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INSTALLATION OPERATION AND MAINTENANCE MANUAL

VERTICAL INLINE SINGLE STAGE PWI SERIES

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Section 1 – *PWI Pump Description*

The PumpWorks 610 PWI pump is a single stage, vertical in-line centrifugal pump manufactured in accordance with the American Petroleum Institute (API) Standard 610.

Our PWI-BB (OH3) design features a vertical bearing housing system to take the radial and axial forces exerted upon the pump, and connects the pump and driver with a flexible spacer coupling. The standard PWI (OH4) design relies on the bearings in the vertical driver to take the forces, and utilizes a rigid spacer coupling design. Both systems allow for the removal of the mechanical seal without removing the driver or suction and discharge piping.

NOTE: *All reference numbers (provided in parentheses) in this manual refer to the typical sectional drawing, Figure 3.*

Section 2 - *Handling & Storage*

Inspection

Upon receipt, carefully inspect the unit for damage and validate against the bill of lading. Report any damaged or missing items to the carrier's local representative and submit a copy of the report to PumpWorks 610. While removing packaging do not discard any small accessories that may be attached.

Handling

Lift the complete unit using the provided lifting lugs on the pump driver stand (3160) with proper lifting techniques.

Storage - Short Term

When storing the unit for less than 6 months prior to installation, store on a skid in a dry location to protect the unit from moisture, sand, grit and other contaminants. Do not remove the provided protective covers on the suction and discharge flanges.

Storage - Long Term

When storing the unit more than 6 months prior to installation, the pump must be covered or stored indoors. Perform the following upon receipt and at 6 month intervals:

1. (PWI-BB only) Prior to storage, remove the oil vent plug and fill the bearing housing with one quart of vapor emitting oil. Reinstall vent plug.

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2. Coat all unpainted exterior machined surfaces liberally with a light petroleum grease or equivalent rust preventative.
3. Rotate pump shaft (2210) 3.5 turns (180º from original position).
4. Remove the protective covers on the suction and discharge flanges. Remove any visible rust on internal surfaces and coat with a light petroleum grease or equivalent rust preventative. Replace protective covers on the flanges.

NOTE: *Accumulation of condensation in the unit must be avoided. Store the unit away from climatic extremes.*

When auxiliary equipment such as drivers, mechanical seals (4200), or instrumentation is provided, additional preparation for long term storage may be required. Refer to the appropriate manufacturer's literature for specific instructions.

Section 3 - *Installation*

General

Support and anchor suction and discharge piping independently near the pump so strain will not be transmitted to the pump casing when flange bolting is tightened. Piping must independently align with the pump flanges; never force piping into place at suction or discharge flanges.

If an expansion joint or non-rigid pipe coupling is used, install a pipe anchor as near to the suction and/or discharge flanges as possible. Proper installation of the pipe anchor will eliminate any undesirable forces on the pump.Use large-radius elbows wherever possible. Flush all piping thoroughly to remove any foreign matter before connecting to the pump. Per the Hydraulic Institute, there should be at least five to ten pipe diameters of straight pipe length coming into the suction before the first fitting, strainer, or valve is installed, and it is preferable to have the same conditions after the discharge.

Location

The unit should be positioned as close to the suction source as practical, in order to optimize suction conditions, while ensuring sufficient clearance around the unit to allow for cooling and maintenance accessibility.

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Suction Piping

1. The nominal suction pipe diameter must be the same size as the nominal suction flange size.

2. Ensure that suction lines are sealed to avoid leakage and air pockets.

3. Per the Hydraulic Institute, reducers, if used, should be of the conical type and sufficiently long to prevent fluid turbulence. Contour type reducers are not recommended.. Eccentric or concentric reducers may be used when the liquid source is above the pump and the suction piping is sloping upwards toward the source.

4. Start-up, cone-type suction strainers should be used and must have a net free area of at least three times the suction pipe area; they should point upstream into oncoming flow.

5. Installing a gate valve in the suction line permits closing the line for pump inspection and maintenance.

CAUTION: *Never throttle the pump with the suction valve; while pump is in operation, this valve should always be fully open.*

Discharge Piping

1. A check valve and gate valve should be installed in the discharge piping. The check valve, placed between the unit and gate valve, prevents pumpage from running back through the unit. The gate valve is used in priming, starting, and shutdown of the unit and to control discharge flow.

2. If increasers are used in the discharge piping, they should be located between the check valve and the unit.

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Section 4 - *Preparing for Operation*

General

When pumps and drivers are received from the factory with the motor installed and pinned on the pump driver stand, they have been accurately aligned before shipment. Realignment is necessary after the suction and discharge piping have been installed.

Alignment should be checked after working on the mechanical seal or removing the driver to ensure minimal repair and maintenance of the unit after re-assembly.

Driver Lubrication

Motor bearings should be serviced and lubricated as outlined in the motor manufacturer's instructions. For the PWI (OH4), all pump hydraulic thrust loads are taken by the motor bearings.

Bearing Housing Lubrication (PWI-BB only)

The bearing housing incorporates an oil flinger and pumping ring to circulate oil to the bearings. Fill the bearing housing to the proper level (Centerline of the bull's eye) with ISO/ASTM VG 32 oil. For lubrication changing intervals, refer to Section 7 Operational Checks.

The constant level oiler bottle will be found already mounted to the bearing housing. Adjustment should be made as detailed below:

Fill the bearing housing with proper grade of oil through the constant level oiler cup to 1/4" (6.35 millimeters) below the level mark. Then fill the oiler bottle with oil and place it in the oiler cup. The housing is filled when oil remains in the oiler bottle.

If the oil level is not at the proper level, remove bottle and reset level adjuster (See Figure 1). Replace bottle (repeat operation until proper level is obtained). Thereafter, it is only necessary to keep bottle filled with oil.

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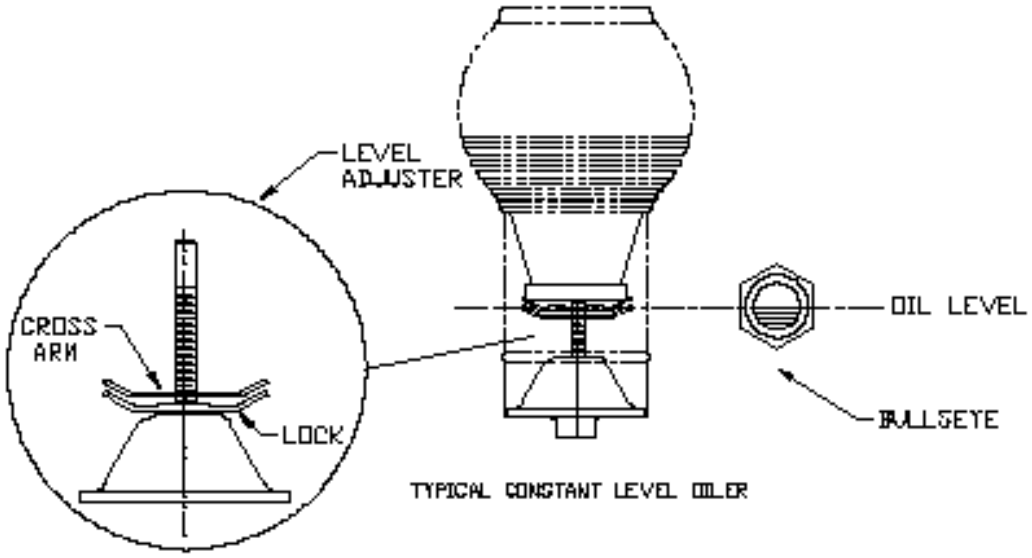

Figure 1

Mechanical Seals

As a standard, the PWI pump is equipped with a cartridge-type mechanical seal (4200), which complies with the service requirements outlined on the pump data sheet. The seals are factory-installed, and no adjustment is required.

NOTE: *Seal setting devices must be disengaged prior to start-up, but are required to be installed when removal of the coupling spacer is necessary. The mechanical seal is not designed to withstand the entire weight of the rotating assembly.*

Seal Flush Piping

Seal flush piping should be installed in accordance with the service requirements outlined in the pump data sheet and the seal manufacturer's recommendations. Vent seal cavity to prime seal and piping prior to start up. Refer to the general arrangement drawing and auxiliary system IOM details, as necessary, provided in the final data package.

Rotation

The driver rotation must be verified prior to start-up. To check rotation, remove the coupling guard **and coupling spacer** to disengage the pump from the driver. Make momentary contact with the motor starter, also known as a “bump test”, to verify correct rotation.

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WARNING: *Keep clear of rotating components when checking the motor rotation. Be sure that tools and loose hardware are clear before starting motor.*

Alignment of Spacer Type Couplings (OH4 only)

WARNING: *Be sure that power to the motor is off and locked out before removing or installing the coupling or coupling guard.*

A spacer type coupling is used between the pump and driver. To align the spacer coupling, first replace the mechanical seal setting devices per the seal manufacturer's guidelines, loosen the set screws fastening the seal drive collar to the shaft, remove the spacer between the pump and driver, then remove the pump coupling hub and mechanical seal. Either construct solid brackets or use magnetic clamps, as shown in Figure 2, in order to hold both dial indicators at the required locations.

NOTE: *All T.I.R. measurements are to be taken perpendicularly to each face marked in Figure 2.*

Position 1: Fix one bracket/clamp to the motor coupling hub horizontal face and assemble the dial indicator so that it is located and oriented on the seal chamber bore. Fix the other bracket/clamp to the pump seal chamber horizontal face and assemble the dial indicator so that it is located and oriented on the outer diameter of the motor coupling hub flange as shown. Maximum total run-out readings on both dial indicators shall be per coupling manufacturer recommendation, and not exceed 0.005" T.I.R. If the runout exceeds this value, loosen the motor mounting bolts and realign the motor. Once the motor is realigned, carefully tighten the motor mounting bolts and repeat this procedure as many times as necessary.

NOTE: It is not necessary to have two dial indicators. Position 1 can be done as a two-step process with a single indicator.

Position 2: Using the first bracket mounted to the motor hub, align the dial indicator on the back face of the case cover plate. The runout should not exceed 0.002".

Position 3: Mount a bracket on the back of the case cover face, seen as the left bracket in the figure, and align the indicator to the inside edge of the motor hub. The runout should not exceed 0.0005".

Position 4: Using the same bracket mounting face location from the third position, check the runout of the motor hub by indicating on the face as shown. This runout should also not exceed 0.0005".

Position 5: Do a final check on the pump shaft by fully assembling the coupling and setting up a bracket on the case cover face and indicating on the shaft. This runout should not exceed 0.002".

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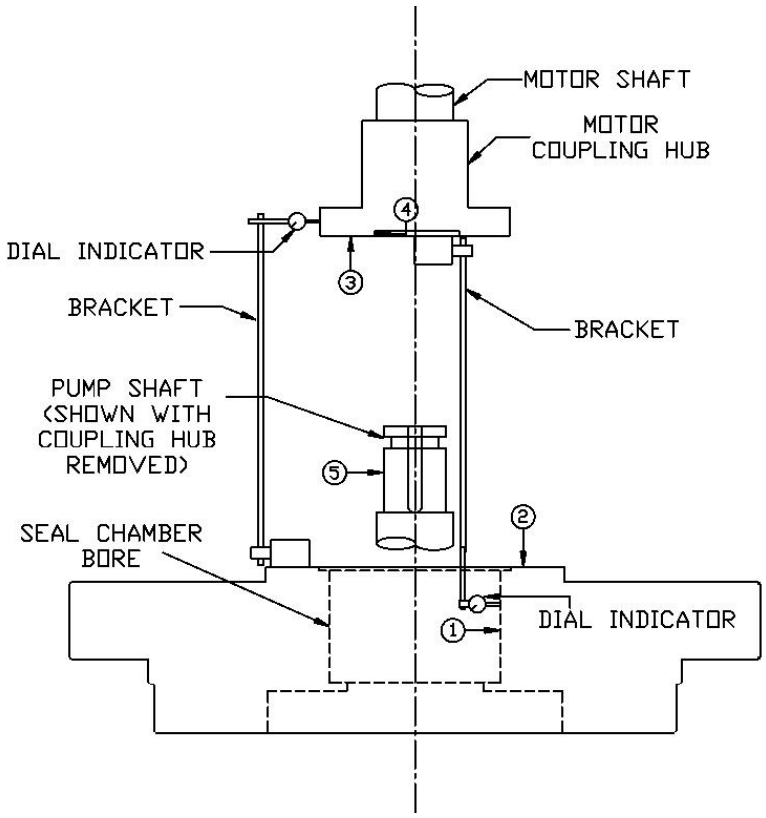

Figure 2

High Temperature Operation

Pumps handling liquids at temperatures above 300º F (150º C) should be gradually brought to operating temperature prior to start-up. This can be accomplished by circulating hot pumpage through the pump and controlling the circulation so that the pump casing temperature rise does not exceed 150º F (37.8º C) per hour. The pump casing temperature must be within 75º F (24º C) of the pumpage before start-up and operation.

WARNING: *Bring the pump up to the operating temperature slowly before start up. Severe thermal shock can damage the pump and cause injury*.

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Section 5 – *Operation*

Operating Capacity

Centrifugal pumps should not be operated at greatly reduced capacity or with a closed discharge valve because the energy required to drive the pump is converted to heat and the temperature of the liquid may reach its bubble point. If this occurs, the rotating parts are exposed to vapor with no lubrication and damage to internal parts will occur.

There are several ways to protect the pump from damage:

1. Add a liquid temperature sensor to shut the pump down if the pumpage temperature exceeds a predetermined level. See the High Temperature Operation passage of Section 4 for some guidelines.
2. Add a flow meter to the suction with an alarm level set for the minimum continuous safe flow (MCSF) ability of the pump, which can be found on the pump data sheet. Operating below the MCSF increases the radial loading on the system, which can lead to shortened bearing life, increases the NPSH of the pump, and can lead to internal cavitation.
3. Installing a constant open minimum-flow by-pass between the pump discharge and the suction source should unexpected blockage occur in the pipeline.
4. Adding a suction pressure sensor upstream from the pump to shut the pump down if the suction pressure drops below a predetermined level.
5. Adding a vibration sensor to shut the pump down if the vibration level exceeds a predetermined value.

NOTE: *Never throttle pump on suction side. The suction valve should always be fully open during pump operation.*

Freezing

During cold weather when the pump is not in operation, the pump should be drained to prevent the liquid inside from freezing. Proper storage procedures should be followed while the pump is not in use.

WARNING: *If the pumpage is toxic, flammable, or corrosive, take proper precautions for handling pumpage before draining the pump.*

Shut-Down

To avoid water hammer, it is recommended that the discharge valve be partially closed to the minimum flow point just prior to shut-down of the pump.

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Section 6 - *Starting the Pump*

Start-up Checklist

Before starting the pump, check the following:

_ Pump rotation direction matches motor rotation direction (bump test)
_ Seal setting devices removed per seal manufacturer's recommendations
_ Seal flush piping is properly installed
_ Pump vent and drain lines installed, and any vent and drain valves closed after pump is primed.
_ Motor bearings lubricated per motor manufacturer's recommendations
_ (PWI-BB only) Pump bearing housing has the appropriate level of oil to lubricate the pump bearings.
_ Pipe connections and plugs tightened and sealed
_ Coupling spacer installed and pump and driver aligned
_ Pump shaft rotates 360º freely
_ Coupling guards installed
_ Pump and all auxiliary systems are fully vented
_ Suction valve fully open
_ Discharge valve in start-up position
_ Instrumentation connections made
_ All personnel clear of equipment

Priming

NOTE: *The pump casing, suction line and seal flush must be filled with liquid and fully vented BEFORE the pump is started.*

Starting

A centrifugal pump usually requires less power to operate with the discharge valve closed than with the discharge valve open. For this reason, it is recommended that this valve be partially closed when starting. However, **ensure the pump is not operating below the minimum stable flow conditions at any time**.

Start the pump and immediately bring to operating speed. Slowly open the discharge valve as soon as there is a discharge pressure indication. Continue opening the discharge valve until rated capacity and discharge pressure are obtained. If the rated conditions cannot be obtained, refer to the Trouble Checklist in Section 8.

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Section 7 - *Operational Checks*

First 60 Minutes

It is recommended that the following parameters be recorded at 10 minute intervals during the first 60 minutes of operation and periodically thereafter:

1. Suction and discharge pressures
2. Pumpage temperature
3. Vibration levels
4. Leakage
5. (PWI-BB only) Bearing housing temperature

Satisfactory operation is indicated by correct capacity, discharge pressure, and low vibration levels. Keep records for future troubleshooting reference and performance trend analysis.

A periodic check of the items listed above will ensure the pump is maintained in its best operating condition.

Mechanical Seal

Check mechanical seals for leakage during the first hours of operation. Minor leakage through the seal usually stops after a short operation period, but, if leakage continues, shut down the pump and investigate the cause. Excessive leakage past the seal generally indicates worn or broken parts requiring replacement.

Lubrication

Driver Lubrication

Driver bearings should be serviced and lubricated according to the motor manufacturer's instructions. Consult lubrication directions on nameplate and literature provided in the final data package.

Pump Lubrication (PWI-BB Only)

Great care should be exercised to keep the housing clean and only clean lubricants should be used. Foreign solids or liquids within the bearing housing can completely ruin the bearings in a short time. Keep the oiler bottle filled with the correct grade of oil (See Section 4). Under normal conditions the oiler will maintain proper oil level. A routine check of the oil level will verify proper working order of the oiler.

After the initial start-up, change the oil after 24 hours of running time. Thereafter, change the oil at the following intervals:

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Service	Change	Check Level
High Temp	Monthly	Daily
Continuous	Every 3 Months	Weekly
Intermittent	Every 6 Months	Monthly

Table 1

When changing the oil, flush the inside of the housing with clean oil to remove any accumulated contaminants.

Due to rolling friction and drag of the bearing races, heat is generated within the bearings and they will operate at temperatures above the surrounding atmosphere unless cooled. Oil lubricated ball bearings can safely be operated up to 180°F (82.2°C) and bearing temperatures of 160°F (71.1°C) are normal. **Do not use the human hand as a thermometer.** Determine the temperatures accurately by placing a contact type thermometer against the bearing housing. Record this temperature on a regular basis and maintain a log of the reading. A stable temperature indicates normal operation.

Sudden increases in temperature or excessively high temperature are indications of operational problems or a pending bearing failure.

Check to see that oil is of proper viscosity and the oil level is neither too high nor too low.

The unit should also be checked for unstable hydraulic operation and unnecessary mechanical loads, such as shaft misalignment.

Bearing Housing Temperatures

Periodically check bearing housing surface temperature. Normal bearing housing operating temperature is 125° - 180° F (50º - 80º C).

NOTE: *Stop the pump immediately if bearing housing temperature exceeds 190° F (88° C). Inspect for possible problems such as those stated above before restarting the pump.*

NOTE: ***Bearing housings equipped with water cooling coils are to be adjusted to operate so as to maintain an oil temperature no less than 25°F above the surrounding ambient temperature to prevent condensation.***

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Section 8 - *Trouble Checklist*

No Liquid - No liquid discharge from the pump may be caused by:

1. Pump not primed.
2. Speed too low--check to see if motor receiving full voltage.
3. Insufficient NPSH available.
4. Impeller or piping plugged.
5. Wrong rotation.
6. Air leaks or pockets in suction line.

Insufficient Liquid - Insufficient liquid discharge may be caused by:

1. Speed too low.
2. Suction lift too high or insufficient NPSH available.
3. Impeller or piping partially plugged.
4. Wrong rotation.
5. Air leaks or pockets in suction line.
6. Mechanical defects (worn wear rings or impeller damage).

Insufficient Pressure - Insufficient pressure may be caused by:

1. Speed too low.
2. Air or gases in liquid.
3. Capacity too great.
4. Mechanical defects (worn wear rings or damaged impeller).
5. Wrong rotation.

Surges in Performance - Surges in performance may be caused by:

1. Air leak in suction line.
2. Air pocket in suction line.
3. Not enough NPSH available.
4. Air or gases in liquid.
5. Impeller plugged, or unplugged, by debris.
6. Unstable current to the motor.

Excessive Power - Excessive power consumption may be caused by:

1. Improper operational speed.
2. Head too low (causing excessive capacity).
3. Specific gravity or viscosity of liquid pumped has been modified from its originally rated condition.
4. Mechanical defects (bent shaft, worn wear rings, etc.).
5. System resistance is too low, causing excessive pump flow.

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Section 9 - *Maintenance*

General

The procedures given below are general and apply to all PWI pumps. For procedures specific to a particular unit, refer to the drawings and instructions supplied in the final data package with that unit.

WARNING: *Be sure that power to the motor is off and locked out before starting maintenance procedures.*

Pump Disassembly

The disassembly procedure applies generally to the PWI series supplied with a cartridge-type seal. Refer to the specific drawings supplied with your unit to augment this procedure.

NOTE: *Typical sectional drawings are for disassembly and assembly purposes only and should not be used for specific detailed dimensions.*

1. Turn power off and lock in off position.

WARNING: *Be sure the power to the motor is turned off and locked in the off position before beginning disassembly.*

2. Close suction and discharge gate valves and any auxiliary valves.

NOTE: *The back pull-out design of this pump allows the complete Back Pull-Out unit to be removed without disturbing the suction and discharge piping or the driver.*

3. Drain the pump by opening the case drain.

WARNING: *If the pumpage is toxic, flammable or corrosive take proper precautions for handling pumpage before draining the pump.*

4. Disconnect and remove all seal flush piping after the pump is completely drained.

5. If the pump is equipped with an auxiliary seal flush reservoir, drain the reservoir and disconnect the seal flush piping.

NOTE: *Always cap off open ports and lines to prevent dirt from entering.*

6. Remove coupling guard.

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7. Replace seal setting devices per seal manufacturer's recommendation, then loosen set screws fastening seal drive collar to shaft (2110). Remove nuts (6580.2) attaching seal (4200) to casing cover (4100).

8. Disassemble and remove coupling spacer. Remove pump coupling hub and coupling key (6700.2).

9. **(PWI ONLY)** Remove mechanical seal (4200) from casing cover (4100). Refer to seal manufacturer's guidelines for proper mechanical seal maintenance.

10. With lifting strap or hook attached to driver eyebolt or lifting lug, remove cap screws that secure driver to driver stand (3160) and lift driver off of the driver stand.

11. Remove cap screws (6577) that secure driver stand (3160) to pump casing (1110) or casing cover (4100) and lift driver stand off of pump casing or casing cover.

WARNING: *Do not work under a heavy suspended object unless there is a positive support under it which will protect personnel should a hoist or sling fail.*

CAUTION: *The back pull-out unit is heavy. Proper lifting equipment must be used to avoid injury*.

12. Remove nuts (6580.1) attaching casing cover (4100) to pump casing (1110) and remove casing cover by tightening jack bolts in the tapped holes in casing cover to facilitate removal of the rotating assembly. Remove casing gasket (4510).

(PWI-BB ONLY) WARNING: The back pull out unit with the bearing housing is very heavy. Proper lifting equipment must be used to avoid injury.

Disassembly of Back Pull-Out Unit (OH4 Only)

After the complete back pull-out unit has been taken to a clean work area, the unit can be fully dismantled by following the instructions given below.

1. Remove impeller locknut setscrew and impeller locknut (2912).

NOTE: *The impeller locknut loosens in a clockwise direction. It has a left hand thread.*

2. Remove impeller (2200) and impeller key (6700.1). The impeller is a slip fit but may require the use of a puller for removal.

CAUTION: *Do not bend or damage the impeller when removing with a puller.*

3. To disassemble casing/casing cover wear rings (1500.1, 1500.2) remove set screws holding the wear ring. Remove the wear ring. Note that some wear rings are fuse-welded in place; in this case, grind off the fuse welds and remove the wear rings.

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4. To remove the sleeve bearing (3000), use a press. Examine casing cover (4100) to ensure there is no damage that will prevent installation of a new sleeve bearing.

CAUTION: *Sleeve bearings are typically made of a soft carbon material. Too much force or impulse will cause the sleeve bearing to crack or shatter.*

Disassembly of Back Pull-Out Unit (PWI-BB Only)

After the complete back pull-out unit has been taken to a clean work area, the unit can be fully dismantled by following the instructions given below and referring frequently to the pump sectional drawing Figure 4.

1. Remove impeller locknut set screw, if installed, and impeller locknut (821-1). NOTE: *The impeller locknut loosens in a clockwise direction. It has a left hand thread. Also, some lock nut designs do not require set screws.*

2. Remove impeller and impeller key. The impeller is a slip fit but may require the use of a puller for removal. (805, 811-1)
CAUTION: *Do not bend or damage the impeller when removing with a puller.*

3. Remove inboard heat sink guards.

4. Engage seal locating devices. Loosen the cartridge seal drive collar set screws. Refer to seal drawing in final data package.

5. Unscrew cap screws holding bearing bracket (849) to casing cover (802) and pull casing cover and seal from remaining rotating assembly.

CAUTION: *When separating the casing cover from the bearing bracket, be careful not to damage the mechanical seal.*

6. Unbolt and remove the cartridge seal assembly and seal chamber gasket from casing cover. Refer to the manufacturer's instructions for seal maintenance.

7. To disassemble casing/cover wear rings (808-1,2), remove set screws holding the wear ring. Remove the wear ring. NOTE: *Some Wear Rings Are Fuse Welded In Place.*

8. To remove the throat bushing (847), grind off welds between cover and bushing and remove bushing.

9. For disassembly of bearing bracket see following instructions.

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Bearing Bracket Disassembly (PWI-BB Only)

After dismantling the casing cover, the bearing bracket can be disassembled.

1. Remove pump coupling hub and drive key.

2. Remove the fan guard (812), inboard heat sink (829-2), and fan (853) as applicable.

3. Loosen capscrews and remove outboard end cap/bearing seal assembly (813-2, 829-2), and plastic shims (815-3).

4. Slide shaft assembly out of bearing bracket.

5. Remove ball bearing locknut and lockwasher (821-2 and 831) from fan shaft.

6. Using an arbor press with appropriate fixturing, remove thrust bearings (881-2) and radial bearing (881-1) from the pump shaft.

7. Remove oil rings (817) from shaft or loosen set screws and remove oil flinger.

Inspection of Pump Parts

Clean all parts with an appropriate cleaning solvent and inspect for wear or damage. Closely inspect sleeve bearings, wear rings, and shaft keyways and keys. Replace any part that shows signs of wear or damage.

Impeller

Inspect impeller (2200) passages and vane surfaces for evidence of erosion. Replace if excessively worn or corroded. The impeller is dynamically balanced at the factory, and balance must be maintained for proper operation of the pump.

Case & Impeller Wear Rings

Impeller wear rings (1500.1, 1500.2, 2300.1, 2300.2) are always provided on the front of the impeller, and may or may not be on the back side depending on the specific process conditions (2200). These rings allow a small clearance to be maintained between the rotating impeller and the stationary casing (1110). For proper hydraulic performance, rings should be replaced when excessive increase in clearance begins to affect performance.

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Standard Minimum Running Clearances (API 610)

Wear Ring Diameter (in)	Min. Diametrical Clearance	
	(in)	*(µm)*
3.500 - 3.999	0.014	356
4.000 - 4.499	0.015	381
4.500 - 4.999	0.016	406
5.000 - 5.999	0.017	432
6.000 - 6.999	0.018	457
7.000 - 7.999	0.019	483
8.000 - 8.999	0.020	508
9.000 - 9.999	0.021	533
10.000 - 10.999	0.022	559
11.000 - 11.999	0.023	584
12.000 - 12.999	0.024	610
13.000 - 13.999	0.025	635

Table 2

NOTE: *For materials with known galling tendencies, and for all materials operating at temperatures above 500º F, add 0.005"(127 micrometers) to the above diametrical clearances. Pumps utilizing special non-galling wear materials may use smaller wear ring clearances. The clearances referenced above act as a guideline, with the final clearances determined by PumpWorks 610 for each process condition.*

Seals

Inspect all mechanical seals (4200) for irregularities or damage. Consult the seal manufacturer's data for seal reconditioning and service. Seal faces, "O" rings and the seal sleeve must be in perfect condition. Replace all worn parts.

Shaft

Inspect the shaft (2110) for damage and straightness. Dress minor damage and polish areas where the shaft contacts a seal. Support the shaft in rollers or V-blocks about ¼ of the overall length from each end and check run-out. Run-out must not exceed .002 inch TIR on all diameters.

General

All parts should be cleaned before assembly. This is especially important at "O" ring grooves, threads, cylindrical fits and gasket surfaces. Any burred edge must be removed before part is installed into the pump. Coat all parts with light oil and cover with protective cloth if the pump is not immediately reassembled.

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Assembly

When assembling this pump it is recommended that only genuine PumpWorks 610 parts be used. Always use new O-rings, gaskets and lock washers. Assembled parts must be clean and free of dust or dirt.

Assembly of Pump Unit (OH4 Only)

The pump unit can be reassembled by following the instructions given below.

1. If removed during disassembly, press sleeve bearing (3000) into casing cover (4100).

CAUTION: *Sleeve bearings are typically made of a soft carbon material. Too much force or impulse will cause the sleeve bearing to crack or shatter.*

2. If removed during disassembly, press, or cryogenically shrink, casing or casing cover wear rings (1500.1, 1500.2) into casing (1110) and fusion weld in four places, equispaced. Check rings for proper clearance to the impeller rings (2300.1, 2300.2).

3. Lubricate pump shaft (2110) and slide cartridge seal (4200) onto shaft with seal setting devices in place.

CAUTION: *Care must be taken not to damage seal sleeve gasket or seal faces.*

4. Place seal gland gasket on pilot or in groove of casing cover (4100).

5. Slide casing cover (4100) over pump shaft (2110) from the impeller side.

6. Install casing gasket (4510) over casing cover (4100) pilot outer diameter.

7. Install impeller key (6700.1) and impeller (2200). Due to the small clearance between the impeller bore and mating shaft (2110) diameter, gentle force with a soft mallet may be required to ensure impeller is fully seated against shaft shoulder.
8. Lift back pull-out unit (impeller, shaft, casing cover, and seal) with shaft (2110) axis oriented vertically and install casing cover (4100) on casing (1110) and tighten casing stud nuts (6580.1) evenly, alternating between diametrically opposed nuts in a circular pattern.

9. Using the pilot outer diameter on the casing (1110) or casing cover (4100), install the driver stand (3160) on the casing or casing cover. Tighten cap screws (6577) mating the driver stand to the casing or casing cover.

10. If motor was removed from driver stand (3160), install the motor on the driver stand.

11. Install coupling hubs and spacer and lubricate if required.

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12. Tighten seal gland nuts (6580.2) evenly until metal to metal contact is realized between seal gland and cover.

13. Check shaft alignment for proper coupling performance. Refer to Preparation For Start-Up.

14. Remove seal setting devices.

15. Install coupling guard.

16. Replace all previously removed piping.

17. Refer to the Preparation for Start-Up section.

Bearing Bracket Assembly (PWI-BB Only)

The bearing bracket can be reassembled by following the instructions given below and by referring to the pump drawing Figure 4.

NOTE: The bearing bracket is common for both the mechanical seal and Seal Reservoir arrangements.

1. Press inboard bearing seal (829-1) and firmly seat into bearing bracket (849) if removed during disassembly.

NOTE: *Bearing seal oil return slot must be located such that it faces down with the bearing bracket in its normally mounted position.*

2. Assemble oil rings, if applicable, (817) on shaft (820), installing each in the groove in the shaft.

3. Assemble oil flinger, if applicable, (817) on shaft (820) against the shoulder and lock in place with set screws.

4. Lubricate thrust bearing seat on shaft. Slide thrust bearing (881-2) on shaft (820) as far as possible by hand. Place sleeve over shaft, being sure it rests against inner race only. Press sleeve evenly until bearing is seated firmly against shaft shoulder.

NOTE: *Heating the bearings using an induction bearing heater or hot oil bath can be used to obtain a slip fit assembly. Be sure the bearing is not magnetized if induction heating is used. Do not heat bearings above 250°F.*

NOTE: *Install thrust bearings back to back. Generally this means that the markings on the outer race are installed together. Bearings must always be replaced in pairs.*

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5. Assemble thrust bearing lockwasher (831) and locknut (821-2). Crimp tab of lockwasher into bearing locknut slot.

6. Lubricate radial bearing seat on shaft. Slide radial bearing (881-1) on shaft (820) as far as possible by hand. Place sleeve over shaft, being sure it rests against inner race only. Press sleeve evenly until bearing is firmly seated against shaft shoulder.

NOTE: *Heating the bearings using an induction bearing heater or hot oil bath can be used to obtain a slip fit assembly. Be sure the bearing is not magnetized if induction heating is used. Do not heat bearings above 250°F.*

7. Install shaft and bearing subassembly into bearing bracket.

8. Install outboard bearing end cap/bearing seal assembly (813-2,829-2), and plastic shims (815-3) onto bearing bracket.

9. Check axial end play of shaft. End play should be adjusted to 0.003” to 0.005” by adding or removing shims.

10. Install inboard bearing seal by pressing or lightly tapping into bearing bracket. Rotate shaft to check for possible rubs on inpro seals and adjust if necessary.

11. Install oil ring retainers, if applicable.

12. Install inboard heat sink (829-2), outboard fan (817), and fan shroud (812) as required.

13. Install pump coupling hub and drive key (811-2).

Assembly of Back Pull-out Unit (PWI-BB Only)

The back pull-out unit can be reassembled by following the instructions given below and referring to the appropriate pump sectional drawing Figure 4.

1. For assembly of bearing bracket see preceding instructions.

2. If removed during disassembly press throat bushing (847) into casing cover (802).

3. If removed during disassembly, press casing or cover wear rings (808-1,2) into casing or cover and fusion weld in four locations, equispaced. Check rings for proper clearance to the impeller rings.

4. Lubricate pump shaft and slide cartridge seal assembly and if part of your unit, the inboard heat sink (829-2), onto shaft.

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CAUTION: *Care must be taken not to damage seal sleeve gasket or seal face.*

5. Place gland gasket (815-2) on pilot or in groove of gland plate.

6. Slide casing cover (802) over pump shaft (820) and seal. Insert and tighten cap screws between bearing bracket (849) and cover.

7. Draw gland nuts up evenly until metal to metal contact is realized between gland and cover.

8. Install impeller key (811-1) and impeller (805). The impeller is a very snug slip fit, therefore the use of gentle force may be required to fully seat it to the shaft shoulder.

9. Tighten the seal drive collar set screws and packing sleeve follower if applicable. Disengage seal locating devices and check rotation.

10. Check shaft and make sure it is free to rotate. Re-engage seal locating device prior to storing or installing back pull-out unit in casing.

Assembly of Back Pull-Out Unit to Pump Casing (PWI-BB Only)

The pump back pull-out unit which includes the impeller (805), the casing cover (802), the bearing bracket (849), and the shaft (820) is now ready for reassembly to the pump in the field. Follow the instructions given below and refer to the pump sectional drawing Figure 4.

1. Return complete Back Pull-Out unit to pump.

2. Slide casing gasket (815-1) over cover.

3. Slide Back Pull-Out unit into casing (800) and tighten casing stud nuts evenly.

CAUTION: *Check shaft that it is free to rotate and does not bind.*

4. Check coupling alignment. Refer to Preparation For Start-Up.

5. Install coupling spacer and lubricate if required.

6. Install coupling guard.

7. Replace all previously removed piping.

8. Refer to the Preparation for Start-Up section.

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Section 10 – *Torque Values*

Recommended Stud Torque Values

Nominal Dia. (in)	Threads per Inch	Recommended Torque (ft-lb)
3/4	10	225
7/8	9	360
1	8	535
1-1/8	8	775
1-1/4	8	1075
1-3/8	8	1450
1-1/2	8	1895
1-5/8	8	2430
1-3/4	8	3055
2	8	4605
2-1/2	8	9115

Table 3

Material: ASTM A193 GR B7
Lubricant: Nickel-based Anti-sieze (μ = .13)

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Section 11 - *Spare Parts*

Save time and money by maintaining one complete set of the essential wearing parts for each pump. Do not wait until breakdown occurs. Recommended spare parts for the PWI are tabulated below.

SECTIONAL REFERENCE NUMBER	DESCRIPTION	START-UP	PUMP RECONDITION	CRITICAL SERVICE
4510	Casing Gasket	1	1	2
4200	Cartridge Seal	1	1	1
2200	Impeller	-	1	1
2912	Impeller Locknut	-	1	1
2110	Shaft	-	1	1
2300.1 2300.2	Impeller Wear Rings	-	2	2
1500.1 1500.2	Casing Wear Rings	-	2	2
3000	Sleeve Bearing	-	1	2

Table 4

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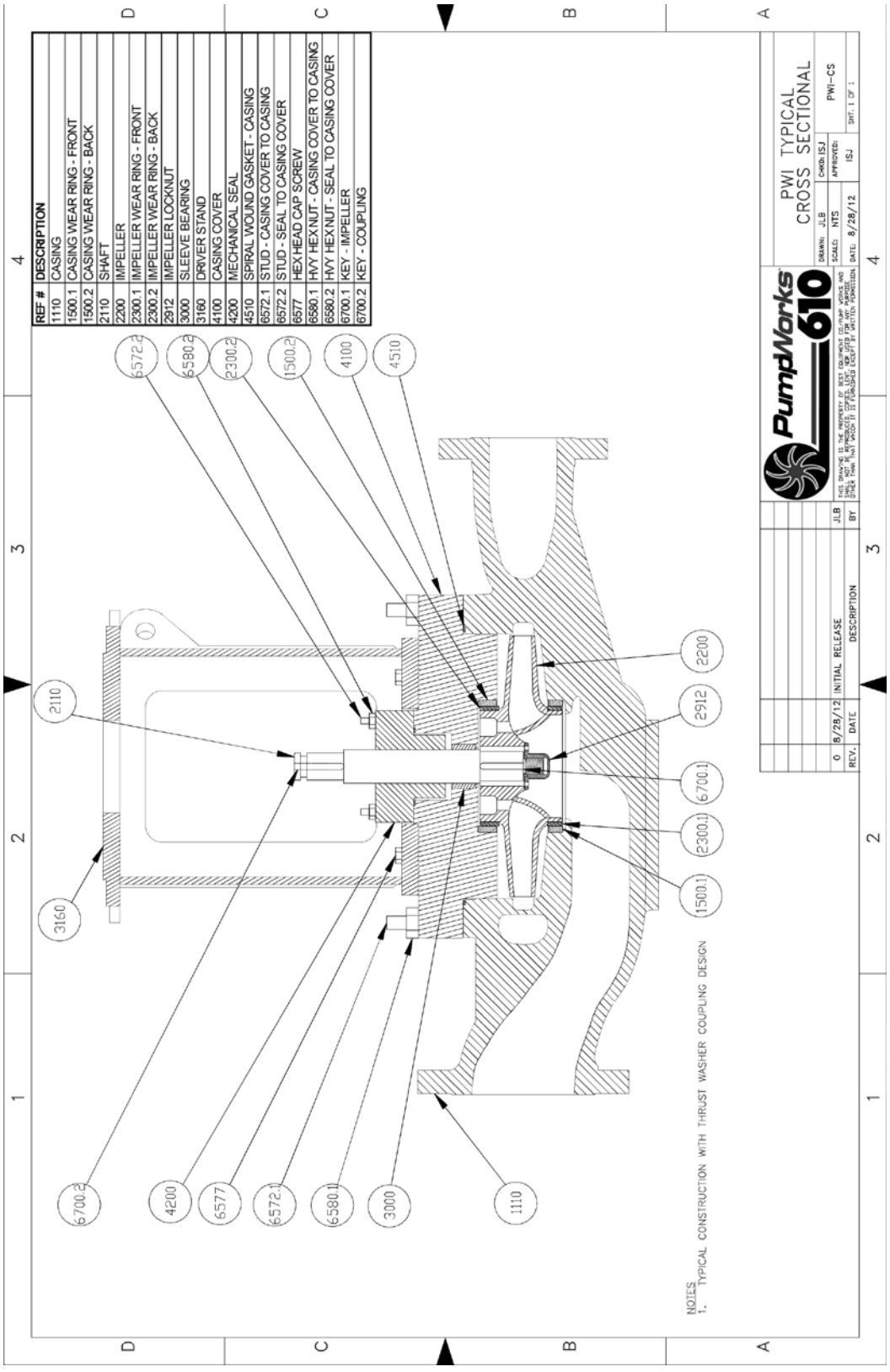

Figure 3