

BLACKMER LIQUEFIED GAS PUMPS

For Liquefied Gas Service Truck And Base Mounted

INSTALLATION OPERATION AND MAINTENANCE INSTRUCTIONS

MODELS: SGLD2, SGLD3, SGLD4B, SGLWD3, SGLWD4

964425

INSTRUCTIONS NO. 801-B00

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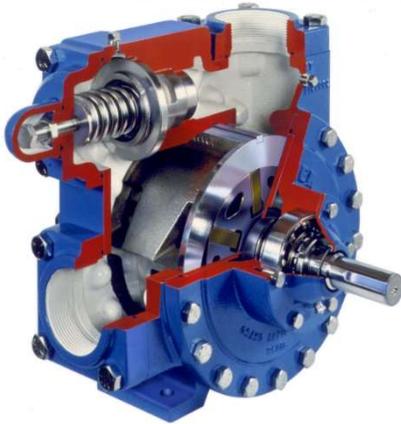


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NOTE: Numbers in parentheses following individual parts indicate reference numbers on Blackmer Parts Lists 801-B01.

Blackmer pump manuals and parts lists may be obtained from Blackmer's website (www.blackmer.com) or by contacting Blackmer Customer Service.

SAFETY DATA



This is a **SAFETY ALERT SYMBOL**.

When you see this symbol on the product, or in the manual, look for one of the following signal words and be alert to the potential for personal injury, death or major property damage



Warns of hazards that **WILL** cause serious personal injury, death or major property damage.



Warns of hazards that **CAN** cause serious personal injury, death or major property damage.



Warns of hazards that **CAN** cause personal injury or property damage.

NOTICE:

Indicates special instructions which are very important and must be followed.

NOTICE:

Blackmer liquefied gas pumps **MUST** only be installed in systems which have been designed by qualified engineering personnel. The system **MUST** conform to all applicable local and national regulations and safety standards.

This manual is intended to assist in the installation and operation of the Blackmer liquefied gas pumps, and **MUST** be kept with the pump.

Blackmer liquefied gas pump service shall be performed by qualified technicians **ONLY**. Service shall conform to all applicable local and national regulations and safety standards.

Thoroughly review this manual, all Instructions and hazard warnings, **BEFORE** performing any work on the Blackmer liquefied gas pumps.

Maintain **ALL** system and Blackmer liquefied gas pump operation and hazard warning decals.

SAFETY DATA

⚠WARNING



Hazardous machinery can cause serious personal injury.

Failure to set the vehicle emergency brake and chock wheels before performing service can cause severe personal injury or property damage.

⚠WARNING



Hazardous voltage. Can shock, burn or cause death.

Failure to disconnect and lockout electrical power before attempting maintenance can cause shock, burns or death.

⚠WARNING



Hazardous machinery can cause serious personal injury.

Failure to disconnect and lockout electrical power or engine drive before attempting maintenance can cause severe personal injury or death.

⚠WARNING



Do not operate without guard in place

Operation without guards in place can cause serious personal injury, major property damage, or death.

⚠WARNING



Hazardous pressure can cause serious personal injury or property damage

Disconnecting fluid or pressure containment components during pump operation can cause serious personal injury or property damage.

⚠WARNING



Hazardous pressure can cause serious personal injury or property damage

Failure to relieve system pressure prior to performing pump service can cause serious personal injury or property damage. Systems with meters will still be pressurized even after the hose is emptied.

⚠WARNING



Hazardous or toxic fluids can cause serious injury.

If pumping hazardous or toxic fluids, system must be flushed and decontaminated, inside and out, prior to performing service or maintenance.

PUMP DATA

PUMP IDENTIFICATION

A pump Identification tag, containing the pump serial number, I.D. number, and model designation, is attached to each pump. It is recommended that the data from this tag be recorded and filed for future reference. If replacement parts are needed, or if information pertaining to the pump is required, this data must be furnished to a Blackmer representative.

TECHNICAL DATA

Maximum Operating Temperature	240°F (115°C)
Minimum Operating Temperature	-30°F (-34°C)
Maximum Pump Speed	640 RPM
Maximum Differential Pressure	
2" and 3" models	150 PSI (10.3 Bar)
4" model	125 PSI (8.6 Bar)
Maximum Working Pressure	525 PSI (36.2 Bar)
Maximum Working Pressure (Dual Seal, Plan 52 and 53)	350 PSI (24.1 Bar)

Technical Data is for standard materials of construction. Consult Blackmer Material Specs for optional materials of construction.

INITIAL PUMP START UP INFORMATION

Model No.: _____
Serial No.: _____
ID No.: _____
Date of Installation: _____
Inlet Gauge Reading: _____
Discharge Gauge Reading: _____
Flow Rate: _____

GENERAL INSTALLATION AND OPERATION

NOTICE:

Blackmer pumps must only be installed in systems designed by qualified engineering personnel. System design must conform with all applicable regulations and codes and provide warning of all system hazards.

WELDED CONNECTIONS

NOTICE:

Pumps with welded connections contain three non-metallic o-ring seals that will be damaged if welding is done with these O-rings installed.

Prior to welding the piping, remove the O-rings from under the inlet flange, outlet flange and relief valve cover as indicated in Figure 1.

Reinstall the inlet and outlet flanges. Weld the piping to the inlet and outlet flanges. After the welding is complete, reinstall the O-rings.

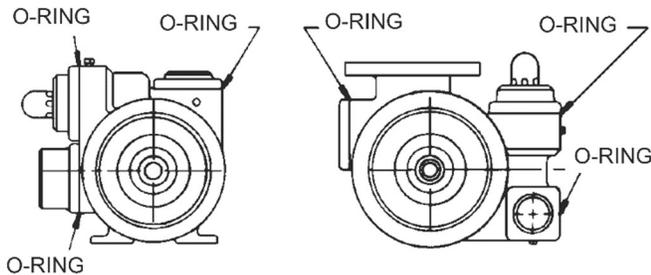


Figure 1

PRE-INSTALLATION CLEANING

NOTICE:

New pumps contain residual test fluid and rust inhibitor. If necessary, flush pump prior to use.

Foreign matter entering the pump WILL cause extensive damage. The supply tank and intake piping MUST be cleaned and flushed prior to pump installation and operation.

LOCATION AND PIPING

Pump life and performance will be significantly reduced when installed in an improperly designed system. Before starting the layout and installation of the piping system, review the following:

1. Locate the pump as near as possible to the source of supply to avoid excessive inlet pipe friction.
2. The inlet piping and fittings should be at least as large as the intake port on the pump. It should slope downward to the pump, and should not contain any upward loops. Minimize the number of intake line fittings and eliminate restrictions such as sharp bends; globe valves, unnecessary elbows, and undersized strainers.
3. A strainer must be installed in the inlet line to protect the pump from foreign matter. The strainer should be located at least 24" (0.6m) from the pump, and have a net open area of at least four times the area of the intake piping. Strainers must be cleaned regularly to avoid pump starvation.
4. The intake and discharge piping system must be free of all leaks.
5. Expansion joints, placed at least 36" (0.9m) from the pump, will compensate for expansion and contraction of the pipes. Contact the flexible connector/hose manufacturer for required maintenance/care and design assistance in their use.
6. ALL piping and fittings MUST be properly supported to prevent any piping loads from being placed on the pump.
7. Check alignment of pipes to pump to avoid strains which might later cause misalignment. See Figure 2. Unbolt flanges or break union joints. Pipes should not spring away or drop down. After pump has been in operation for a week or two, completely recheck alignment.

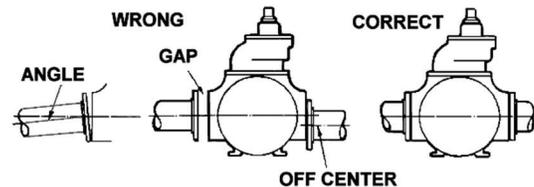


Figure 2

8. Install pressure gauges in the NPT ports provided in the pump casing to check pump performance at start up.
9. The use of a vapor return line will speed up delivery by preventing pressure build up at the receiving tank and pressure reduction in the supply tank.
10. Keeping the liquefied gas systems full of liquid, even when idle, will keep the O-rings from changing shape, shrinking or super cooling. Evaporation of liquefied gas leaves an abrasive powder on the surface which can cause wear to the pump, meter, and seals.

GENERAL INSTALLATION AND OPERATION

INTERNAL PUMP RELIEF VALVE AND EXTERNAL BYPASS VALVE

NOTICE:

The pump internal relief valve is designed to protect the pump from excessive pressure and must not be used as a system pressure control valve.

For ALL liquefied gas applications, install an external bypass valve, and any necessary piping, back to the tank. DO NOT pipe the bypass valve back to the intake line. The setting on the external bypass valve must be at least 25 psi (1.7 bar) lower than the pump internal relief valve setting. Typically, pump relief valves are factory set at the spring range mid-point.

The valve and piping must be of adequate size to accommodate the full flow from the pump when the discharge line is closed.

The 'Alternate Discharge to Storage Tank' line and manual valve may be used to unload transports without pumps into the storage tank. The manual valve in this line must remain closed during all other operations.

Refer to Blackmer Bypass Valve Installation and Maintenance Instructions for bypass valve settings and adjustments.

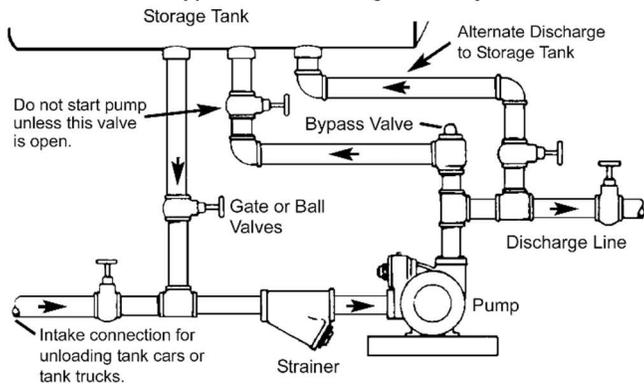


Figure 3 – Bypass Valve Mounting

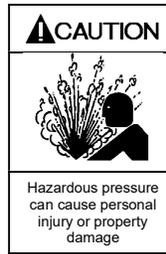
RELIEF VALVE SETTING AND ADJUSTMENT

The relief valve pressure setting is marked on a metal tag attached to the valve cover. Generally, the relief valve should be set at least 15 - 20 psi (1.0 - 1.4 Bar) higher than the operating pressure, or the external bypass valve setting.

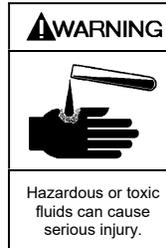
DO NOT remove the R/V Cap OR adjust the relief valve pressure setting while the pump is in operation.

1. To **INCREASE** the pressure setting, remove the relief valve cap, loosen the locknut, and turn the adjusting screw *inward*, or clockwise. Replace the valve cap and O-ring.
2. To **DECREASE** the pressure setting, remove the relief valve cap, loosen the locknut, and turn the adjusting screw *outward*, or counterclockwise. Replace the valve cap and O-ring.

Refer to the individual Blackmer pump parts lists for various spring pressure ranges.



Incorrect settings of the pressure relief valve can cause pump component failure, personal injury, and property damage.



Relief valve cap is exposed to pumpage and will contain some fluid

CHECK VALVES

The use of check valves or foot valves in the supply tank is not recommended with self-priming, positive displacement pumps.

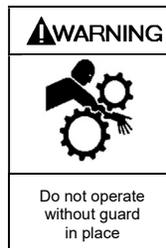
If the possibility of liquid backflow exists when the pump is off, a check valve in the pump discharge piping is recommended because the pump can motor in the reverse rotation and create undue stress on all attached components. Never start a pump when it is rotating in the reverse rotation as the added starting torque can damage the pump and related equipment.

PUMP ROTATION

NOTICE:

Confirm correct pump rotation by checking the pump rotation arrows respective to pump driver rotation.

Blackmer SGL pumps have a double ended rotor and shaft, enabling them to be driven from either shaft end. To change rotation, rotate the pump 180 degrees so that the opposite shaft becomes the driven shaft. The shaft protector (186) **MUST** be mounted over the non-driven shaft.



Operation without guards in place can cause serious personal injury, major property damage, or death.

MOTOR DRIVEN PUMPS - INSTALLATION AND OPERATION



- ⚠ Install, ground and wire to local and National Electrical Code requirements.
- ⚠ Install an all-leg disconnect switch near the unit motor.
- ⚠ Disconnect and lockout electrical power before installation or service
- ⚠ Electrical supply MUST match motor nameplate specifications.

⚠ Motors equipped with thermal protection automatically disconnect motor electrical circuit when overload exists. Motor can start unexpectedly and without warning.

NOTICE:

Consult the "General Installation and Operation" section of this manual for system information.

PUMP MOUNTING

Permanently mount the unit by securing the base plate with adequately sized anchor bolts to a level concrete floor following recommended industry standards (See Figure 4). A solid foundation will reduce system noise and vibration, and will improve pump performance. Refer to ANSI/HI standards or a suitable pump handbook for information on typical pump mounting and foundations. Check coupling alignment after pump and base assembly is secured to the foundation.

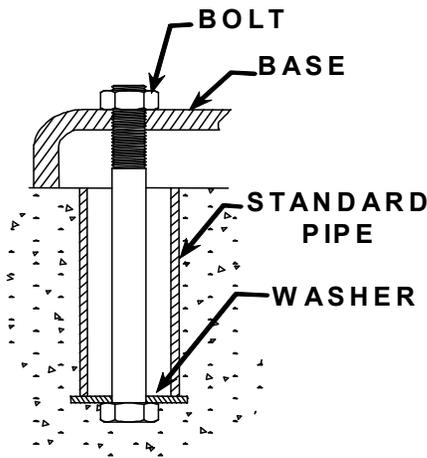


Figure 4

COUPLING ALIGNMENT

The pump must be directly coupled to a gear reducer and/or driver with a flexible coupling. Verify coupling alignment after installation of new or rebuilt pumps. Both angular and parallel coupling alignment MUST be maintained between the pump, gear, motor, etc. in accordance with manufacturer's instructions. See Figure 5.

1. Parallel alignment: The use of a laser alignment tool or dial indicator is preferred. If a laser alignment tool or dial indicator is not available, use a straightedge. Turn both shafts by hand, checking the reading through one complete revolution. Maximum offset should be less than .0005" (0.127 mm).

2. Angular alignment: Insert a feeler gauge between the coupling halves. Check the spacing at 90° increments around the coupling (four checkpoints). Maximum variation should not exceed 0.005" (0.127 mm). Some laser alignment tools will also check angular alignment.
3. Replace the coupling guards after setting alignment.

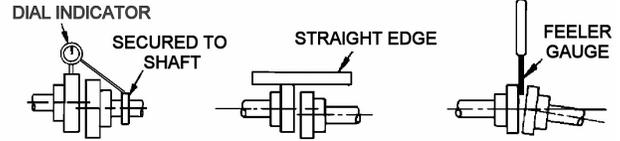


Figure 5 – Coupling Alignment

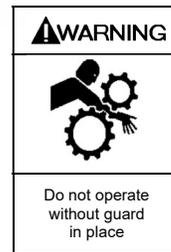
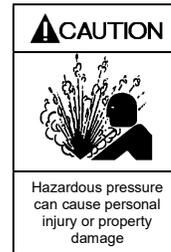


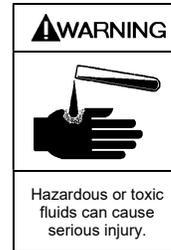
Figure 3 – Alignment Check

Operation without guards in place can cause serious personal injury, major property damage, or death.

SEAL SUPPORT SYSTEM INSTALLATION (Plan 52 and 53 Dual Seal Option Only)



Incorrect installation and operation of the seal support system may cause release of pressurized fluid.



The Plan 52 and Plan 53 seal designs require proper installation and operation of a seal support system. Failure to do so can result in primary seal failure and fluid release to atmosphere.

INSTALLATION AND CONNECTION:

The 3" and 4" pumps may be fit with optional Dual Seals. The following describes the general installation procedure for a pump configured with Dual Seals.

The Seal Pot Assembly (to be referenced as SPA) is procured and assembled by the customer. The SPA should be rigidly mounted to the floor or base within approximately 4' of the pump that it services.

Once firmly affixed to the floor/mounting surface, the SPA may be plumbed to the pump. For pump seal integrity, it is important that the pump seal is completely full of oil at all times.

MOTOR DRIVEN PUMPS - INSTALLATION AND OPERATION

INSTALLATION AND CONNECTION:Continued

Reference the included drawings when reading the following instructions.

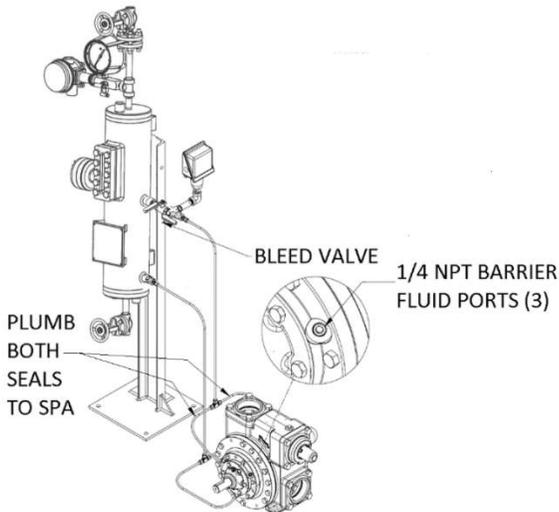
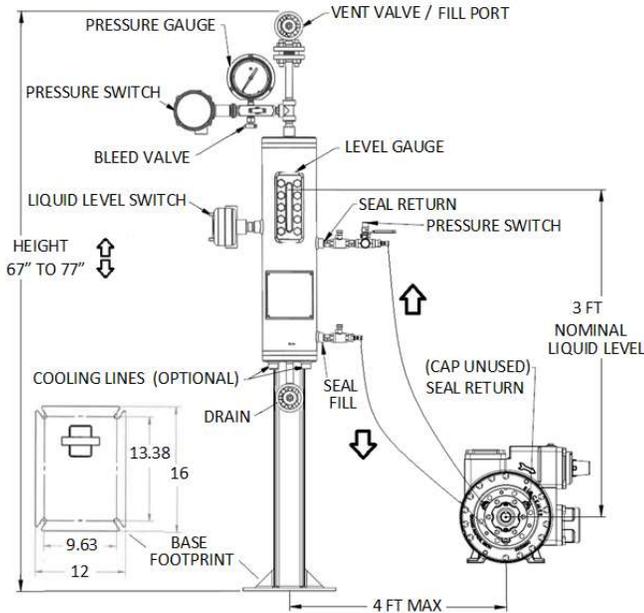


Figure 6 Recommended Seal Pot Assembly (SPA) piping arrangement for API plan 52 & 53

- 1) Find barrier fluid ports on seal cartridge (figure 6). Each side of the pump has three (3) tapped ports that lead to the chamber between the mechanical seals (total of six (6) tapped ports). These ports are 1/4" NPT and are located at 120 degree intervals. The LOWER port is to be used for the barrier fluid oil supply to the seal. Either of the TOP ports is used for the return connection to the SPA. The ports in the SPA for both seal oil and optional cooling lines are 1/2" NPT. (Cooling fluid volume requirement depends on specific application. Consult manufacturer.)

- 2) Plumb connection from the port labeled "Seal Supply" on SPA into the ports on bottom of seal cartridge labeled "From SPA" (see figure 6)
- 3) Plumb connection between ports on seal cartridge labeled "To SPA" and port on SPA labeled "Seal Return". Unused remaining port labeled "To SPA" on both seal cartridges must remain plugged.
- 4) Once plumbing is completed, fill SPA reservoir with barrier oil. Use recommended barrier oil "**Phillips 66 Conoco Syncon Barrier Oil ISO grade 5**" or equivalent.
- 5) Close valve on seal return port on SPA. Slowly pressurize SPA to approximately 10 PSI, slightly open bleed valve on seal return line to allow trapped air to escape system. Once oil is observed venting from bleed valve, close bleed valve. The system is now purged of air.

Note: this step may	
	<p>The Plan 53 seal design requires the barrier fluid to be pressurized above pump discharge pressure, at all times. Failure to do so may result in primary seal failure and product leakage.</p>
<p>Hazardous or toxic fluids can cause serious injury.</p>	

- 6) **For the Plan 53 seal only:** Connect the SPA to a tank of dry Nitrogen gas. SLOWLY allow the flow of gas from the Nitrogen bottle to the SPA until the SPA has an internal pressure 30 – 50 psi higher than the maximum anticipated discharge pressure of the system. See product specification for operating limits. **IMPORTANT NOTE:** This step is very important to provide proper seal performance. To prevent leakage, barrier fluid pressure must remain slightly higher than process fluid pressure at all times. Failure to do so could cause the seal to open and process fluid contamination into seal barrier chamber. The seal may not properly reset once pressure is restored. Let SPA pressure equalize (approximately 2-5 minutes). SPA pressure should remain constant.
 - a. If SPA pressure drops consistently, this indicates that there is a leak in the system. Check connections on gas side of SPA. If no leaks are evident in SPA or piping connections, the leak is most likely internal to the seal and the pump should be removed and replaced.
 - b. If the barrier oil pressure drops below process pressure, the oil must be replaced. Take care to contain any emissions from oil when draining SPA. Wear proper protection against exposure to pumped product.

MOTOR DRIVEN PUMPS - INSTALLATION AND OPERATION

- 7) Connect and set the pressure switch to a set-point approx. 10-30 psi above the system process pressure. Ensure the switch is set at a pressure between the Nitrogen set point and the max anticipated discharge pressure. This pressure switch should be wired to a panel or warning light or alarm to prevent a decrease in barrier fluid pressure below the pressure of the process fluid. This would prevent process fluid from ever escaping into the intra-seal cavity and potentially to atmosphere.

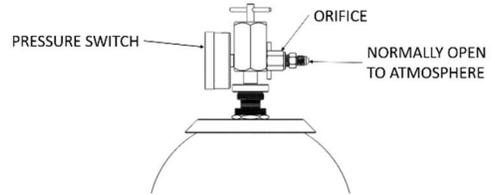
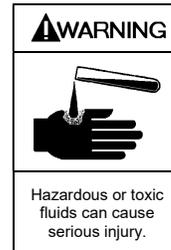


Figure 7 Plan 52 Pressure Switch Installation



Dual Seal designs require sensing devices to monitor seal performance and detect leakage. Failure to properly install sensing devices may result in product leakage.



Dual Seal designs require sensing devices to monitor seal performance and detect leakage. Failure to properly install sensing devices may result in product leakage.

- 8) **A sensing device is required to ensure that process fluid does not escape pump in case of seal failure. If the seal fails, the barrier fluid pressure and the barrier fluid level in the SPA will drop. A pressure switch or a liquid level switch may be used to sense these conditions and the system should then be shut down to prevent product leakage to atmosphere.**
- 9) **For the Plan 52 Seal only:** Ensure the SPA tank is vented to atmosphere through an orifice. The vapor space of the Seal Pot should be open atmospheric pressure during operation. The tank should be kept below discharge pressure of the pump, at all times. This includes during periods of non-operation. If the SPA tank pressure exceeds discharge pressure, the outer seal can open and may cause contamination of barrier oil into system. The seal may not reseal once pressure is dropped.
- 10) Close the SPA tank vent and slowly allow the pump to fill with the pumping fluid while monitoring the SPA tank pressure and barrier oil level (if possible). If the barrier oil pressure or level increases, there is a seal leak and the pump should be removed from service and replaced.
- 11) Connect and set a pressure switch to a set-point of approx. 10 psig. This pressure switch should be wired to a panel or warning light or alarm to prevent the barrier pressure from exceeding the process pressure. This would prevent barrier fluid leaking into the system or process fluid from contaminating the barrier oil due to the outer seal opening. Standard voltage for pressure switch is 24 VDC. Optional 120 VAC. (UL/CSA Certificate available from pressure switch manufacturer.)
Note: A suitable orifice should be installed inline. This will allow a leak to be detected by increasing the SPA tank pressure. Under normal operation vapor emissions should be properly contained and disposed (e.g. flared off).
- 12) **A sensing device is required to ensure that process fluid does not escape pump in case of seal failure. If the seal fails, the barrier fluid pressure and the barrier fluid level in the SPA will increase. A pressure switch or a liquid level switch must be used to sense these conditions and the system should then be shut down to prevent product leakage to atmosphere.**
- INSTALLATION AND CONNECTION:**
- 13) The following is a checklist for completion prior to operation of the pump:
- All plumbing connected, 1 barrier fluid supply line to each side of pump and one return line to each side of pump.
 - All air has been bled out of system.
 - Bleed valve shut. Seal supply and Seal return valves open.
 - Pressure of barrier fluid system is 30 – 50 psi above process pressure for the Plan 53 Seal or at 0 psig for the Plan 52 Seal.
 - Once pressurized, the nitrogen pressure supply to the SPA is shut off for the Plan 53.
 - SPA pressure is constant.
 - There are no barrier fluid leaks in the tubing/piping/hoses.
 - Open pump inlet valve and ensure no process fluid leakage.
 - Open pump discharge valve
 - During operation, pressure in the barrier fluid system (SPA) stays constant.
- Having completed these steps and the checklist above, the pump should be ready for operation.

MOTOR DRIVEN PUMPS - INSTALLATION AND OPERATION



Pumps operating against a closed valve can cause system failure, personal injury and property damage

V-BELT DRIVE

1. For installation of Blackmer V-belt units, first mount the pump and the motor base to the unit base. Do not fully tighten the motor mounting bolts until properly installing and adjusting the belts as follows:
2. Wipe the cone surface of the pump QD hub (152A) and the inside of the pump sheave hub with a clean cloth moistened with a light grade of machine oil. This will allow for a more uniform draw and prevent the cone surfaces from "freezing" before being tightened.
3. With the pump shaft key (35) in place, align the key seat and slide the QD hub (152A) on the shaft, flange end first. Slide the large end of the sheave (152) bore over the taper on the QD hub. Insert the three sheave capscrews (152G) through the clearance holes in the sheave, and start them into the tapped holes of the QD hub (152A). Repeat this procedure to assemble the motor QD hub (152E) and sheave (152D).
4. To install the belts (181), shorten the center distance of the drive by moving the motor towards the pump, until the belts can be put on the sheaves (152 & 152D) without forcing.
5. Align the sheaves so that the faces are parallel, then snug up the sheave capscrews (152C & G).
6. Measure the span length as shown in Figure 8.

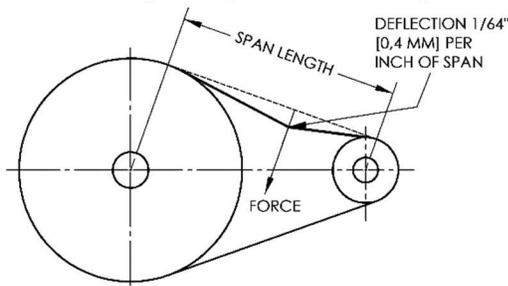


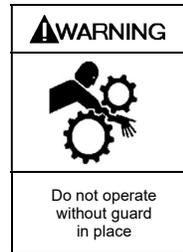
Figure 8 - V-Belt Adjustment

7. Adjust the motor base (183) and apply a specified force (see Table 1) against the belt, at the center of the span, so that the belt is deflected 1/64 inch (0.04 mm) for every inch (25.4 mm) of span. For example, the deflection of a 20 inch (508 mm) span would be 20/64 or 5/16 inch (7.9 mm). The force required should be within the range given in Table 1 for a properly tensioned drive. A new set of belts should be initially tensioned to the upper limit.

SMALL SHEAVE OUTSIDE DIAMETER	BELT DEFLECTION FORCE	
	Minimum	Maximum
2.5" to 4.5" (63 mm to 114 mm)	3.0 lbs (1.4 kgs)	4.75 lbs (2.2 kgs)
4.75" to 7.0" (121 mm to 178 mm)	4.0 lbs (1.8 kgs)	6.0 lbs (7.7 kgs)

Table 1 - Deflection Force Per Belt

8. Check again to ensure the sheaves (152 & 152D) are parallel, then tighten the sheave capscrews (152C & 152G), the motor mounting nuts (183B) and the adjusting screw locknut (183B).
9. Assemble the belt guard (182) and the belt guard brace (182A) to the unit base (32).



Operation without guards in place can cause serious personal injury, major property damage, or death.

10. Check the belt tension after 24-48 hours of operating. Recheck the tension periodically and tighten the belts as required. DO NOT overtighten belts. Inspect belts periodically for signs of excessive wear, and replace as required.

V-BELT DISASSEMBLY

1. Remove the belt guard (182) and the guard base (182A). Loosen the adjusting screw locknut (183B) on the motor base (183) and the motor mounting nuts.
2. Ease the tension on the belts (181) by moving the motor towards the pump to shorten the center distance of the drive. Remove the belts by sliding them over the sheaves (152 & 152D). DO NOT force the belts over the grooves.
3. To remove the sheave from the hub, first remove the three sheave capscrews (152C or 152G). Then screw two of the capscrews into the threaded holes in the sheave hub (152A or E). If the cone grip is hard to break loose, tap the end of the shaft or the QD hub with soft-faced mallet while maintaining pressure on the screw.
4. The QD hub should slide smoothly off the shaft. If it is tight on the shaft, gently pry it loose with a screwdriver or a small wedge placed in the split part of the flange.
5. **Refer to Blackmer V-Belt Parts List and Instructions for V-belt drive and guard part numbers.**

MOTOR DRIVEN PUMPS - INSTALLATION AND OPERATION

PRE-START UP CHECK LIST

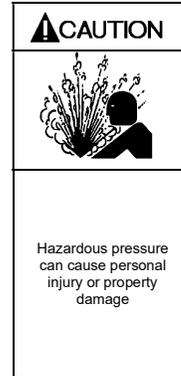
1. Inspect complete piping system and supports to ensure that no piping loads are being placed on the pump.
2. Verify proper coupling or V-belt alignment.
3. Install pressure gauges in the 1/4" NPT intake and discharge ports located on the pump casing to check pump performance after start-up.
4. Ensure all valves and fittings in piping system are in the start-up or operating positions.
5. Jog the pump motor to verify proper pump rotation.

START UP PROCEDURES

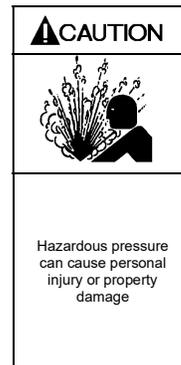
NOTICE:

Consult the "Troubleshooting" sections of this manual if difficulties during start up are experienced.

1. If dual seals are installed, check that all instructions for seal barrier installation have been completed and that barrier system is pressurized to 30-50 psi above maximum expected working pressure (Plan 53) or no greater than 10 psig (Plan 52).
2. SLOWLY build pressure in the pump.
3. Start the motor.
4. Check pressure gauges to ensure the system is operating within expected parameters. Record the gauge readings in the "Initial Start Up Information" section of this manual for future reference.
5. Inspect piping, fittings, and associated system equipment for leaks, noise, vibration and overheating.
6. If dual seals are installed, check barrier system pressure and shut off pump if barrier pressure drops continuously, which would indicate a seal leak.
7. Check the flow rate to ensure the pump is operating within the expected parameters. Record flow rate in the "Initial Start Up" section of this manual.
8. Close the discharge valve and check the differential pressure across the pump. Pressure must not exceed the pressure setting of the external bypass valve.
9. If dual seals are installed, recheck barrier pressure and shut pump off if barrier pressure drops continuously, which would indicate a seal leak.
10. With the discharge valve still closed, momentarily close the manual shut-off valve in the bypass return line to check the pump internal relief valve. The differential pressure will be approximately 150 and 170 PSI (10.3 and 11.7 bar).
11. The external bypass valve must always be set at least 25 PSI (1.7 bar) lower than the internal pump relief valve.
NOTE: The normal operating pressure must be at least 5 - 15 PSI (0.3 - 1.0 bar) less than the external bypass valve setting. Pump speeds which result in higher pressures (nearing the valve setting) forces the liquid to recirculate, creating excessive wear on the pump and equipment.



Pumps operating against a closed valve can cause system failure, personal injury and property damage



Pumps outfitted with a plan 53 seal must have pressurized barrier oil above pump discharge pressure at all times. Failure to do so can result in fluid leakage and barrier system contamination.



Failure to set the vehicle emergency brake and chock wheels before performing service can cause severe personal injury or property damage.

TRUCK MOUNTED PUMPS - INSTALLATION AND OPERATION

NOTICE:

Consult the "General Installation and Operation" section of this manual for system information.

Angle of Drive Shaft		
1° through 5°	6° through 10°	11° through 15°
Very good	Good	Fair

Table 2

TRUCK MOUNTING

SGL pumps can be bolted to the truck frame or on a saddle hung below the frame, and MUST be adequately supported.

PUMP DRIVE

The pump may be driven by a power take-off through universal joints. When using universal joints, a splined slip joint, properly lubricated, must be used on the connecting jack shaft to prevent end thrust on the pump shaft. It is very important to install a proper drive line to avoid excessive wear, vibration and noise (see Fig. 9 and Table 2).

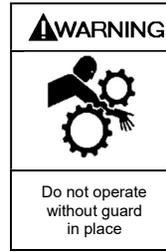
General guidelines to follow for proper pump drive:

1. Do not use square slip joints.
2. Use the least number of jack shafts as is practical.
3. Use an even number of universal joints.
4. The pump shaft and power take-off shaft must be parallel in all respects. Use an angular level measuring device to ensure the PTO and pump shaft are parallel to each other. If necessary, the pump can be shimmed to correct any misalignment. The PTO shaft coming off at the transmission does not need to be perfectly horizontal as long as the pump is shimmed to have its shaft parallel in all respects to the PTO shaft.
5. The yokes of the universals at both ends of the jack shaft must be parallel and in phase.
6. The maximum recommended angle between the jack shaft and the pump shaft is 15 degrees. See Table 2.

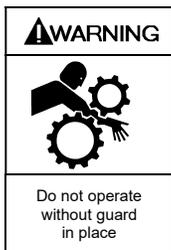
Failure to follow any of these guidelines may result in a gallop or uneven turning of the pump rotor, which will in turn cause a surging vibration to the liquid stream and piping system. Contact the supplier of the drive line components for specific design assistance.

HYDRAULIC DRIVE

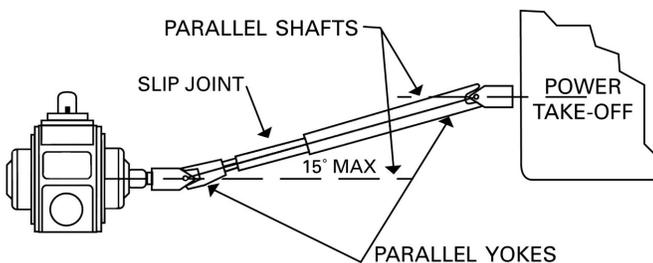
Truck mounted pumps may also be driven hydraulically. Hydraulic motors should be well supported with their shafts parallel to the pump shaft in all respects. Blackmer provides an optional close-coupled hydraulic motor adapter. The adapter provides for straight alignment of a hydraulic motor drive through a solid coupling connected to a straight key pump shaft. This coupling connection requires grease lubrication every three months at minimum. See the "Lubrication" section of this manual.



Operation without shaft protector can cause serious personal injury, major property damage, or death.



A drive shaft guard between the PTO and pump must be provided to prevent personal injury, property damage, or death.



Note: A Drive Shaft Guard between the pump and the PTO MUST be provided. (Not Shown)

Figure 9 – Pump Drive

TRUCK MOUNTED PUMPS - INSTALLATION AND OPERATION

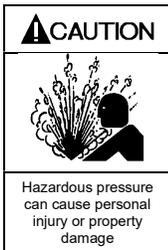
PRE-START UP CHECK LIST

1. Install pressure gauges in the 1/4" NPT ports located on the pump casing. These can be used to check the actual inlet and discharge conditions after pump start-up.
2. Check the alignment of the pipes to the pump. Pipes must be supported so that they do not spring away or drop down when the pump flanges or union joints are disconnected.
3. Secure appropriate hose connections.

START UP PROCEDURES

NOTICE:

Consult the "General Pump Troubleshooting" section of this manual if difficulties during start up are experienced.



Pumps operating against a closed valve can cause system failure, personal injury and property damage

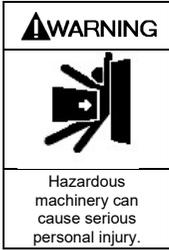
1. Open the shut-off valve in the bypass return line.
2. If the tank outlet valve is:
 - a. **Lever Operated** - Pull the control knob all the way out. Manually check the lever under the truck to see that it is in the completely OPEN position.
 - b. **Discharge Pressure Operated** - Keep the discharge line valve closed. When pump is started, it will build up enough pressure to open the tank outlet valve.
NOTE: This type of valve usually requires approximately 20 PSI (1.4 bar) differential pressure to open and approximately 15 PSI (1.0 bar) differential pressure to keep it open. If the piping is quite large, it may be necessary to restrict the discharge line shut-off valve in order to maintain sufficient pressure to keep the tank outlet valve open.
3. Start the pump. Confirm proper pump rotation by checking the pump rotation arrows.
4. Check the pump speed. Pump speed must never exceed the recommended maximum. See "Technical Data" section of this manual.
5. Check the pressure gauges to ensure the system is operating within expected parameters. Record the gauge readings in the "Initial Start Up Information" section of this manual for future reference.
6. Inspect piping, fittings, and associated system equipment for leaks, noise, vibration and overheating.
7. Check the flow rate to ensure the pump is operating within the expected parameters. Record the flow rate in the "Initial Start Up Information" section of this manual for future reference.
8. Close the discharge valve and check the differential pressure across the pump. It must not exceed the pressure setting of the external bypass valve.

9. With the discharge valve still closed, momentarily close the manual shut-off valve in the bypass return line to check the internal pump relief valve. The differential pressure should be about 100 PSI (6.9 bar).
10. The external bypass valve must always be set at least 25 PSI (1.7 bar) lower than the pump internal relief valve.
NOTE: The normal operating pressure must be at least 5 - 15 PSI (0.3 - 1.0 bar) less than the external bypass valve setting. Pump speeds which result in higher pressures (nearing the valve setting) forces the liquid to be recirculated, creating excessive wear on the pump and equipment.

PUMP SPEED

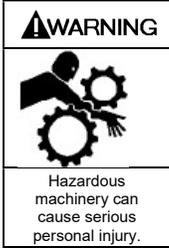
PTO and hydraulically driven units MUST contain speed control devices to prevent pump speeds above the maximum RPM specifications, regardless of the truck engine unloading speeds. Should fluid delivery be appreciably less than expected, see the "Troubleshooting" section.

MAINTENANCE



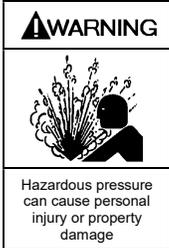
Failure to set the vehicle emergency brake and chock wheels before performing service can cause severe personal injury or property damage.

Hazardous machinery can cause serious personal injury.



Failure to disconnect and lockout electrical power or engine drive before attempting maintenance can cause severe personal injury or death.

Hazardous machinery can cause serious personal injury.



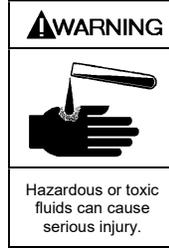
Disconnecting fluid or pressure containment components during pump operation can cause serious personal injury or property damage.

Hazardous pressure can cause personal injury or property damage



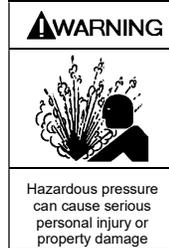
Failure to disconnect and lockout electrical power before attempting maintenance can cause shock, burns or death.

Hazardous voltage. Can shock, burn or cause death.



If pumping hazardous or toxic fluids, system must be flushed and decontaminated, inside and out, prior to performing service or maintenance.

Hazardous or toxic fluids can cause serious injury.



Failure to relieve system pressure prior to performing pump service can cause serious personal injury or property damage. Systems with meters will still be pressurized even after the hose is emptied.

Hazardous pressure can cause serious personal injury or property damage

Notice:

Maintenance shall be performed by qualified technicians only, following the appropriate procedures and warnings as presented in this manual.

STRAINERS

Strainers must be cleaned regularly to avoid pump starvation. Schedule will depend upon the application and conditions.

LUBRICATION

NOTICE:

To avoid possible entanglement in moving parts do not lubricate pump bearings, hydraulic adapter coupling, gear reducer or any other parts while pump is running.

NOTICE:

If pumps are repainted in the field, ensure that the grease relief fittings (76A) are functioning properly after painting. Do NOT paint them closed. Remove any excess paint from the fittings.

Pump bearings and hydraulic motor couplings (if equipped) must be lubricated every three months at a minimum. More frequent lubrication may be required, depending on the application and the operating conditions.

Pumps outfitted with dual seals should have their oil changed after either 500 hours of operation or after any pressure event that may have caused contamination. More frequent oil changes may be required depending on application.

Recommended Grease:

Mobil® - Mobilgrease XHP222,
Exxon® - Ronnex MP Grease
or equivalent Lithium grease.

Recommended Barrier Oil

Conoco® Syncon Barrier Oil ISO grade 5

Greasing Procedure:

1. Remove the grease relief fittings (76A) from the bearing covers (27) or hydraulic motor adapter (135).
2. SLOWLY apply grease with a hand gun until grease begins to escape from the grease relief fitting port. Discard excess grease in accordance with the proper codes and regulations.
3. Replace the grease relief fittings (76A).

DO NOT over grease pump bearings. While it is normal for some grease to escape from the grease tell-tale hole after lubrication, excessive grease can cause mechanical seal failure. The tell-tale hole is located in the head (20) between the bearing (24) and the mechanical seal (153).

Barrier Oil Change Procedure

1. Evacuate pump of any fluid/vapor until a pressure of 0 psig is read in the pump.
2. Vent the barrier fluid tank until a pressure of 0 psig is achieved.

Notice: A small amount of pumping fluid/gas may have leaked into the barrier oil. Take the proper precautions when venting.

3. Remove seal drain plugs from bottom of seal cartridges (153)
4. Allow oil to drain from each seal and barrier pot.
5. Replace plugs and fill barrier pot, with new barrier oil, to the seal pot manufacturer recommended volume.

MAINTENANCE

VANE REPLACEMENT

NOTICE:

Maintenance shall be performed by qualified technicians only, following the appropriate procedures and warnings as presented in this manual.

1. Drain and relieve pressure from the pump and system as required.
2. Remove the head assembly from the outboard (non-driven) side of the pump according to steps 4 - 7 in the "Pump Disassembly" section of this manual.
3. Turn the shaft by hand until a vane (14) comes to the top (12 o'clock) position of the rotor. Remove the vane.
4. Install a new vane (14), ensuring that the rounded edge is UP, and the relief grooves are facing towards the direction of rotation. See Figure 10.
5. Repeat steps 3 and 4 until all vanes have been replaced.
6. Reassemble the pump according to the "Pump Assembly" section of this manual.

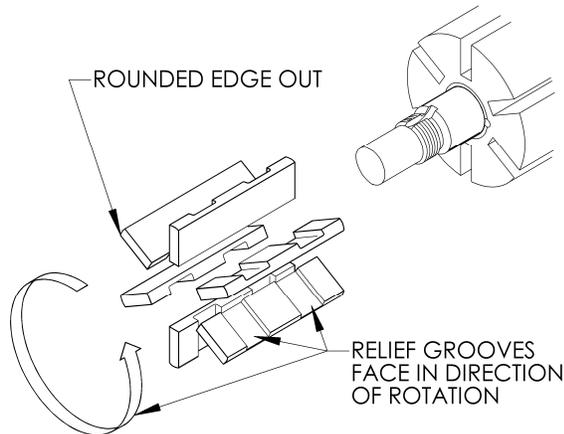


Figure 10 – Vane Installation

PUMP DISASSEMBLY

NOTICE:

Follow all hazard warnings and instructions provided in the "Maintenance" section of this manual.

1. Drain and relieve pressure from the pump and system as required.
2. Starting on the inboard (driven) end of the pump, clean the pump shaft thoroughly, making sure the shaft is free of nicks and burrs. This will prevent damage to the mechanical seal when the inboard head assembly is removed.
3. Remove the inboard bearing cover capscrews (28) and slide the inboard bearing cover (27) and gasket (26) off the shaft. Discard the bearing cover gasket. On 2-inch models, the dirt shield will slide off with the bearing cover.
4. Remove the outboard bearing cover capscrews (28) and slide the outboard bearing cover (27) and gasket (26) off the shaft. Discard the bearing cover gasket.

5. To remove locknuts and lockwashers (24A and 24B):
 - a. Bend up the engaged lockwasher tang and rotate the locknut (24A) counterclockwise to remove it from the shaft
 - b. Slide the lockwasher (24B) off the shaft. Inspect the lockwasher for damage and replace as required.
 - c. Repeat steps a and b on the opposite shaft end.

For Single Seal Pump Follow Steps 6 – 11,

For Double Seal Pump Skip to Step 12

Single Seal Disassembly

6. Remove the head capscrews (21) and carefully pry the head (20) away from the casing (12).
7. Slide the head (20) off the shaft. The head O-ring (72), bearing (24), mechanical seal stationary seat and stationary O-ring (153A & 153D) will come off with the head assembly. On 4-inch models, the disc and rotating seal assembly will also come off with the head assembly. Remove and discard the head O-ring.
 - a. 4-inch models: Remove the four disc machine screws and lockwashers (71A & 71B) to release the disc (71) from the head (20). The mechanical seal rotating assembly (153B, 153C & 153E) will be released when the disc is removed.
 - b. Pull the bearing (24) from the housing in the head (20).
 - c. To remove the mechanical seal stationary seat (153A), use the blunt end of a screw driver to gently push the backside of the stationary seat from the head. Place a cloth under the seal to avoid damage. Be careful not to contact the polished face of the seal during removal. Remove and discard mechanical seal stationary O-ring.
8. 2 and 3-inch models: Carefully pull the rotating seal assembly, including the seal jacket, rotating seal face and O-ring (153C, 153B, 153E) from the shaft. Remove and discard the rotating O-ring. Remove the disc (71).

NOTICE:

The rotor and shaft weighs 34 - 69 pounds (15 - 31 kg). Be careful not to pinch the hand under the rotor and shaft when removing from casing.

9. Carefully pull the rotor and shaft (13) from the casing (12). While one hand is pulling the shaft, cup the other hand underneath the rotor to prevent the vanes (14) and push rods (77) from falling out. Carefully set the rotor and shaft aside for future vane replacement and reassembly.
10. Lay the pump flat with the remaining head (20) facing upward to remove the head assembly mechanical seal (153) and disc (71) from the outboard side of the pump, per steps 6 - 8 above.
11. If necessary, remove the liner (41) by tapping around the outside diameter of the liner with a hard wood drift and a hammer until it is driven from the casing (12).

MAINTENANCE

Dual Seal Disassembly – Plan 53

12. Remove seal cartridge capscrews (21A) and insert two of these capscrews into threaded holes on seal cartridge. Use the protruding capscrews as handles and pull seal cartridge assembly (153) away from pump housing (12). Bearing (24) will remove with seal cartridge assembly (153). If bearing is not free from the shaft, the three threaded holes on seal cartridge can be used as jackscrews to remove bearing from shaft.
13. Remove the head ring capscrews (21) and carefully pry the head ring (20A) away from the casing (12). Take care not to damage head ring or casing
14. Slide the head ring (20A) off the shaft. The head O-ring (72), will come off with the head assembly. Remove and discard the head O-ring.
 - a. With one swift motion, pull the bearing (24) from the housing in the seal cartridge assembly (153).
 - b. Remove and discard seal cartridge O-ring (153F).
15. Carefully pull the rotor and shaft (13) from the casing (12). While one hand is pulling the shaft, cup the other hand underneath the rotor to prevent the vanes (14) and push rods (77) from falling out. Carefully set the rotor and shaft aside for future vane replacement and reassembly.

NOTICE:

The rotor and shaft weighs 34 - 69 pounds (15 - 31 kg). Be careful not to pinch the hand under the rotor and shaft when removing from casing.

16. Lay the pump flat with the remaining head (20) facing upward to remove the head assembly mechanical seal (153) and disc (71) from the outboard side of the pump, per steps 6 - 8 above.
17. If necessary, remove the liner (41) by tapping around the outside diameter of the liner with a hard wood drift and a hammer until it is driven from the casing (12).

Dual Seal Disassembly – Plan 52

18. Remove seal cartridge capscrews (21A) and insert two of these capscrews into threaded holes on seal cartridge. Use the protruding capscrews as handles and pull seal cartridge assembly (153) away from pump housing (12). Bearing (24) will remove with seal cartridge assembly (153). If bearing is not free from the shaft, the three threaded holes on seal cartridge can be used as jackscrews to remove bearing from shaft.
19. Remove the head capscrews (21) and head (20).
20. Remove 6 socket head capscrews from the rotating face. See Figure 11 for details. Discard screws, they should not be reused.
21. With 2 small pry bars, carefully remove rotating face from rotor/shaft (13)
22. Skip to **Assembly – Dual Seal Plan 52**
23. Turn pump over and complete disassembly (steps 18-22) for the other side

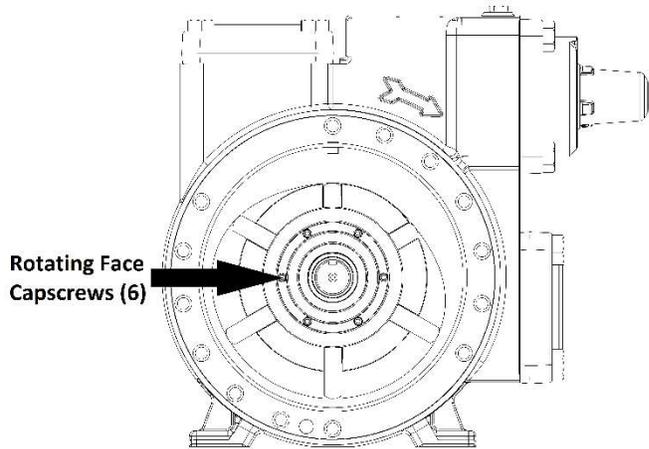


Figure 11 – Rotating Face Disassembly

MAINTENANCE

PUMP ASSEMBLY – Single Seal

Before reassembling the pump, inspect all component parts for wear or damage; replace as required. Wash out the bearing/seal recess of the head and remove any burrs or nicks from the rotor and shaft, and liner.

Reassemble the OUTBOARD side of the pump first:

1. Apply a small amount of grease to the liner key (74) to hold the key in place during liner installation. Install the liner key (74) in the groove on top of the liner (41).
2. Align the liner key (74) with the pump casing keyway and start the liner (41) into the casing (12). The word 'INTAKE' cast on the liner must face the intake port of the pump casing. Uniformly tap the outer edge of the liner with a rubber mallet to fully insert into the casing. NOTE: If the liner is installed backwards, it will restrict the port openings and cause cavitation, noise and loss of capacity.
3. 2 and 3-inch models: Place the disc (71) against the liner with the seal cavity outward.
4-inch models: Attach the disc (71) to the outboard head without the mechanical seal components. Install the disc machine screws (71A) and lockwashers (71B).
4. Without installing head O-ring or mechanical seal components, temporarily attach the outboard head and bearing to the casing. Install and hand-tighten two head capscrews, 180 degrees apart. This head will be used to hold and align the rotor and shaft while the inboard side of the pump is assembled.
5. Remove the vanes (14) and push rods (77) from the rotor and shaft assembly. Inspect for wear and damage, and replace as follows:
 - a. Insert the vanes into the bottom three rotor slots with the relief grooves facing in the direction of pump rotation, and with the rounded edges outward. See Figure 10.
 - b. Hold the three bottom vanes in place while inserting the three push rods (77). See Figure 12.
 - c. Carefully insert the non-driven end of the rotor and shaft (13) into the pump casing (12).
 - d. Install the remaining vanes (14) into the top positions of the rotor.

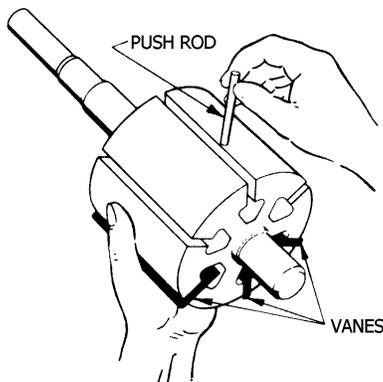


Figure 12 – Pushrod Installation

6. **DISC – 2 and 3-inch pumps**
Install the disc (71) on the inboard side of the pump with the seal cavity facing outward and the disc relief hole located as shown in Figure 13.

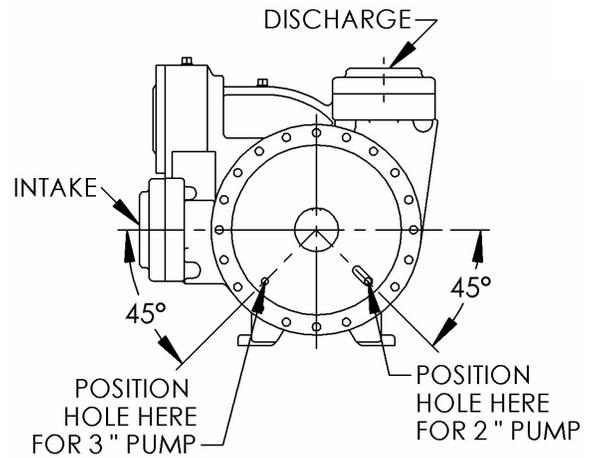


Figure 13 - Disc Relief Hole Location (2 and 3-inch pumps)

7. MECHANICAL SEAL – 2 and 3-inch pumps Rotating Assembly –

- a. Apply a small amount of motor oil on the shaft between the shaft threads and the rotor.
- b. Slide the seal jacket assembly (153C) over the shaft and into the disc cavity with the drive tangs of the jacket towards the rotor. Rotate the jacket assembly to engage the drive tangs in the rotor slots.
- c. Install a new rotating O-ring (153E) in the rotating seal face (153B). Align and insert the rotating assembly into the seal jacket with the polished face outward. Clean the polished face with a clean tissue and alcohol.

Stationary Seat -

- a. Apply a small amount of motor oil in the seal recess of the head (20).
- b. Install a new stationary O-ring (153D) in the stationary seat (153A). Align the pin in the stationary seat with the slot in the head recess and push the seat fully into the seal recess with the polished face outward. Clean the polished face with a clean tissue and alcohol.

8. MECHANICAL SEAL – 4-inch pumps Stationary Seat -

- a. Apply a small amount of motor oil in the seal recess of the head (20).
- b. Install a new stationary O-ring (153D) in the stationary seat (153A). Align the pin in the stationary seat with the slot in the head recess and push the seat fully into the seal recess with the polished face outward. Clean the polished face with a clean tissue and alcohol.

Rotating Assembly –

- a. Install a new rotating O-ring (153E) in the rotating seal face (153B). Clean the polished face with a clean tissue and alcohol. Place the polished face of the rotating seal against the face of the stationary seat in the head recess.
- b. Align the seal jacket assembly (153C) with notches of the rotating face and install jacket with the drive tangs of the jacket outward.

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9. DISC – 4-inch pumps

Place the disc (71) against the head (20) with the seal cavity inward and the disc relief hole located so that when the head is mounted on the pump with the "Blackmer" name in an upright position, the disc relief hole will be at the pump intake, (see Figure 13). Install and tighten the disc machine screws and lockwashers (71A and 71B). The drive tangs of the seal jacket should protrude through the center hole of the disc.

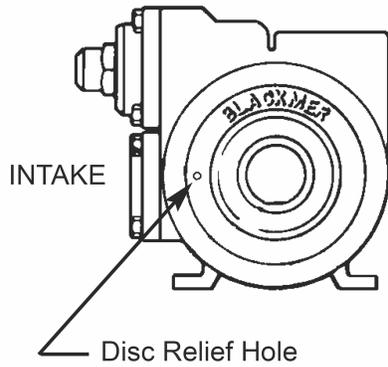


Figure 14 - Disc Relief Hole Location (4" pumps)

10. Install a new head O-ring (72) in the groove on the inside face of the head (20). Lay the O-ring flat and start in on one side of the groove, stretching ahead with the fingers, as shown in Figure 15.

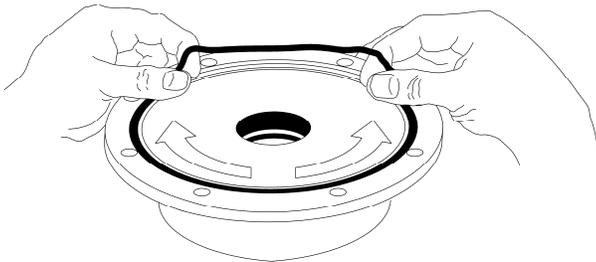


Figure 15 – Head O-ring Installation

11. Carefully install the head assembly (20) on the pump casing (12). Rotate the head so that the drain hole, located at the back of the bearing cavity, faces downward when the pump is mounted for operation. Install and uniformly tighten four head capscrews (21) 90° apart; torque to 30 lbs ft (40.7 Nm).
- 4-inch pumps: Make sure the head is mounted with the 'Blackmer' name upright and the disc relief hole towards the intake side of the pump. The seal jacket drive tangs must be engaged in the rotor slots
12. Hand pack the ball bearing (24) with grease. See the "Lubrication" section for recommended greases.
13. Install the bearing (24) into the head recess. The bearing balls should face outward, with the grease shield inward. Ensure the bearing is fully and squarely seated in the head (20).
14. Turn the pump casing around and remove the outboard head and disc previously installed.
15. Install the outboard head, O-ring (72), mechanical seal (153), disc (71) and bearing (24) per steps 7 through 14.

16. Rotate the shaft by hand to engage the mechanical seal drive tangs, and to test for binding or tight spots. If the rotor does not turn freely, lightly tap the rims of the heads with a soft faced mallet until the correct position is found. Install the remaining head capscrews (21) for each head (20) and uniformly torque to 30 lbs ft (40.7 Nm).

17. LOCKNUT ADJUSTMENT

It is important that the bearing locknuts (24A) and lockwashers (24B) be installed and adjusted properly. Overtightened locknuts can cause bearing failure or a broken lockwasher tang. Loose locknuts will allow the rotor to shift against the discs (71), causing wear. See Figure 16.

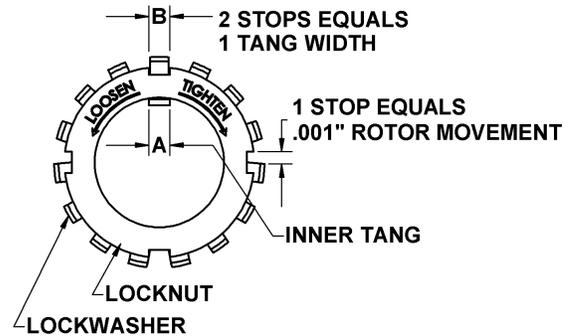
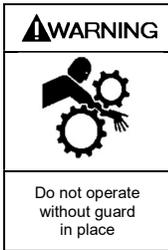


Figure 16 - Locknut Adjustment

- On both ends of the pump shaft, install a lockwasher (24B) with the tangs facing outward, followed by a locknut (24A) with the tapered end inward. Ensure the inner tang "A" of the lockwasher is located in the slot in the shaft threads, bending it slightly, if necessary.
 - Tighten both locknuts (24A) to ensure that the bearings (24) are bottomed in the head recess. DO NOT overtighten and bend or shear the lockwasher inner tang.
 - Loosen both locknuts one complete turn.
 - Tighten one locknut until a slight rotor drag is felt when turning the shaft by hand.
 - Back off the nut the width of one lockwasher tang "B". Secure the nut by bending the closest aligned lockwasher tang into the slot in the locknut. The pump should turn freely when rotated by hand.
 - Tighten the opposite locknut (24A) by hand until it is snug against the bearing (24). Then, using a spanner wrench, tighten the nut the width of one lockwasher tang. Tighten just past the desired tang, then back off the nut to align the tang with the locknut slot. Secure the nut by bending the aligned lockwasher tang into the slot in the locknut. The pump should continue to turn freely when rotated by hand.
 - To check adjustment, grasp the nut and washer with fingers and rotate back and forth. If this cannot be done, one or both locknuts are too tight and should be alternately loosened one stop at a time (.001" – 25 microns). Begin by loosening the locknut adjusted last.
18. Inspect the grease seal (104) for wear or damage and replace as required. Grease the outside diameter of the grease seal and push it into the inboard bearing cover (27) with the lip of the seal inward.

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19. Attach a new bearing cover gasket (26) and the bearing cover (27) to the inboard head (20). Make sure the grease fittings (76) are accessible. Install and torque the bearing cover capscrews (28) to 30 lbs ft (40.7 Nm).
20. Install the grease seal (104) and bearing cover (27) on the opposite side of the pump per steps 19 - 20.
21. 2-inch pumps: Slide the dirt shield (123A) over the shaft and push it firmly against the inboard bearing cover.
22. Attach the shaft protector (186) to the non-driven shaft end of double ended pumps.



Operation without guards in place can cause serious personal injury, major property damage, or death.

23. RELIEF VALVE ASSEMBLY

- a. Insert the valve (9) into the relief valve bore of the casing with the fluted end (2 and 3-inch pumps) or stepped bore end (4" pumps) inward.
- b. Install the relief valve spring (8) and spring guide (7) against the valve.
- c. Attach a new relief valve O-ring (10) and the valve cover (4) on the cylinder.
- d. Screw the relief valve adjusting screw (2) with locknut (3) into the valve cover (4) until it makes contact with the spring guide (7).
- e. After the relief valve has been adjusted, tighten the locknut (3) and install the relief valve cap (1) and O-ring (88)

NOTICE:

The relief valve setting MUST be tested and adjusted more precisely before putting the pump into service. Refer to "Relief Valve Setting and Adjustment"

24. See "Pre-Start Up Check List" and "Start Up Procedures" sections of this manual prior to restarting pump operation.

MAINTENANCE

PUMP ASSEMBLY – Dual Seal (Plan 53)

Before reassembling the pump, inspect all component parts for wear or damage; replace as required. Wash out the bearing/seal recess of the head and remove any burrs or nicks from the rotor and shaft, and liner.

Reassemble the OUTBOARD side of the pump first:

1. Apply a small amount of grease to the liner key (74) to hold the key in place during liner installation. Install the liner key (74) in the groove on top of the liner (41).
2. Align the liner key (74) with the pump casing keyway and start the liner (41) into the casing (12). The word 'INTAKE' cast on the liner must face the intake port of the pump casing. Uniformly tap the outer edge of the liner with a rubber mallet to fully insert into the casing. NOTE: If the liner is installed backwards, it will restrict the port openings and cause cavitation, noise and loss of capacity.
3. Install a new head O-ring (72) in the groove on the inside face of the head ring (20A). Lay the O-ring flat and start in on one side of the groove, stretching ahead with the fingers, as shown in Figure 15.
4. Place the head ring (20A) against the liner with the seal pressure groove in the 3:00 position toward the discharge (see Figure 17).

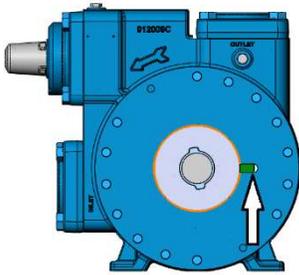


Figure 17 Groove placement

5. Attach the outboard head to the casing. Install and hand-tighten four head capscrews (21), 90 degrees apart.
6. Remove the vanes (14) and push rods (77) from the rotor and shaft assembly. Inspect for wear and damage, and replace as follows:
 - a. Insert the vanes into the bottom three rotor slots with the relief grooves facing in the direction of pump rotation, and with the rounded edges outward. See Figure 10.
 - b. Hold the three bottom vanes in place while inserting the three push rods (77). See Figure 12.
 - c. Carefully insert the non-driven end of the rotor and shaft (13) into the pump casing (12).
 - d. Install the remaining vanes (14) into the top positions of the rotor.
7. Install a new head O-ring (72) in the groove on the inside face of the inboard head ring (20A). Lay the O-ring flat and start in on one side of the groove, stretching ahead with the fingers, as shown in Figure 15.
8. Attach the inboard head ring (20A) to the casing per step 4. Groove should be toward the discharge port. Install and hand-tighten four head capscrews (21), 90 degrees apart.

9. MECHANICAL SEAL – Dual Seal (Plan 53) Rotating Assembly

- a. Apply a small amount of motor oil on the shaft between the shaft threads and the rotor.
- b. Install a new rotating O-ring (72B) on the seal cartridge and place in corner up against mounting face. (see figure 18)

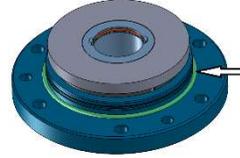


Figure 18 - Seal Cartridge O-ring Position

- c. Slide the seal cartridge assembly (153) over the shaft and into the head ring cavity with the drive tangs of the jacket towards the rotor. Rotate the jacket assembly to engage the two drive tangs in the two drive slots in the rotor near the shaft. When the drive tangs are properly engaged, you can feel the positive stops when the seal is rotated in relation to the shaft. The seal will only freely move for a very small angle before the rotor is likewise engaged. Before installing capscrews, turn the seal cartridge (153) so there is one seal feed hole in the 6:00 position toward the pump feet.
 - d. Hand pack the ball bearing (24) with grease. See the "Lubrication" section for recommended greases.
 - e. Install the bearing (24) into the seal cartridge recess over shaft. The bearing balls should face outward, with the grease shield inward. Ensure the bearing is fully and squarely seated in the seal cartridge (153).
 - f. Install Seal cartridge capscrews (22) and tighten to 30 ft-lbs (40.7 Nm)
10. Install the outboard seal cartridge assembly (153) and bearing (24) per steps 7a through 9. Rotate the shaft by hand to engage the mechanical seal drive tangs, and to test for binding or tight spots. If the rotor does not turn freely, lightly tap the rims of the heads with a soft faced mallet until the correct position is found. Install the remaining head capscrews (21) for each head ring (20A) and uniformly torque to 30 lbs ft (40.7 Nm).

MAINTENANCE

11. LOCKNUT ADJUSTMENT

It is important that the bearing locknuts (24A) and lockwashers (24B) be installed and adjusted properly. Overtightened locknuts can cause bearing failure or a broken lockwasher tang. Loose locknuts will allow the rotor to shift against the heads (20), causing wear.

- a. On both ends of the pump shaft, Install a lockwasher (24B) with the tangs facing outward, followed by a locknut (24A) with the tapered end inward. Ensure the inner tang "A" of the lockwasher is located in the slot in the shaft threads, bending it slightly, if necessary.
 - b. Tighten both locknuts (24A) to ensure that the bearings (24) are bottomed in the head recess. DO NOT overtighten and bend or shear the lockwasher inner tang.
 - c. Loosen both locknuts one complete turn.
 - d. Tighten one locknut until a slight rotor drag is felt when turning the shaft by hand.
 - e. Back off the nut the width of one lockwasher tang "B". Secure the nut by bending the closest aligned lockwasher tang into the slot in the locknut. The pump should turn freely when rotated by hand.
 - f. Tighten the opposite locknut (24A) by hand until it is snug against the bearing (24). Then, using a spanner wrench, tighten the nut the width of one lockwasher tang. Tighten just past the desired tang, then back off the nut to align the tang with the locknut slot. Secure the nut by bending the aligned lockwasher tang into the slot in the locknut. The pump should continue to turn freely when rotated by hand.
 - g. To check adjustment, grasp the nut and washer with fingers and rotate back and forth. If this cannot be done, one or both locknuts are too tight and should be alternately loosened one stop at a time (.001" – 25 microns). Begin by loosening the locknut adjusted last.
14. Inspect the grease seal (104) for wear or damage and replace as required. Grease the outside diameter of the grease seal and push it into the inboard bearing cover (27) with the lip of the seal inward.
 15. Attach a new bearing cover gasket (26) and the bearing cover (27) to the seal cartridge (153). Make sure the grease fittings (76) are accessible. Install and torque the bearing cover capscrews (28) to 30 lbs ft (40.7 Nm).

16. Install the grease seal (104) and bearing cover (27) on the opposite side of the pump per steps 15-16.
17. 2-inch pumps: Slide the dirt shield (123A) over the shaft and push it firmly against the inboard bearing cover.
18. Attach the shaft protector (186) to the non-driven shaft end of double ended pumps.



Operation without guards in place can cause serious personal injury, major property damage, or death.

19. RELIEF VALVE ASSEMBLY

- a. Insert the valve (9) into the relief valve bore of the casing with the fluted end (2 and 3-inch pumps) or stepped bore end (4" pumps) inward.
 - b. Install the relief valve spring (8) and spring guide (7) against the valve.
 - c. Attach a new relief valve O-ring (10) and the valve cover (4) on the casing (21).
 - d. Screw the relief valve adjusting screw (2) with locknut (3) into the valve cover (4) until it makes contact with the spring guide (7).
 - e. After the relief valve has been adjusted, tighten the locknut (3) and install the relief valve cap (1) and O-ring (88).
- NOTICE:**
The relief valve setting MUST be tested and adjusted more precisely before putting the pump into service. Refer to "Relief Valve Setting and Adjustment"
20. See "Pre-Start Up Check List" and "Start Up Procedures" sections of this manual prior to restarting pump operation

MAINTENANCE

PUMP ASSEMBLY – Dual Seal (Plan 52)

Before reassembling the pump, inspect all component parts for wear or damage; replace as required. Wash out the bearing/seal recess of the cartridge and remove any burrs or nicks from the rotor and shaft, and liner.

Reassemble the OUTBOARD side of the pump first.

1. Install ID O-ring into Rotating Seal Face. Lubricate with compatible grease. See Figure 19.

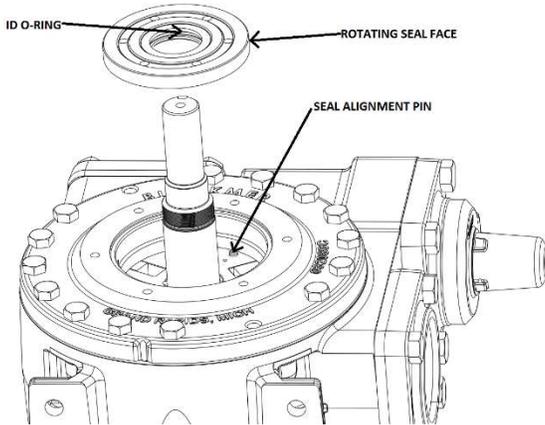


Figure 19 – Plan 52 Rotating Seal Face Installation

2. Slide Rotating Seal Face onto Rotor/Shaft (13), while making sure to align Rotor Seal Alignment Pin with Rotating Seal Face hole. See Figure 17. Ensure that ID O-ring is not damage as it slides over shaft threads.
3. Install Sealing Cap Screw into 6 holes. Start threading screws by hand. Refer to Figure 11.
4. Tighten Sealing Cap Screws to 20 in-lbf. Tighten screws in an alternating pattern, start and one side then torque screw on the opposite side. Continue until all screws are torqued.
5. Install Head Ring (20) onto casing, while ensuring not to touch or damage Rotating Seal Face. Pressure feed groove in Head Ring should be located near discharge area of pump. See Figure 15.
6. Install Head Ring Capscrews (21) and torque to 30 ft-lbf.
7. Install Stationary Seal Assembly (153) into Head Ring (20), making sure to carefully lower assembly in a controlled manner; dropping the seal assembly may damage carbons. See Figure 18.
8. Install Capscrew (22) into Stationary Seal Assembly (153). Finger tighten screws.
9. Hand pack the ball bearing (24) with grease. See the "Lubrication" section for recommended greases.
10. Install the bearing (24) into the seal cartridge recess over shaft. The bearing balls should face outward, with the grease shield inward. Ensure the bearing is fully and squarely seated in the seal cartridge (153).
11. Install Lockwasher (24B) and Locknut (24A) onto Rotor/Shaft.

12. Install the Inboard seal by following steps 1-11.

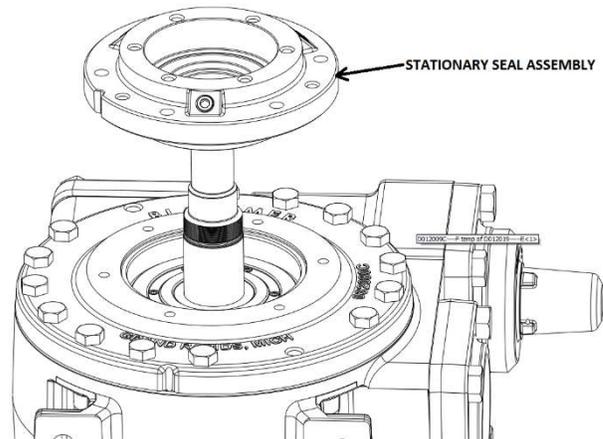


Figure 18 – Plan 52 Stationary Seal Assembly Installation

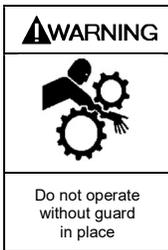
13. LOCKNUT ADJUSTMENT

It is important that the bearing locknuts (24A) and lockwashers (24B) be installed and adjusted properly. Overtightened locknuts can cause bearing failure or a broken lockwasher tang. Loose locknuts will allow the rotor to shift against the heads (20), causing wear.

- a. On both ends of the pump shaft, make sure a lockwasher is installed (24B) with the tangs facing outward, followed by a locknut (24A) with the tapered end inward. Ensure the inner tang "A" of the lockwasher is located in the slot in the shaft threads, bending it slightly, if necessary.
 - b. Tighten both locknuts (24A) to ensure that the bearings (24) are bottomed in the head recess. DO NOT overtighten and bend or shear the lockwasher inner tang.
 - c. Loosen both locknuts one complete turn.
 - d. Tighten one locknut until a slight rotor drag is felt when turning the shaft by hand.
 - e. Back off the nut the width of one lockwasher tang "B". Secure the nut by bending the closest aligned lockwasher tang into the slot in the locknut. The pump should turn freely when rotated by hand.
 - f. Tighten the opposite locknut (24A) by hand until it is snug against the bearing (24). Then, using a spanner wrench, tighten the nut the width of one lockwasher tang. Tighten just past the desired tang, then back off the nut to align the tang with the locknut slot. Secure the nut by bending the aligned lockwasher tang into the slot in the locknut. The pump should continue to turn freely when rotated by hand.
 - g. To check adjustment, grasp the nut and washer with fingers and rotate back and forth. If this cannot be done, one or both locknuts are too tight and should be alternately loosened one stop at a time (.001" – 25 microns). Begin by loosening the locknut adjusted last.
14. Inspect the grease seal (104) for wear or damage and replace as required. Grease the outside diameter of the grease seal and push it into the inboard bearing cover (27) with the lip of the seal inward.
 15. Attach a new bearing cover gasket (26) and the bearing cover (27) to the seal cartridge (153). Make sure the

grease fittings (76) are accessible. Install and torque the bearing cover Capscrews (28) to 30 lbs ft (40.7 Nm).

16. Install the grease seal (104) and bearing cover (27) on the opposite side of the pump per steps 15-16.
17. 2-inch pumps: Slide the dirt shield (123A) over the shaft and push it firmly against the inboard bearing cover.
18. Attach the shaft protector (186) to the non-driven shaft end of double ended pumps.



Operation without guards in place can cause serious personal injury, major property damage, or death.

Do not operate
without guard
in place

19. RELIEF VALVE ASSEMBLY

- f. Insert the valve (9) into the relief valve bore of the casing with the fluted end (2 and 3-inch pumps) or stepped bore end (4" pumps) inward.
- g. Install the relief valve spring (8) and spring guide (7) against the valve.
- h. Attach a new relief valve O-ring (10) and the valve cover (4) on the casing (21).
- i. Screw the relief valve adjusting screw (2) with locknut (3) into the valve cover (4) until it makes contact with the spring guide (7).
- j. After the relief valve has been adjusted, tighten the locknut (3) and install the relief valve cap (1) and O-ring (88)

NOTICE:

The relief valve setting MUST be tested and adjusted more precisely before putting the pump into service. Refer to "Relief Valve Setting and Adjustment"

20. See "Pre-Start Up Check List" and "Start Up Procedures" sections of this manual prior to restarting pump operation

TROUBLESHOOTING

NOTICE:

Maintenance shall be performed by qualified technicians only, following the appropriate procedures and warnings as presented in this manual.

SYMPTOM	PROBABLE CAUSE
Pump Not Priming	<ol style="list-style-type: none">1. Pump not wetted.2. Worn vanes.3. Internal control valve closed.4. Strainer clogged.5. Inlet line or valves clogged or too restrictive.6. Broken Drive Train (truck mounted pumps)7. Pump vapor-locked.8. Pump speed too low for priming.9. Relief valve partially open, worn or not seating properly.10. Vanes installed incorrectly (see "Vane Replacement").
Reduced Capacity	<ol style="list-style-type: none">1. Pump speed too low.2. Internal control valve not fully open.3. Excessive restriction in the inlet line (i.e.: undersized piping, too many elbows & fittings, clogged strainer, etc.).4. Damaged or worn parts (vanes, cylinder, or rotor).5. Excessive restriction in discharge line causing partial flow through the relief valve.6. Relief Valve worn, set too low, or not seating properly.7. External Bypass Valve set too low.8. Operating without a vapor return line.9. Vanes installed incorrectly (see "Vane Replacement").10. Liner installed backwards.
Noise	<ol style="list-style-type: none">1. Excessive pressure drop on the pump due to:<ol style="list-style-type: none">a. Undersized or restricted fittings in the inlet line.b. Pump speed too fast.c. Pump too far from fluid source.2. Running the pump for extended periods with a closed discharge line.3. Pump not securely mounted.4. Improper drive line – truck mounted pumps (See "Pump Drive").5. Misalignment of pump, reducer, or motor - base mounted pumps.6. Bearings worn or damaged.7. Vibration from improperly anchored piping.8. Bent shaft, or drive coupling misaligned.9. Excessively worn rotor.10. Malfunctioning valve in the system.11. Relief valve setting too low.12. Liner installed backwards.13. Damaged vanes (see following category).
Damaged Vanes	<ol style="list-style-type: none">1. Foreign objects entering the pump.2. Running the pump dry for extended periods of time.3. Cavitation.4. Excessive heat.5. Worn or bent push rods, or worn push rod holes.6. Hydraulic hammer - pressure spikes.7. Vanes installed incorrectly (see "Vane Replacement").8. Incompatibility with the liquids pumped.

TROUBLESHOOTING ... continued

SYMPTOM	PROBABLE CAUSE
Broken Shaft	<ol style="list-style-type: none">1. Foreign objects entering the pump.2. Relief valve not opening.3. Hydraulic hammer - pressure spikes.4. Pump/driver, driveline/drive shaft misalignment.5. Excessively worn vanes or vane slots.
Mechanical Seal Leakage	<ol style="list-style-type: none">1. O-rings not compatible with the liquids pumped.2. O-rings nicked, cut or twisted.3. Shaft at seal area damaged, worn or dirty.4. Bearings over greased.5. Excessive cavitation.6. Mechanical seal faces cracked, scratched, pitted or dirty.
Overload on Motor	<ol style="list-style-type: none">1. Motor Horsepower not sufficient for application.2. Improper wiring and/or low voltage to motor.3. Misalignment4. Excessive pressure or speed.5. Bearing locknuts adjusted improperly.6. Faulty or worn bearings.7. Rotor rubbing against discs or liner.8. Dirty mechanical seal faces.



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