will occur in seconds if the pump is started dry.

CAUTION

Never run the PX Booster Pump dry or with low feed flow. Operating with feed pressures less than 15 psi (1 bar) or below recommended the flow range can cause damage to the pump's internal components.

5. Jog the PX Booster Pump and verify that its rotation is correct.

NOTE	The PX Booster Pump should rotate in the clockwise direction when facing the rear of the motor.
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6. Start the PX Booster Pump and verify that the pump is operating on the flow and pressure curves provided in Section 12.0.

6.3 Maintenance and Startup Log

A sample operating-log has been provided in Section 8.0 of this manual and must be submitted by fax or e-mail to Energy Recovery, Inc. in San Leandro, California upon completion of the startup and flow balancing routines. ERI requests submittal of this form with the initial startup data within 24 hours of startup. The data must be recorded daily and maintained during the life of the warranty in order to support any claims. Include pump serial number with all submittals.

NOTE	A sample operating-log has been provided at the end of Section 8.0 and must be submitted by fax or e-mail to Energy Recovery, Inc. upon completion of the startup and balancing routines. The data must be recorded daily and maintained during the life of the warranty in order to support any claims. Include serial number with submittal.
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7.0 MAINTENANCE INSTRUCTIONS

7.1 General

The table below details the specific recommended pump maintenance requirements for the ERI’s PX Booster Pump product line:

Table 7-1 - Periodic Maintenance Task Frequency

	Weekly	3 Months	As Required	Labor Hours (approximate)
Inspect connections	•			0.1
Inspect mechanical seal	•			0.1
Lubricate pump motor		•		0.2
Change mechanical seal			•	2.0

7.2 Lubricate PX Booster Pump Motor

Motor bearings should be checked daily for temperature and noise. Motor bearings must be lubricated a minimum of every three months. Use a grease gun and high-quality ball bearing

SERIES 8500-2400 PX BOOSTER PUMPS

grease such as Shell Dolium R or Chevron SR1 2. Refer to the motor manufacturer's websites for additional guidance and information.

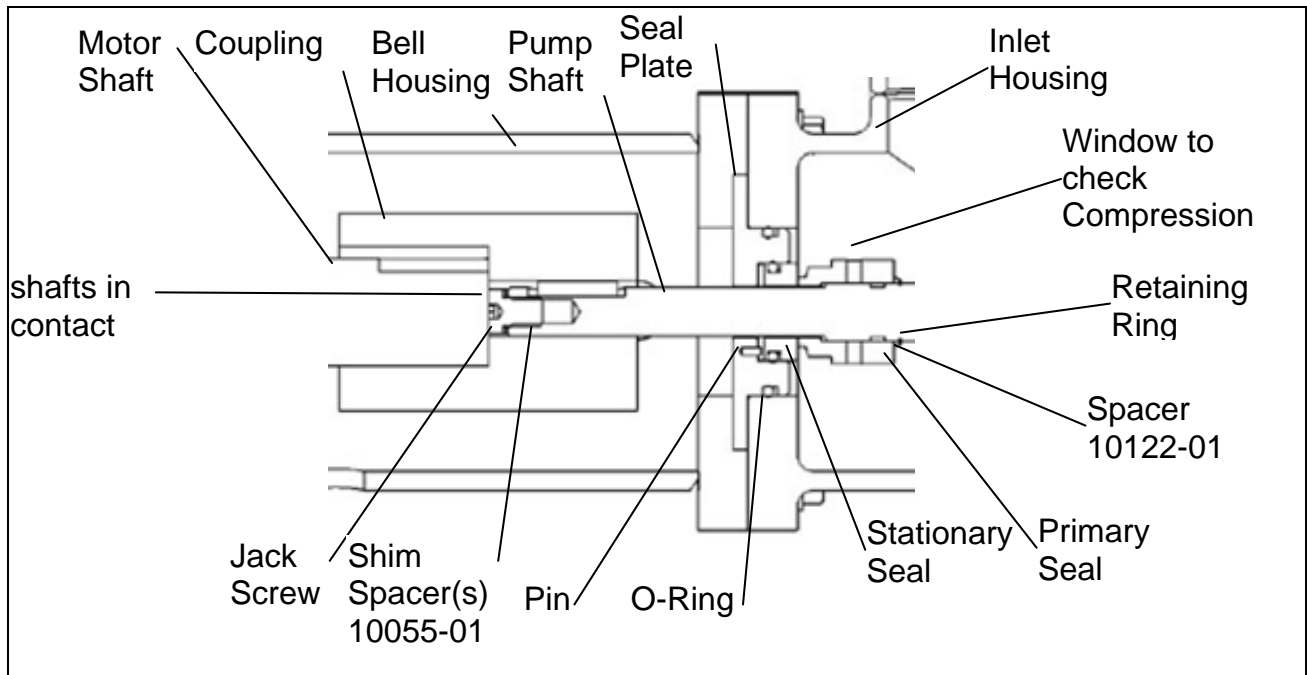
7.3 Mechanical Seal Maintenance

A mechanical seal is used to seal the rotating shaft. This seal will require replacement approximately every 12-18 months. An indication that maintenance is required will be a leak or drip from the rear of the pump into the bell housing. Mechanical seal kits are available from ERI. The kit includes the components listed in Table 7-2 and illustrated in Figure 7-1.

Table 7-2 - Mechanical Seal Kit - ERI Part Number 20004-01

PART NUMBER	DESCRIPTION	QUANTITY
10055-01	SHIM	2
10066-01	RETAINING RING, 3 /4"	1
10117-01	DOWEL PIN	2
10122-01	SPACER	1
10123-01	MECHANICAL SEAL	1
10124-01	FENDER WASHER	2
10128-01	ALLEN WRENCH, 3/32"	1
10134-01	THREAD LOCKER	1
10160-01	O-RING, -225	1
80027-01	MECHANICAL SEAL O&M MANUAL	1

Figure 7-1 - Section View of Shaft and Seal Components



SERIES 8500-2400 PX BOOSTER PUMPS

ERI offers a tool kit (ERI Part Number 20003-01) for PX Booster Pump maintenance operations. Alternately, a list of tools and materials recommended for maintenance of the mechanical seal are provided in Table 7-3.

Table 7-3 - Recommended Tools and Materials

Pump Model	Tool	Application
all	9/16-inch Wrench	Bolts between Inlet Housing and Bell Housing
all	3/4-inch Wrench	Bolts between Bell Housing and Motor
8500-pumps	3/16-inch Allen/Hex Wrench	Coupling
1250- and 2400-pumps	1/4-inch Allen/Hex Wrench	Coupling
all	3/32-inch Allen/Hex Wrench	Seal Set Screws
all	Anti-Seize Compound	All Threads
all	Water Soluble Lubricant	O-Rings

The following procedure provides instructions for removing an old seal and inserting a new one.

7.3.1 Remove the Old Mechanical Seal

1. Verify system is de-energized and un-pressurized.
2. Disconnect the flexible coupling connections from the inlet and outlet of the PX Booster Pump and allow water to drain from system.
3. Unbolt the motor base from the floor.
4. Stand the PX Booster Pump on the motor in a vertical orientation as shown in Figure 7-2.
5. Partially loosen (1-3 turns) the eight (8) shaft coupling screws inside the bell housing. There is an access slot for these screws at the side of the bell housing. See Figure 7-3.
6. Remove the four bolts that hold the inlet housing to the bell housing with a 9/16" wrench as shown in Figure 7-4.

Figure 7-2 - Pump Oriented Vertically



Figure 7-3 - Loosen Coupling Screws

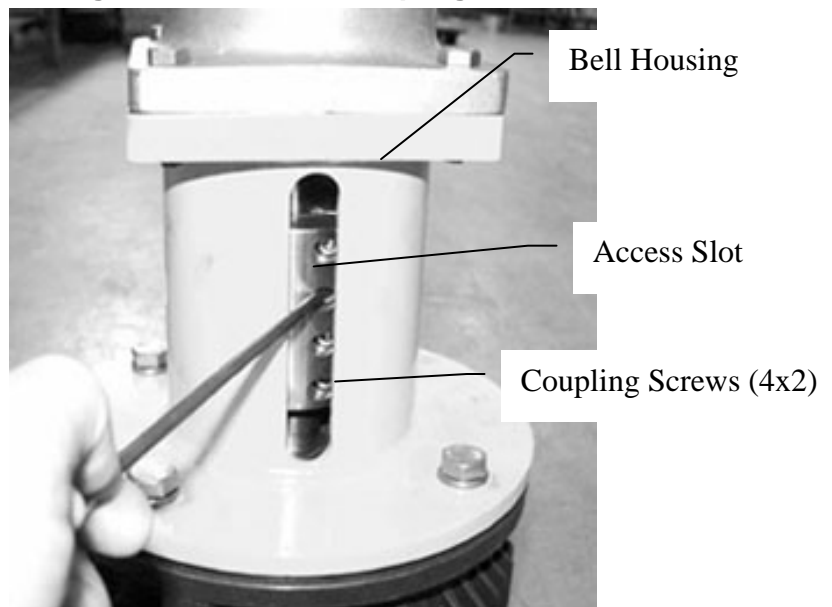


Figure 7-4 - Remove Pump from Bell Housing

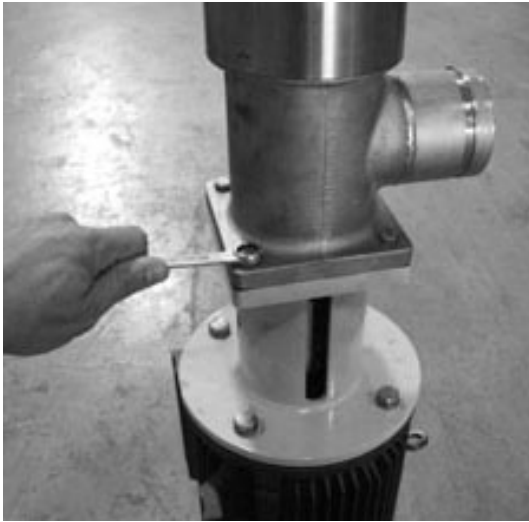


Figure 7-5 - Remove Seal Plate from Inlet



7. Pull the pump, shaft and seal out of the bell housing and away from the motor.
8. Remove the seal plate from the inlet housing as shown in Figure 7-5. It may be necessary to pull on the pump shaft to create an initial gap between the seal plate and the inlet.
9. The mechanical seal includes the primary seal and the stationary or mating plate as shown in Figure 7-6. Extract the stationary plate from the seal plate by pushing through the seal plate with a rod as shown in Figure 7-7. Remove stationary plate from the seal plate.

Figure 7-6 - Mechanical Seal Components

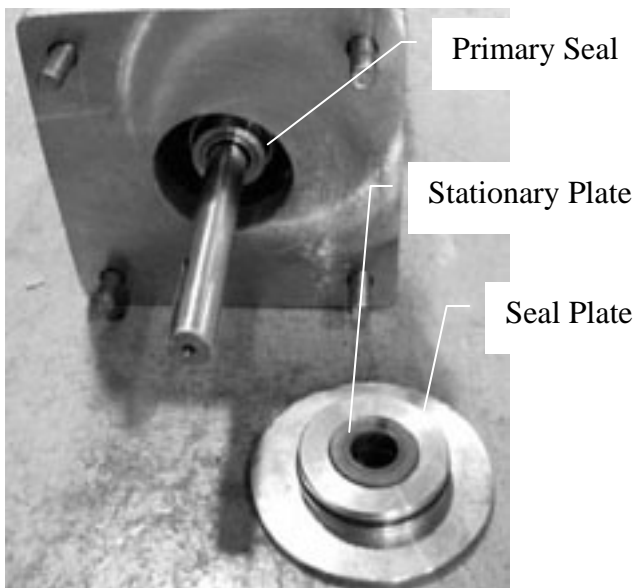
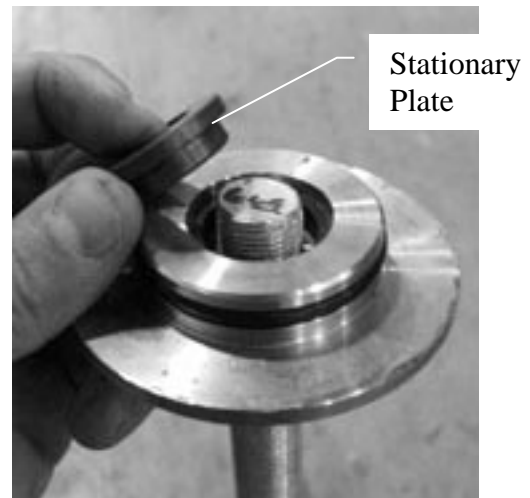
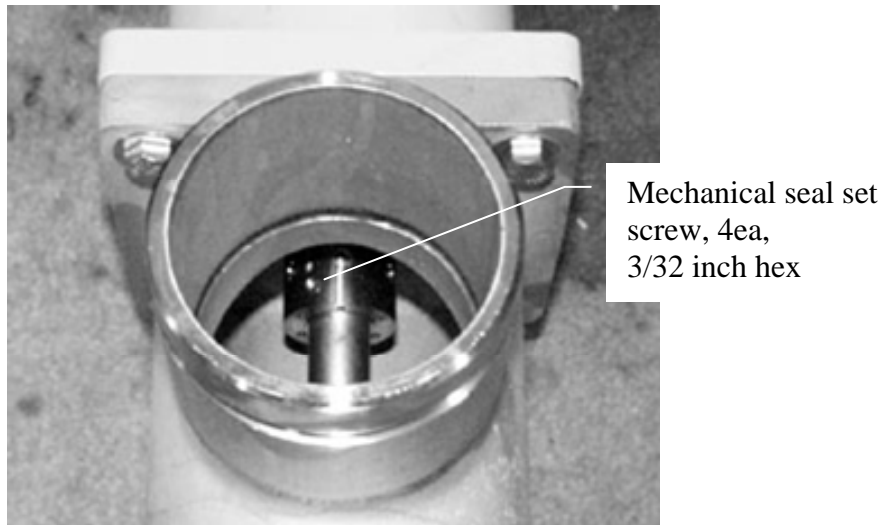


Figure 7-7 - Extract Stationary Plate from Seal Plate



10. Loosen the four (4) set screws (3/32 inch hex) that hold the primary seal onto the shaft as shown in Figure 7-8. Be careful not to strip the set screws. If a particular set screw is very tight, it may be necessary to rotate the shaft and loosen a different set screw first.

Figure 7-8 - Loosen Set Screws



11. Slide the primary seal off the shaft and out of the pump.
12. Remove the bell housing from the motor as shown in Figure 7-9.
13. Remove the coupling from the motor shaft. Disassemble the coupling as shown in Figure 7-10. Clean the coupling and the shaft keys to remove any salt deposits or debris.

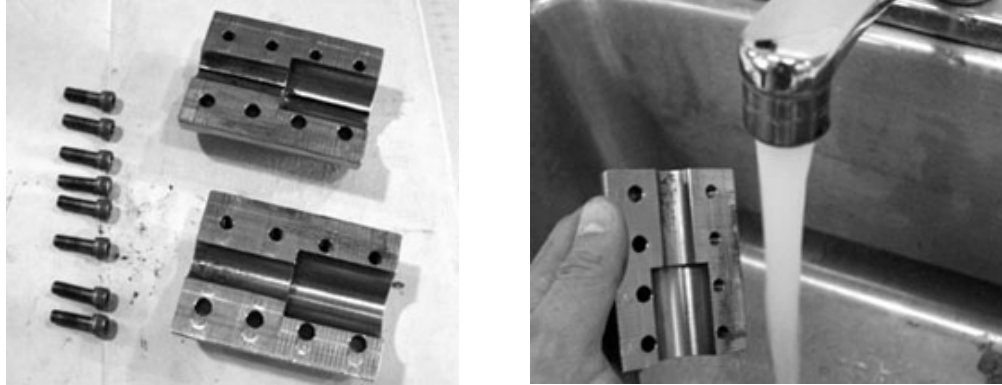
CAUTION

Keep the shafts and coupling clean and free of dirt, rust and foreign matter. Use plenty of anti-seize upon reassembly to ensure easy disassembly the next time.

Figure 7-9 - Remove Bell Housing



Figure 7-10 - Disassemble Coupling and Clean Components



7.3.2 Install the New Mechanical Seal

Before installing the new mechanical seal, completely remove the pump head, the bell housing and the coupling as described above.

1. Reassemble the coupling using plenty of antiseize on the bolts and inside of the coupling. Apply antiseize to the motor shaft.
2. Install the coupling onto the motor shaft as shown in Figure 7-11. Use plenty of antiseize.
3. Install the bell housing onto the motor as shown in Figure 7-11. Use anti-seize compound on the bolt threads. Make sure that the drainage hole is oriented so that it will be on the bottom of the bell housing when the PX Booster Pump is reinstalled. Torque the bolts to 40 foot-pounds (ft-lbs) / 58 N-m.

Figure 7-11 – Install Coupling and Bell Housing onto Motor



4. Lubricate the o-ring in the new primary seal with a water-soluble lubricant. Install new spacer ring and new primary seal onto the pump shaft. Slide these components onto the shaft until they contact the retaining ring. See Figure 7-12 and 7-13 for the correct sequence. Tighten the three set screws to 7 inch-pounds (in-lbs) / 0.79 Newton-meters (N-m) torque using a 3/32-inch hex wrench.

Figure 7-12 - Primary Seal Sequence

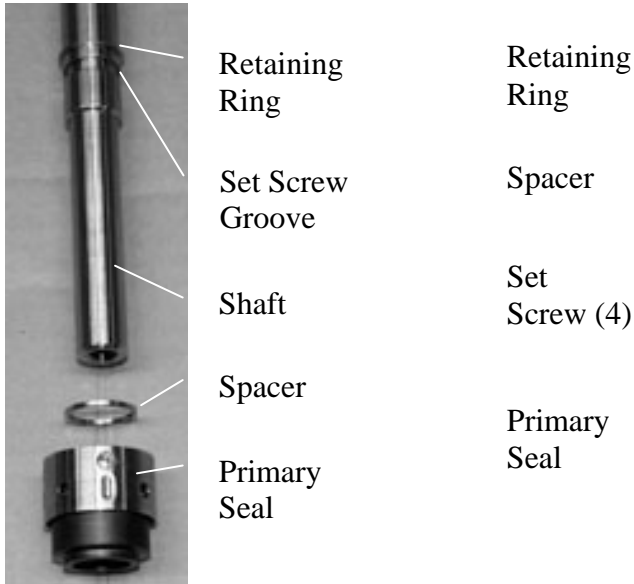


Figure 7-13 - Primary Seal Assembly



5. Insert the anti-rotation pin into the seal plate as shown in Figure 7-14. Once inserted, the pin should not protrude more than 1/16-inch (1.6 mm). Assure that there is no debris inside the seal plate that would prevent the stationary seal from fully seating.
6. Lubricate the O-ring of the new stationary seal with a water-based lubricant such as glycerin or soap. Insert the new stationary seal into the seal plate. Be sure to line up the groove in the bottom of the stationary ring with the anti-rotation pin as shown in Figure 7-15. The stationary seal must seat flat and level in the seal plate.

Figure 7-14 - Insert Anti-Rotation Pin

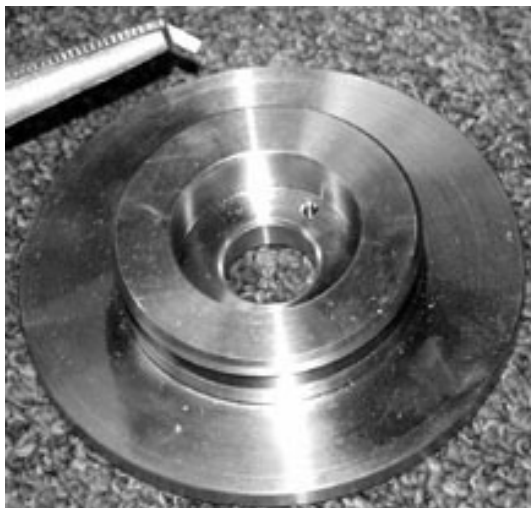
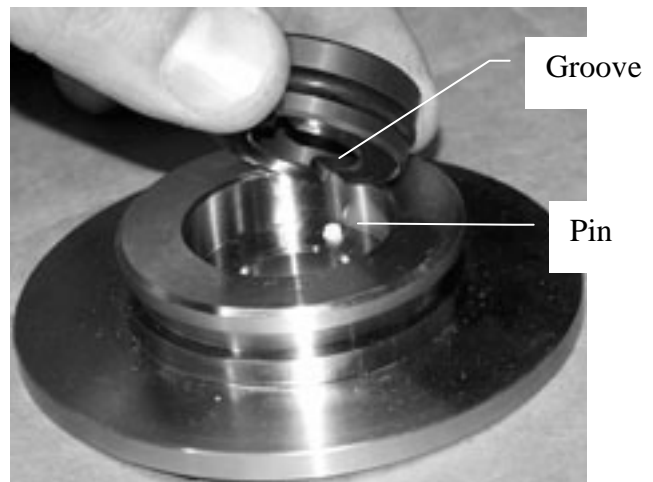
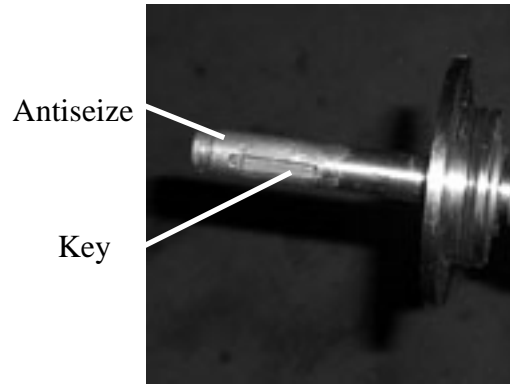
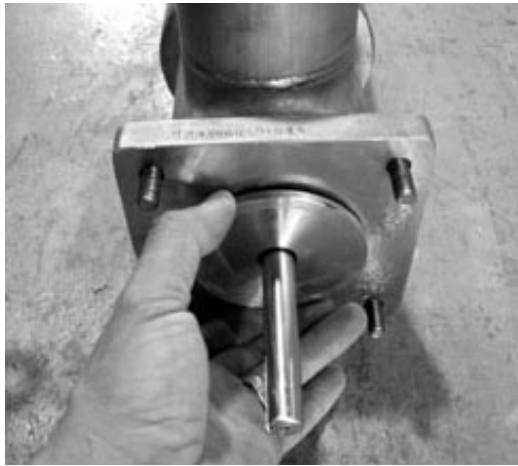


Figure 7-15 - Stationary Seal, Line up Pin with Groove



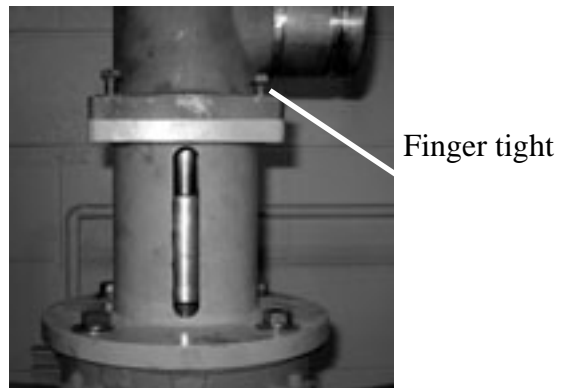
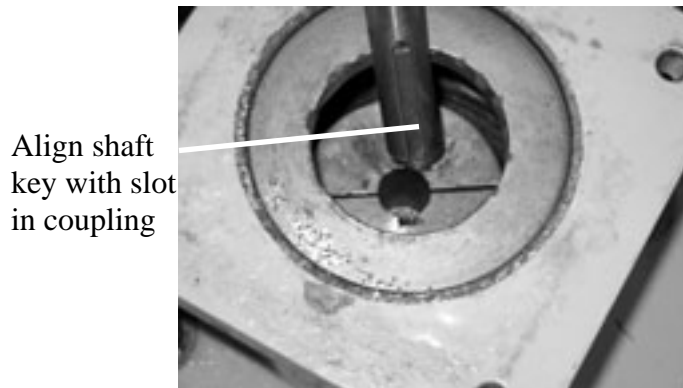
7. Slide the seal plate onto the shaft as shown in Figure 7-16.

Figure 7-16 – Assemble the Shaft, Seal and Seal Plate, Install into Inlet Housing



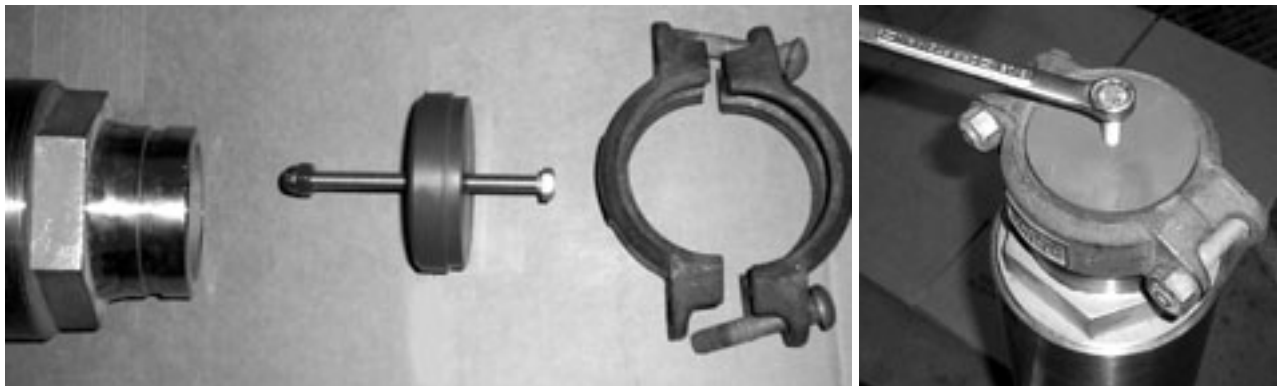
8. Align the shaft key with the slot in the coupling and install the pump onto the bell housing as shown in Figure 7-17.

Figure 7-17 – Install Pump into Bell Housing



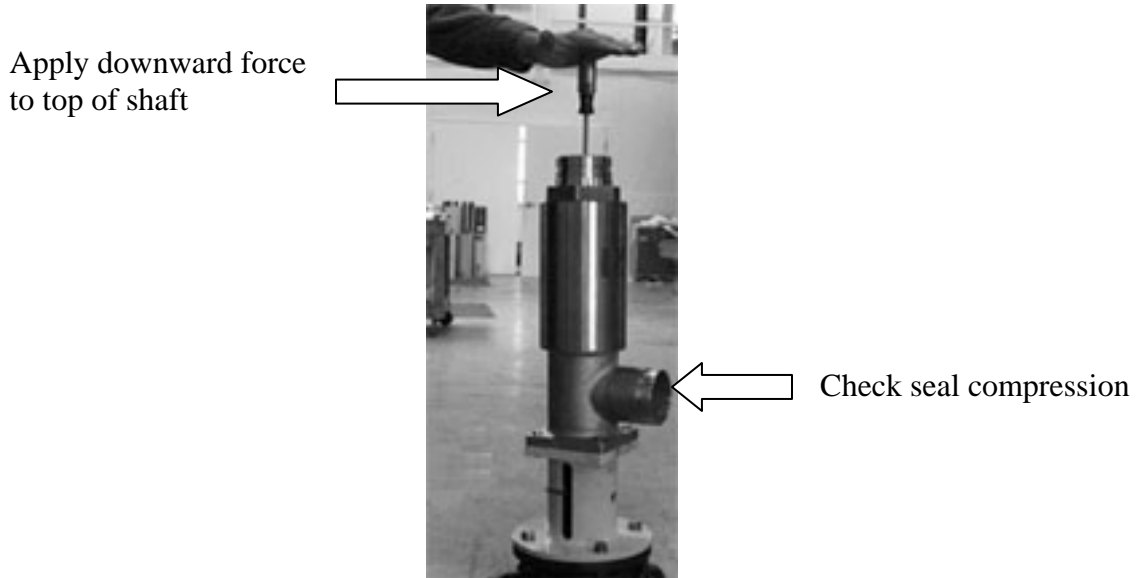
9. Assemble the seal compression tool components using a flexible coupling as shown in Figure 7-18. Alternately, compress seal manually as shown in Figure 7-19.

Figure 7-18 – Assemble and Install Seal Compression Tool Components



10. Check the seal compression by applying downward force on the pump shaft while looking into the inlet housing as shown in Figure 7-19.

Figure 7-19 – Install Pump onto Bell Housing



11. Inspect the mechanical seal inside the inlet housing. Check the compression of the mechanical seal by looking into the circular window as shown in Figure 7-20. If seal is not correctly compressed, remove the pump and install a fender washer into the shaft coupling or a shim spacer onto the shaft as shown in Figure 7-21. Reassemble pump according to the steps above.

Figure 7-20 - Check Seal Compression

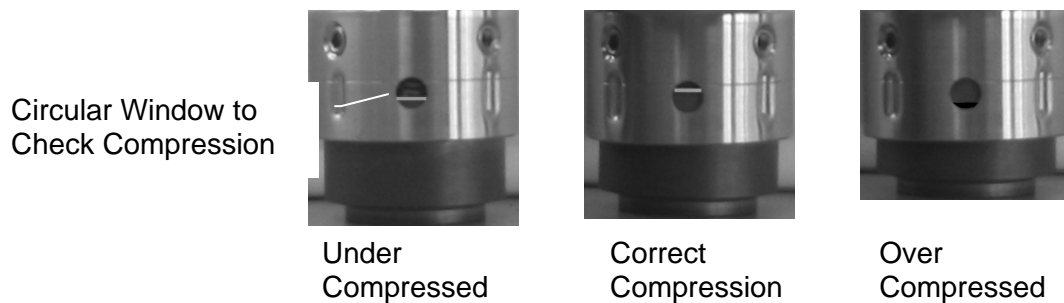
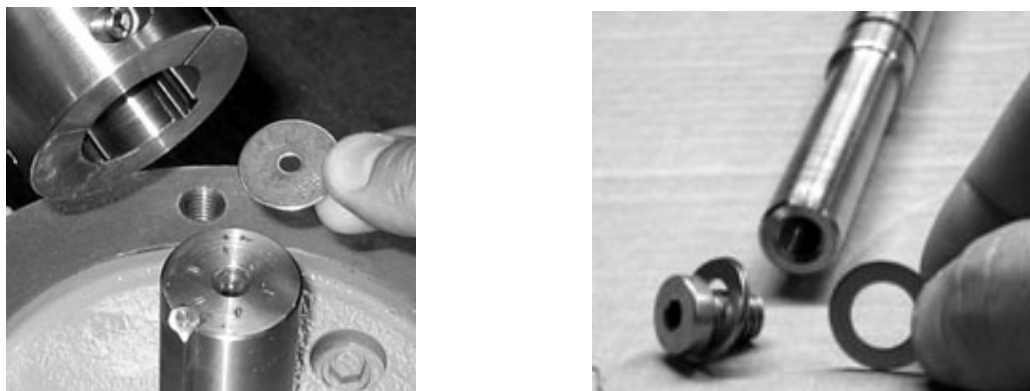


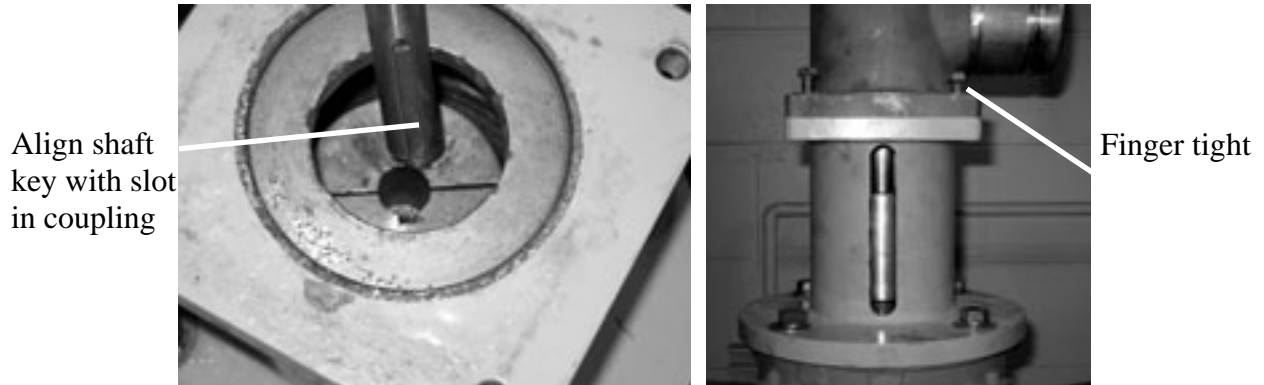
Figure 7-21 – Add or Remove Fender Washer(s) or Shim Spacer(s) to Change Seal Compression



SERIES 8500-2400 PX BOOSTER PUMPS

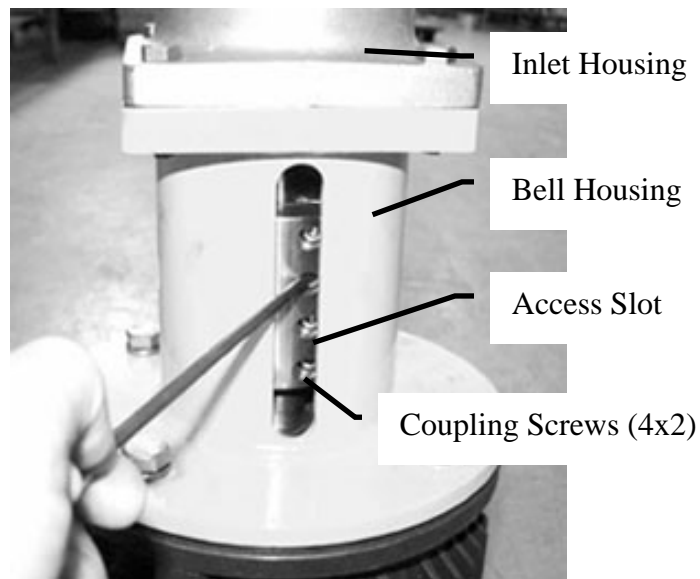
12. Verify that the shaft keys are in place.
13. Line up the key of the pump shaft with the slot in the shaft coupling inside the bell housing as shown in Figure 7-22 below.
14. Install the pump head onto the bell housing. Install the four (4) bolts between the pump to finger tight.

Figure 7-22 – Install Pump into Bell Housing



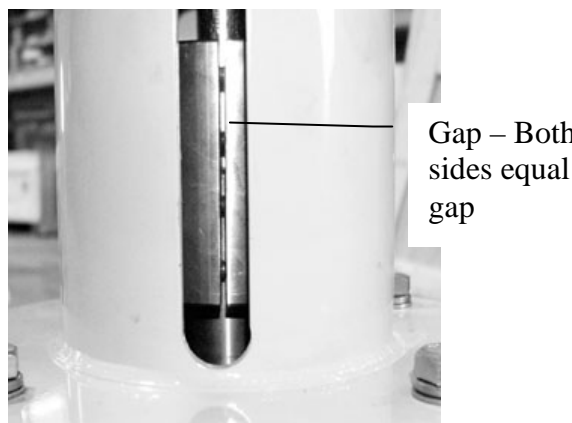
15. With the pump and motor shafts in contact, tighten the eight (8) coupling screw as shown in Figure 7-23. NOTE: THE PUMP AND MOTOR SHAFT MUST BE IN CONTACT.

Figure 7-23 – Tighten Coupling onto Shafts



16. Tighten both halves of the coupling evenly making sure that the gap between the two halves is equal as shown in Figure 7-24.

Figure 7-24 - Check Gap Between Coupling Halves



17. Torque the coupling screws according to the requirements listed in Table 7-4. Make sure the gap between the two halves of the coupling is even on both sides as shown in Figure 7-24. The coupling must be tightened evenly and fully to prevent an out of balance condition, excessive vibration and premature motor bearing failure.

Table 7-4 - Shaft Coupling Torque Requirements

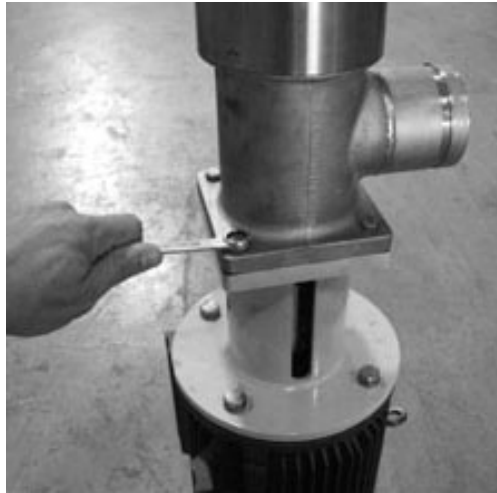
	HP-8503	HP-8504	HP-1253	HP-1254	HP-2402	HP-2403
Coupling Screw Torque	8 ft-lb / 11 N-m	8 ft-lb / 11 N-m	8 ft-lb / 11 N-m	8 ft-lb / 11 N-m	12 ft-lb / 16 N-m	12 ft-lb / 16 N-m

CAUTION

The coupling screws must be tightened evenly according to the torque requirements. The gap between the two halves of the coupling must be equal on both sides. Failure to tighten the coupling evenly and fully could cause an out of balance condition resulting in excessive vibration and premature motor bearing failure.

18. Tighten the four (4) bolts between the inlet housing and the bell housing. Torque bolts to 12 ft-lbs (16 N-m) as shown in Figure 7-25. If the bolts between the pump and the bell housing were tightened before the shaft coupling was tightened, loosen all four (4) bolts 2 revolutions. Then torque the four (4) bolts between the inlet housing and the bell housing to 12 ft-lbs (16 N-m) as shown in Figure 7-25.

Figure 7-25 – Final Step: Tighten Inlet to Bell Housing



CAUTION

Tighten coupling before tightening the bolts between the inlet housing and the bell housing.

19. Check to see that the shaft can turn relatively free by hand. The purpose for the ideal impeller gap spacing is to keep the impellers free inside the bowls. The bowls are held in place by the compression applied by the outlet nozzle while the splined shaft spins the impellers. If the gap spacing is incorrect and the impellers rub/ interfere with the bowls, premature failure of the pump may occur. A small amount of rubbing during an initial break in period is acceptable.
20. After the pump is reassembled and reinstalled, make sure that water is fully flowing through the unit before starting. **THE PUMP CANNOT BE RUN DRY FOR EVEN A FEW SECONDS.** Damage will occur in seconds if the pump runs with insufficient feed flow.

7.4 Disassembly of Wet End

The following procedure should be used when rebuilding the wet end of PX Booster Pumps.

1. Verify that the system is de-energized and un-pressurized.
2. Disconnect the inlet and outlet connections of the PX Booster Pump and allow water to drain from system.
3. Loosen the pump head with a pipe wrench on the outlet nozzle as shown in Figure 7-26.
4. Loosen the shell with a strap wrench as shown in Figure 7-27.

Figure 7-26 – Loosen Outlet Nozzle



Figure 7-27 – Loosen Shell



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5. Stand up the PX Booster Pump in a vertical orientation as shown in Figure 7-1.
6. Remove the outlet nozzle and shell. Remove the snap ring from the end of the shaft.
7. Remove the stage assemblies down to the inlet nozzle as shown in Figure 7-28. Inspect all stage assemblies and components for damage and/or wear.

Figure 7-28 – Remove Shell and Stages



7.5 Assembly of Wet End

This procedure assumes that the pump has been completely disassembled.

1. Clean the face of the motor.
2. Clean the coupling components as shown in Figure 7-14 above. Install the shaft coupling onto the motor shaft as shown in Figure 7-29 below.
3. Install the bell housing as shown in Figure 7-29. Be sure the drainage hole is oriented downward toward the floor. Torque bolts to 40 ft-lbs (58 N-m).

Figure 7-29 - Install Coupling and Bell Housing



Drainage Hole

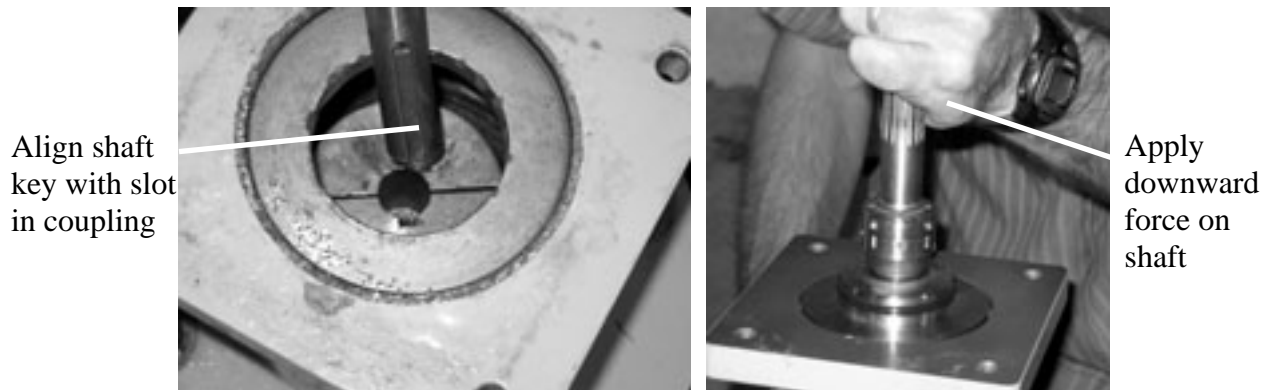
4. Install the seal and seal plate onto the shaft as shown in Figure 7-30.

Figure 7-30 – Install seal and seal plate onto shaft



5. Insert the shaft assembly into the bell housing as shown in Figure 7-31.
6. Check the seal compression while applying downward force on the pump shaft so that the pump shaft and motor shaft are in contact.

Figure 7-31 – Insert Shaft Assembly into Bell Housing and Coupling



7. Check the compression of the mechanical seal while applying downward force on the shaft by looking into the circular window as shown in Figure 7-32. If seal is not correctly compressed, remove the pump and install a fender washer into the shaft coupling or a shim spacer onto the shaft as shown in Figure 7-33. Reassemble pump according to the steps above.

Figure 7-32 - Check Seal Compression

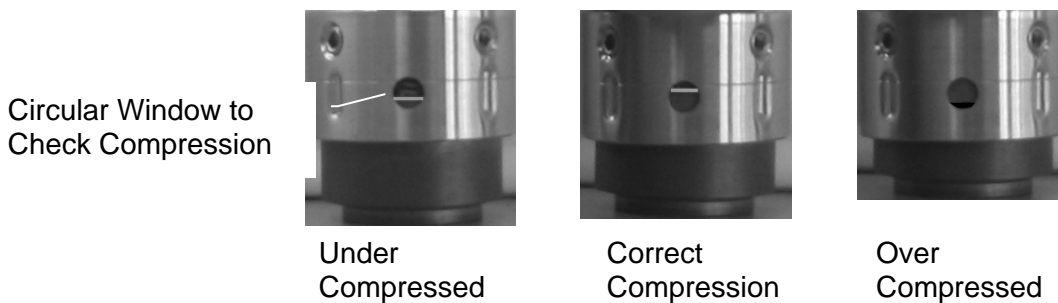
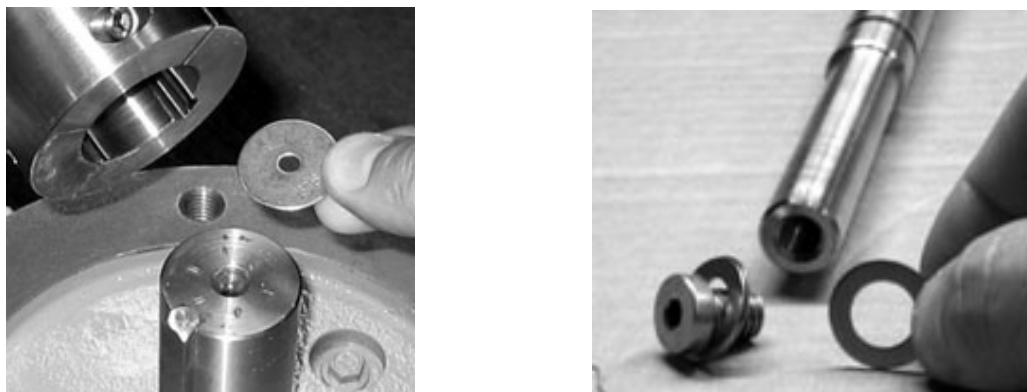


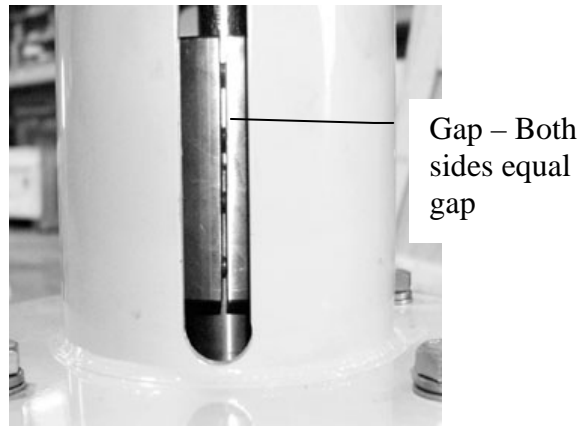
Figure 7-33 – Add or Remove Fender Washer(s) or Shim Spacer(s) to Change Seal Compression



8. When the seal compression is correct, torque the coupling screws according to the requirements listed in Table 7-4 above. Make sure the gap between the two halves of the coupling is even on both sides as shown in Figure 7-34. The coupling must be tightened

evenly and fully to prevent an out of balance condition, excessive vibration and premature motor bearing failure.

Figure 7-34 - Check Gap Between Coupling Halves



9. Install the first impeller. Set the gap between the impeller and the wear ring of the diffuser plate to $1/16'' (1.6\text{mm}) \pm 1/32'' (0.8\text{mm})$ as shown in Figure 7-35. Remove the impeller and add or subtract spacers onto the shaft as necessary to adjust the gap. For 2400-Series PX Booster Pump models, the gap between the impeller and the wear ring cannot be directly viewed. In this case, measure the distance between any two features on the diffuser plate and the impeller as shown in Figure 7-36. Record the measurement. Then raise the diffuser plate until it contacts the impeller. Measure the gap again. The difference between the measurements indicates the gap distance. Remove the impeller and add or subtract spacers onto the shaft as necessary to adjust the gap.

Figure 7-35 - Install First Diffuser Plate

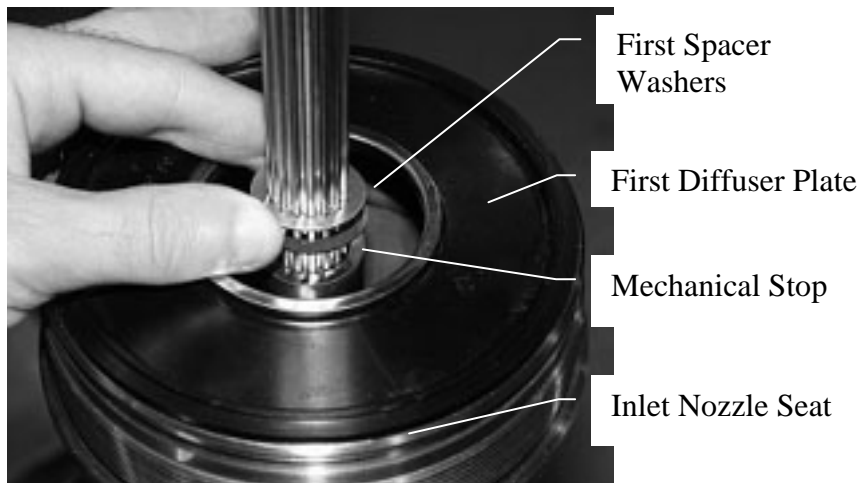


Figure 7-36 - Adjust the Gap Between the Impeller and Diffuser Plate Using Spacers

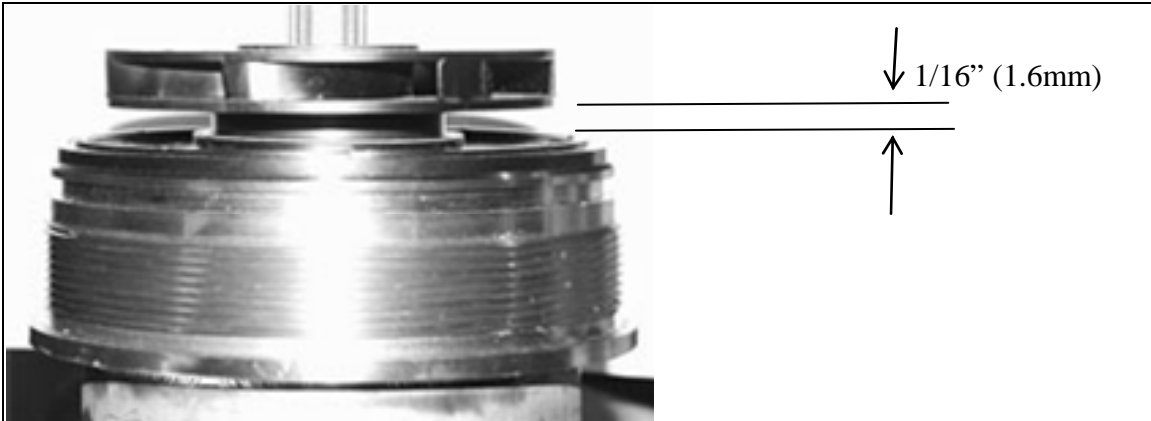
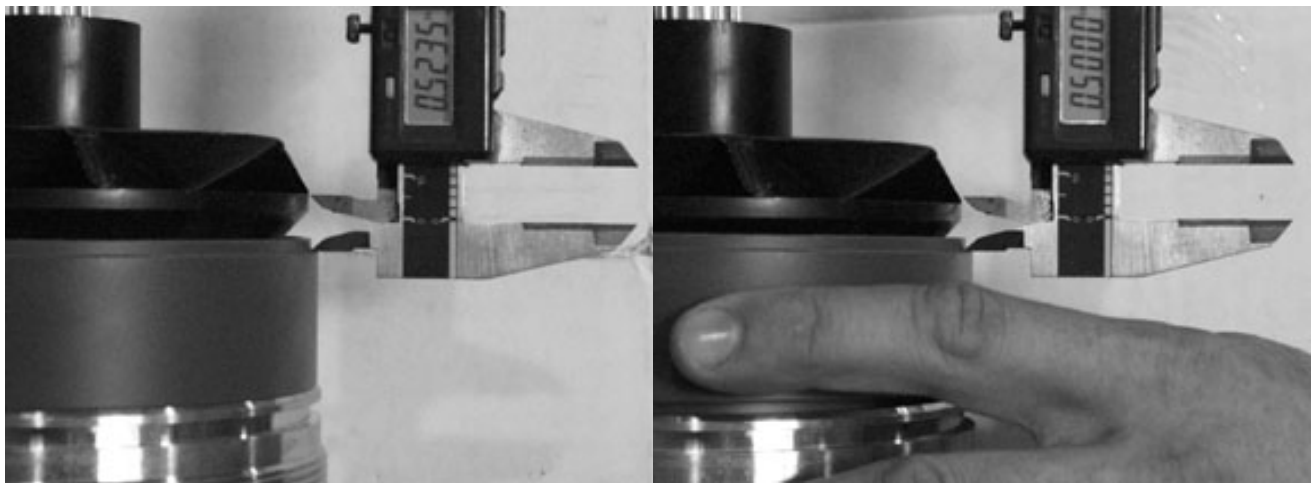


Figure 7-37 - Set the Gap Using Measurements at the Edge of the Parts



10. The next item to go on the shaft is a thrust washer, then a bearing journal, then a diffuser bowl. The diffuser bowl, spacer washer (optional), bearing journal, thrust washer, impeller and diffuser plate make up a complete stage assembly as shown in Figure 7-38. Stack in the order shown in Figure 7-38 or 7-39 until the pump is complete.

Figure 7-38 - Complete Stage Assembly for 8500- and 1250-Series Pumps

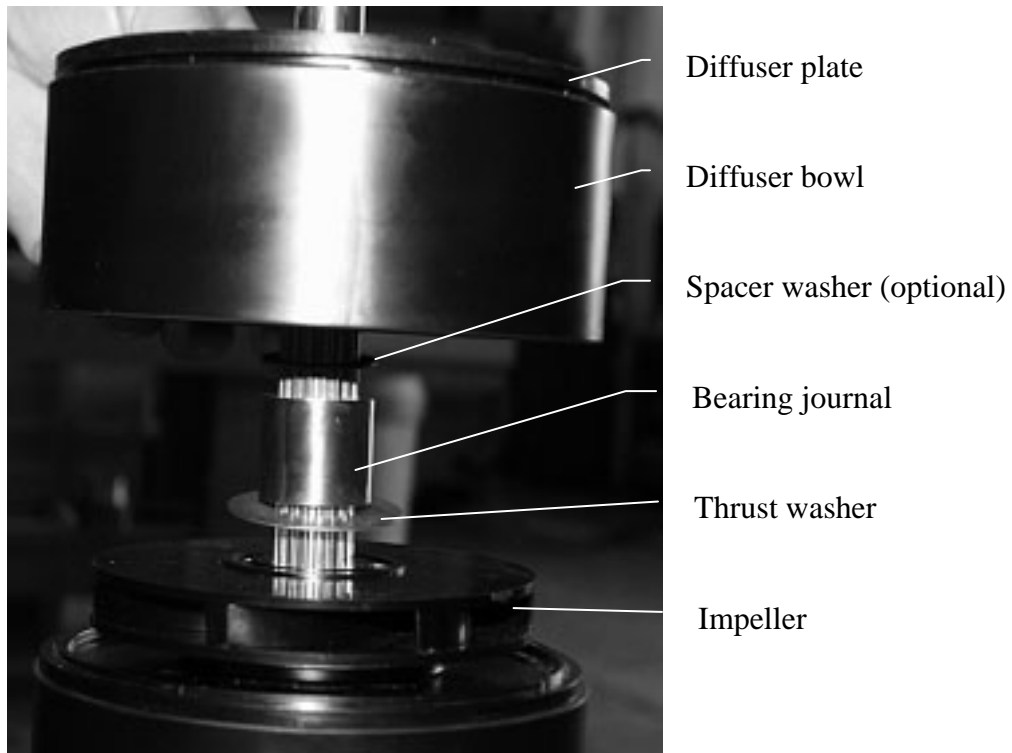
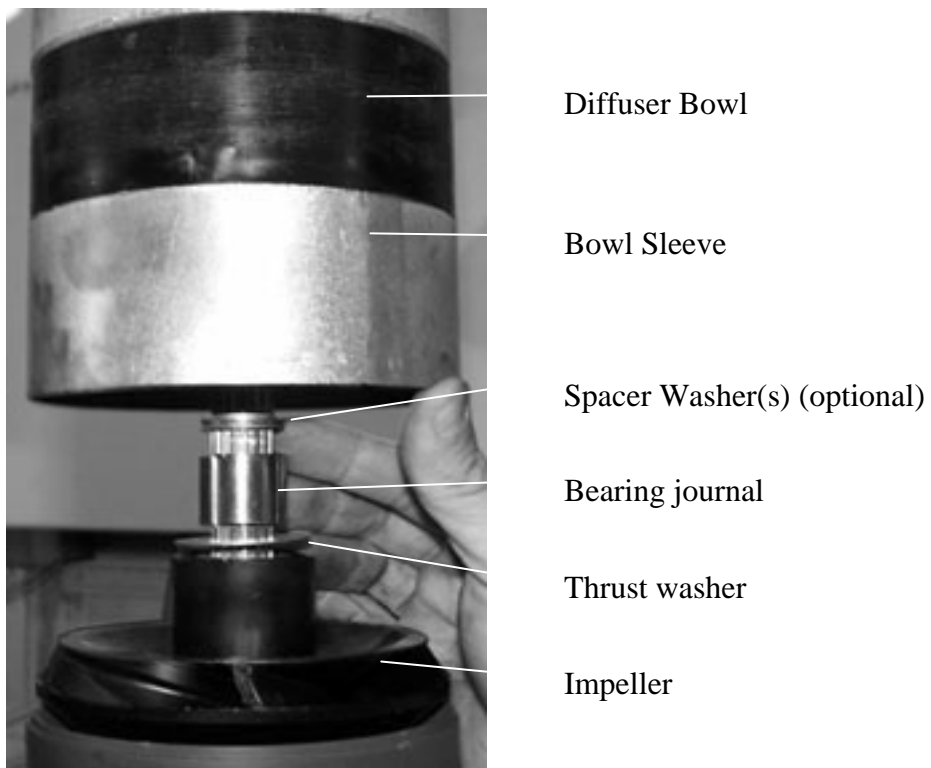


Figure 7-39 - Complete Stage Assembly for 2400-Series Pumps



11. Install the last diffuser plate. Install the snap ring as shown in Figure 7-40 or 7-41.

Figure 7-40 - Install Snap Ring, 2400-Series



Figure 7-41 - Install Snap Ring, 8500-, 1250-Series



12. Install the shell. Apply anti-seize only to the threads of the inlet housing and shell and wipe away excess. Use a lot of anti-seize to avoid galling and to facilitate disassembly, however, avoid getting anti-seize on the o-ring. Lubricate the o-ring with glycerin or liquid soap and install.
13. Screw the shell on to the inlet until it bottoms out and then apply enough torque with a strap wrench to make it tight as shown in Figure 7-43 below.
14. Install the outlet nozzle. Use sufficient anti-seize to avoid galling and to facilitate disassembly. Apply anti-seize only to the threads, wipe away excess and avoid getting anti-seize on the o-ring. Lubricate o-ring and install outlet nozzle. Apply 150 ft-lb (+20 ft-lbs – 0 ft-lbs) of torque to the outlet nozzle with a pipe wrench as shown in Figure 7-44 below. Insufficient torque will result in the bowls breaking free, spinning and pump failure.

Figure 7-42 - Install Shell and Outlet Nozzle

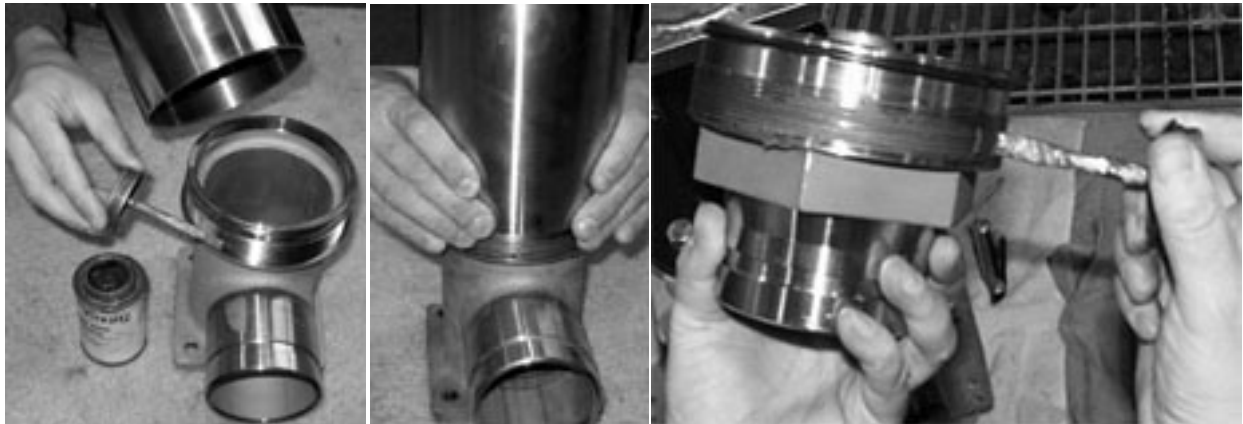


Figure 7-43 – Tighten Shell



Figure 7-44 – Tighten Outlet Nozzle



CAUTION

Insufficient torque on the outlet nozzle will result in the bowls spinning and pump failure.

15. At this point the wet end is completely reassembled. Check to see that the shaft can turn relatively free by hand. The purpose for the ideal impeller gap spacing is to keep the impellers free inside the bowls. The bowls are held in place by the compression applied by the outlet nozzle while the splined shaft spins the impellers. If the gap spacing is incorrect and the impellers rub/ interfere with the bowls, premature failure of the pump may occur. A small amount of rubbing during an initial break in period is acceptable.

After the pump is reassembled and back on the RO plant make sure that water is fully flowing through the unit before starting. The pump cannot be run dry for even a few seconds. Damage will occur in seconds if the pump runs with insufficient feed flow. Refer to Section 6.2 for complete start up procedures.

CAUTION

Never run the PX Booster Pump dry or with low feed flow. Operating with feed pressures less than 15 psi (1 bar) or below recommended the flow range can cause damage to the pump's internal components.

7.6 Motor Bearing Service

The motor bearings in ERI motors will provide a long service life if properly and regularly lubricated. The motor manual included in Section 12.0 provides guidance for proper motor maintenance. In case of bearing failure, ERI supplies the replacement bearings listed in Table 7-5.

Table 7-5 – Replacement Motor Bearings

BOOSTER PUMP MODEL	BACK LOAD BEARING	FRONT THRUST BEARING
HP-8503	10228-01	10227-01
HP-8504	10228-02	10227-03
HP-1253 GE	10228-02	10227-03
HP-1253 Leeson	10228-05	10227-04
HP-1254	10228-04	10227-02
HP-2402	10228-04	10227-02
HP-2403	10228-04	10227-02

In addition to the replacement bearings, the following tools are required: bearing puller, bearing heater, snap ring removal tool, rubber mallet, all-thread, and appropriate sockets and/or wrenches.

The following procedure describes removal and replacement of motor bearings. Consult the current motor manual on the motor vendor’s website for additional guidance or information:

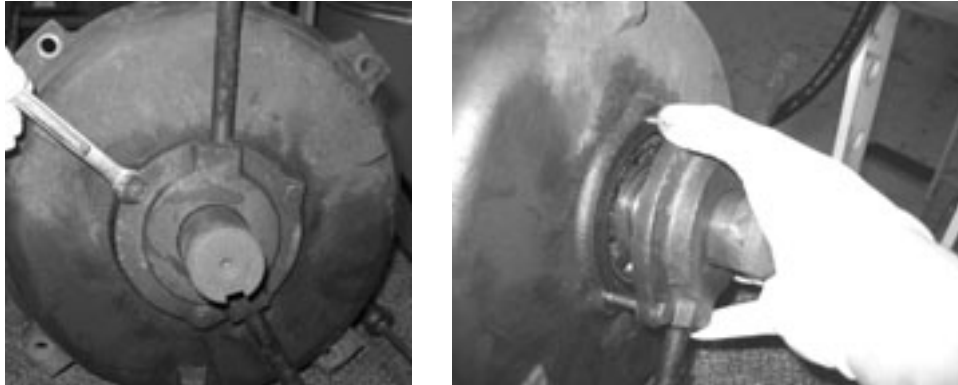
LEESON: http://www.leeson.com/literature/tech_info/
 GE: http://www.geindustrial.com/cwc/library?famid=23&lang=en_US)



Ensure motor is disconnected from power source before servicing.

1. Verify that the system is de-energized and de-pressurized. Disconnect the motor from the power source.
2. Disconnect the inlet and outlet connections of the PX Booster Pump and allow water to drain from system.
3. Disconnect and remove pump head according to steps 1 through 6 of the Mechanical Seal Change procedure provided in Section 7.3 .
4. Remove the bell housing.
5. Remove the coupling from the motor shaft. Disassemble the coupling as shown in Figure 7-10. Clean the coupling and the shaft keys to remove any salt deposits or debris.
6. Remove the fan cover from the motor.
7. Remove fan snap ring.
8. Remove the fan.
9. Remove the rubber slingers (x2).
10. Remove the bearing lubrication covers (x2). See Figure 7-45.

Figure 7-45 – Remove Bearing Lubrication Covers



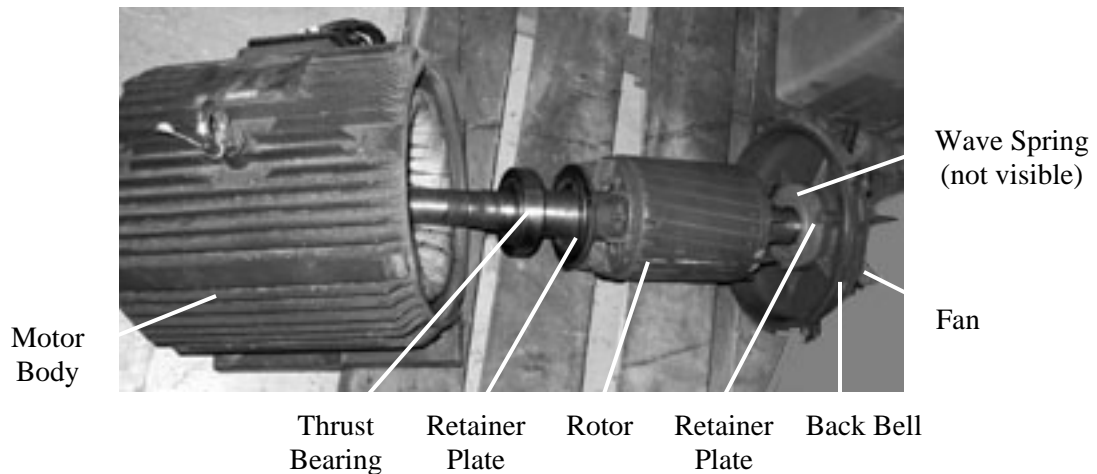
11. Remove the front bell from the motor body. See Figure 7-46.

Figure 7-46 – Remove Front Bell



12. Remove the back bell and the rotor and shaft assembly from the front of the motor body. See Figure 7-47.

Figure 7-47 – Remove Rotor and Shaft Assembly



13. Remove the thrust bearing retaining ring. See Figure 7-48.

Figure 7-48 – Remove Bearing Retaining Ring



14. Use a bearing puller to remove the thrust bearing from the front of the shaft and the back bearing from the back of the shaft. See Figure 7-49.

Figure 7-49 – Pull Bearing with Bearing Puller



15. To install replacement bearings, heat inner bearing ring to 180°F (82°C) and slide onto shaft. See Figure 7-50.

Figure 7-50 – Heat Inner Ring to 180°F (82°C)



16. Insert rotor assembly into motor body.
17. Install back bell onto rotor and shaft assembly. It maybe necessary to tap back bell with a rubber mallet to ease the assembly process.
18. Ensure wave spring is inside counterbore in back motor bell.
19. Slide bearing lubrication cover onto shaft.

20. Use a piece of all thread to pull back bearing retainer cover towards the bearing lubrication cover. Install bolts to fasten back bearing retainer cover to bearing lubrication cover as shown in Figure 7-51.

Figure 7-51 – Use All-thread to Align Retainer Plate



21. Bolt on back motor bell.
22. Reinstall back rubber slinger.
23. Install fan.
24. Install fan retaining ring.
25. Install fan cover.
26. Repeat the preceding steps for front motor bell installation.
27. Grease the bearings with a grease gun through the grease fittings. Use a high-quality bearing grease such as Shell Dolium R or Chevron SR1 2.
28. Reassemble the pump according the procedures provided above.
29. After motor is assembled and connected to power supply, apply power momentarily then switch off (bump). Retighten the bolts on the front and back motor bells.

8.0 TROUBLE SHOOTING

This section is designed to guide the operator in determining the probable cause of the most frequently encountered problems. This section can only be a guide to solving potential problems within the pressure exchanger system and cannot contain all possible malfunctions, nor can it contain all possible ways to determine the cause of a malfunction. The best troubleshooting tool is the knowledge of the plant gained through experience. Any condition not covered in this section may be resolved by contacting Energy Recovery, Inc.'s Service Department.

Preliminary procedures:

1. Always check for proper valve configuration for the operation mode selected.
2. Always check for loose connections or broken wires when checking electrical parts. Checking for continuity and solid contact can prevent hours of wasted effort.
3. Always inspect and test equipment or apparatus for probable cause of malfunction before performing replacement.

When using the troubleshooting guide read all the probable causes before taking any action. Use good common sense and then use the probable cause that most likely fits the given situation.

Table 8-1 - Troubleshooting

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
A. Motor fails to start upon initial installation	Motor is miswired.	Rewire motor according to wiring schematic provided.
	Motor damaged and rotor is striking stator.	May be able to reassemble; otherwise, motor should be replaced.
	Fan guard bent and contacting fan.	Replace fan guard.
B. Motor has been running, then fails to start.	Fuse or circuit breaker tripped.	Replace fuse or reset the breaker.
	Stator is shorted or went to ground. Motor will make a humming noise and the circuit breaker or fuse will trip.	Disassemble motor and inspect windings and internal connections. A blown stator will show a burn mark. Motor must be replaced or the stator rewound.
	Motor overloaded or load jammed.	Inspect to see that the load is free. Verify amp draw of motor versus nameplate rating.
	Capacitor (on single phase motor) may have failed.	First discharge capacitor. To check capacitor, set volt-ohm meter to RX100 scale and touch its probes to capacitor terminals. If capacitor is OK, needle will jump to zero ohms, and drift back to high. Steady zero ohms indicates a short circuit; steady high ohms indicates an open circuit.
	Starting switch has failed.	Disassemble motor and inspect both the centrifugal and stationary switches. The weights of the centrifugal switch should move in and out freely. Make sure that the switch is not loose on the shaft. Inspect contacts and connections on the stationary switch. Replace switch if the contacts are burned or pitted.

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C. Motor runs but dies down.	Voltage drop.	If voltage is less than 10% of the motor's rating contact power company or check if some other equipment is taking power away from the motor.
	Load increased.	Verify the load has not changed. Verify equipment hasn't got tighter. If fan application verify the air flow hasn't changed.
D. Motor takes too long to accelerate.	Defective capacitor	Test capacitor per previous instructions.
	Faulty stationary switch.	Inspect switch contacts and connections. Verify that switch reeds have some spring in them.
	Bad bearings.	Noisy or rough feeling bearings should be replaced.
	Voltage too low. Make sure that the voltage is within 10% of the motor's name.	plate rating. If not, contact power company or check if some other equipment is taking power away from the motor.
E. Motor overload protector continually trips.	Load too high.	Verify that the load is not jammed. If motor is a replacement, verify that the rating is the same as the old motor. If previous motor was a special design, a stock motor may not be able to duplicate the performance. Remove the load from the motor and inspect the amp draw of the motor unloaded. It should be less than the full load rating stamped on the nameplate.
	Ambient temperature too high.	Verify that the motor is getting enough air for proper cooling. Most motors are designed to run in an ambient temperature of less than 40°C. (Note: A properly operating motor may be hot to the touch.)

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	Protector may be defective.	Replace the motor's protector with a new one of the same rating.
	Winding shorted or grounded.	Inspect stator for defects, or loose or cut wires that may cause it to go to ground.
F. Low flow and/or pressure.	Blockage in piping	Check valves and piping.
	Backwards motor rotation	Check rotation and electrical phase connections.
	Flow meter and/or gauge failure. Damaged or blocked stage assemblies.	Check and calibrate instruments and gauges. Check and replace stage assemblies as required.
G. Motor stalled	Power failure or trip.	Verify proper power and voltage connections. Check motor overload mechanisms. I.e. Fuses and /or circuit breakers. Check fuses.
	Jam or block in impeller and stage assemblies. Damaged motor.	Check and replace stage assemblies as required. Replace motor.
H. Leak	Leaky connection.	Check couplings.
	Mechanical seal failure.	Inspect and/or replace mechanical seal.
	Damaged o-ring.	Inspect o-rings.
I. Excessive noise	Excessive flow rate.	Lower flow rate or apply backpressure to pump.
	Insufficient feed water.	Check feed pressure and inspect wet end assembly.
	Motor bearing failure.	Check motor bearings and/or replace motor.

9.0 ERI FIELD COMMISSIONING

The Technical Services staff of ERI offers commissioning service for all our related products whether it is in a field installation or at a RO system manufacturer's location. Although commissioning is not a requirement, some customers might feel more comfortable with the offered service. Rates can be quoted upon request.

Should a problem develop with any ERI product, our Technical Services group is prepared to handle customers' concerns whether the location is domestic or overseas. Service rates are available upon request.

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10.0 WARRANTY AND LIABILITY

Energy Recovery, Inc. (ERI) warrants that its PX Booster Pump(s) will not fail or malfunction as a result of defects in materials, workmanship, or design for a period of twelve (12) months from date of shipment.

Application

This Warranty (i) extends to the original purchaser only, (ii) covers a PX Booster Pump that is installed and put to use at the intended site and under the intended conditions (unless written approval for installation at some other location is obtained from ERI), and (iii) shall apply only if ERI's written Installation, Operation, and Maintenance instructions and Buyer's Responsibilities have been complied with in full throughout the warranty period. This Warranty shall not apply to damage or wear to a PX Booster Pump caused by unprotected storage, abnormal operating conditions, or to accidents, abuse, misuse, or improper disassembly, alterations, or repair.

Limitations

This Warranty is sole and exclusive and in lieu of any rights or remedies otherwise available at law or in equity. In no event shall ERI be responsible or held liable for any indirect, special incidental, or consequential type damages including, by way of example but not by way of limitation, loss of profit, loss of use, loss of product or feedstock, business interruption, or damage caused by the installation or use of ERI's products, however caused, including the fault or negligence of ERI. ERI's aggregate liability shall not exceed an amount equal to the Purchase Price.

Remedy

If a PX Booster Pump covered under this Warranty becomes inoperative, ERI will, at its option, either promptly repair or replace the faulty unit. Repair or replacement parts will be supplied Ex-works, San Leandro, California without charge to Buyer except that Buyer shall be responsible for applicable taxes, duties, and installation costs. ERI shall evaluate and repair or replace the inoperative PX Booster Pump according to the terms of its Return Material Agreement.

Buyer's Responsibilities

The Buyer shall comply with ERI's written Installation, Operation, and Maintenance Manuals and ERI's other manuals, instructions, and recommendations. In addition, Buyer shall be responsible for performance or forbearance as follows:

1. Buyer shall maintain complete and accurate operating records for the PX Booster Pump. These records must show that the PX Booster Pump is operated consistently within the maximum flow and pressure limits listed in ERI's Installation, Operation, and Maintenance Manuals as updated from time to time on ERI's website: <http://www.energy-recovery.com>. Buyer will record all of the operating parameters required by ERI at least once per day. Buyer shall make available to ERI all PX Booster Pump and plant operating records at any time during normal working hours.

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2. The maximum operating flow through the PX Booster Pump must not be less than the minimum rated capacity.
3. Maximum operating pressure must not exceed 1,200 psi [83 bar].
4. All piping shall be cleaned and flushed with water so that all construction debris is removed from the system before installing or operating the PX Booster Pump.
5. In preparation for extended plant shutdowns, PX Booster Pumps must be flushed with permeate and a biocide.

11.0 REVISION LOG

Table 11-1 - Revision Log

Revision	Description	Date	Approval
-	Initial Release	10-25-01	JPM
A	Update photos and as built.	05-03-02	JPM
B	Update procedures and photos. Add seal compression and shim instructions.	11-21-03	RLS
1	Update spare parts numbers, seal change procedure, add RMA form, update drawings	5-13-04	RLS
2	Trademarks, revised pump curves, added motor bearing service, added warranty	1-24-05	RLS
3	Revised warranty, pump curves	8/11/05	RLS

12.0 DRAWINGS AND DATA

1. PX Booster Pump Assembly Drawings, Overall Dimensions and Labeling Diagrams, Shipping Configuration Drawings
2. PX Booster Pump Characteristic (Pump) Curves