
BLASTMAX 50 PUMP

ADVANCED PRESSURE SYSTEMS

OPERATION AND MAINTENANCE MANUAL

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APS

SHAPE TECHNOLOGIES GROUP®

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ADVANCED PRESSURE SYSTEMS 2022



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About This Content

Disclaimer

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Overview

The APS Series 50 is a powerful positive displacement, triplex plunger pump system. These pumps are designed and manufactured to operate in continuous service at a designed flow and pressure. With pressures ranging from 3,000 psi to 40,000 psi (345 bar to 2,758 bar), the Series 50 is an extremely versatile pump. The Series 50 pump is designed for full-scale industrial use including but not limited to industrial cleaning, surface preparation and hydrostatic testing applications.

Features include:

- *A triplex, belt-drive, high-pressure pump with easy access to seals and check valves.*
- *Splash lubrication system.*
- *Over-pressure protection discs, as equipped.*

Adhering to the recommended procedures for operation and maintenance outlined in this manual will ensure optimum benefit from the high-quality components used in the design and construction of the Series 50 pump system.

Safety

Advanced Pressure Systems designed your high-pressure waterjet cutting system and related equipment with safety in mind. Although the waterjet can appear harmless, it is a high-energy cutting tool capable of cutting many materials such as composites, metals, plastics, and wood products. Misuse of this equipment or carelessness in its application is extremely hazardous to personnel. Always treat the waterjet system with respect.



READ CAREFULLY BEFORE USE. KEEP FOR FUTURE REFERENCE!

Safety Precautions

Follow all safety precautions to ensure safe operation of the equipment.

- Only trained, qualified personnel shall service and maintain the equipment.
- Safety glasses and ear protection shall be worn when operating or working near the pump.
- Do not allow the waterjet stream to touch any part of your body—it will cause serious injury.
- Never point a waterjet cutting or cleaning tool at yourself or any person. Do not aim any waterjet tool at anything you do not want to cut.
- During equipment maintenance, take the system out of service. Lock and mark the controls with a warning sign. See section 'Lockout/Tagout' for details.
- All personnel required to do any system operation or service function must pay particular attention to all warning signs and notices posted in the plant and on the equipment.
- All protective guards, shields, and covers must be in place on the equipment at all times.
- First aid facilities shall be provided in convenient locations throughout the plant. All personnel must know the locations of the first aid facilities.
- Always keep the work area around the equipment clean and free of debris. Fluid spillage results in slippery floors. Clean up spills immediately.
- Any unfavorable conditions that can result in injuries must be reported to the plant supervisor immediately.
- Do not wear loose clothing or jewelry while working around equipment with moving parts.
- Pressurized air can drive particles into the eyes and skin if handled incorrectly. Use appropriate personal protective equipment and exercise caution.
- Only use water-based solvents for cleaning parts.

Electrical

- *Only a certified electrician shall do electrical and/or electronic troubleshooting and servicing of electrical devices.*
- *Always assume that power is ON in all electrical systems. Always examine and lockout the main power switches before servicing the equipment. Post a sign, "Maintenance in Progress—Do Not Energize."*
- *Be aware that live electrical circuits are present in the control console whenever the master disconnect switch is in the ON position, regardless of whether the E-Stop is engaged.*
- *Turn off the circuit breakers located inside the electrical enclosure before servicing the electrical system. If this is not possible, have someone stand by to prevent someone from powering up the system.*
- *Take extra precautions when servicing the power system in a damp environment.*
- *Never alter or bypass protective interlocks or devices.*
- *Never use jumper wires across fuses, fuse holders, or breakers.*
- *Never use metal rulers, flashlights, pencils, or tools that have exposed conductive material when working near electrical/electronic components.*
- *Ensure all tools are correctly insulated for the job. Use only correct test apparatus; regularly examine to ensure they are working correctly. Use caution when connecting a test probe to test points.*
- *When connecting a voltmeter to terminals for measurement, use a range higher than the expected voltage.*
- *All replacement wires shall conform to the manufacturer's specifications, including color-coding, wire numbers, and size.*
- *Close and latch the control panel doors or junction box covers after servicing.*
- *Maintain all electrical components, protective guards, and shutdown devices according to approved practices.*

High-Pressure Cleaning Tools

- *Turn off equipment and relieve water pressure before replacing nozzles, tips, or bits.*
- *Hang a warning sign on the control panel that states that the equipment is being serviced and is not available for use until servicing is complete.*
- *Install all protective covers and shielding on equipment before starting the pump.*
- *Examine for leakage after nozzle or tip replacement and correct the leak immediately.*
- *Use only APS manufactured or approved waterjet nozzles, cleaning tips, and drilling or cutting bits.*

Mechanical

- *Do not start the system unless you know how to stop it.*
- *Never maintain, service, or clean around the equipment while it is operating.*
- *Do not use incorrect tools—they can cause injury or costly damage to equipment.*
- *Use only approved test equipment. Examine the equipment regularly for correct operation and calibration.*
- *Never climb on or around the equipment on makeshift devices. Use only approved catwalks, ladders, or platforms.*
- *Do not exceed specified pressure setting limits for pneumatic or hydraulic components. Exceeding these limits may result in serious injury to personnel or damage to the equipment.*
- *Shield and bundle equipment hoses and cables so they do not obstruct the operator's freedom of movement.*
- *Always be alert when working around the equipment.*
- *Remove all tools, parts, and rags from moving parts after servicing the equipment.*

Safety Messages

Safety messages are highlighted with the safety alert symbol and a signal word or a signal word panel. Pay particular attention to these safety messages and all safety precautions posted on the equipment.

Safety Alert Symbol



This is the safety alert symbol. The safety alert symbol informs you of potential physical injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

Signal Words

WARNING! WARNING indicates a hazardous situation, which if not avoided, can result in death or serious injury.

CAUTION! CAUTION indicates a hazardous situation, which if not avoided, can result in minor or moderate injury.

Signal Panel Words



DANGER indicates a hazardous situation, which if not avoided, will result in death or serious injury.



CAUTION emphasize operating or service procedures, or conditions that can result in equipment damage or impairment of system operation.



NOTICE indicates a non-hazardous situation, which if not avoided, can result in property damage.

Personal Protective Equipment (PPE)

Personal protective equipment (PPE) is equipment worn to minimize exposure to serious workplace injuries and illnesses.



Helmets must be worn at all times by all personnel within the work area. Helmet material must withstand a mechanical shock to 10 G in 8 m.s. without fracturing.



Operators must wear safety glasses with side shields and a visor, or goggles and a visor, to guard against spray and flying debris.



Operators and other personnel must wear safety footwear with steel toecaps a minimum of 5 mm (0.02-in.) thick. The toecap must cover at least 30% of the footwear length. Footwear must have metatarsal guards to provide instep protection.



The operators and other personnel exposed to noise levels of more than 90 dBa for more than 1 hour must wear suitable ear protection. Earplugs and muffs are usually adequate.



The operators must wear gloves at all times; leather gloves are preferred.



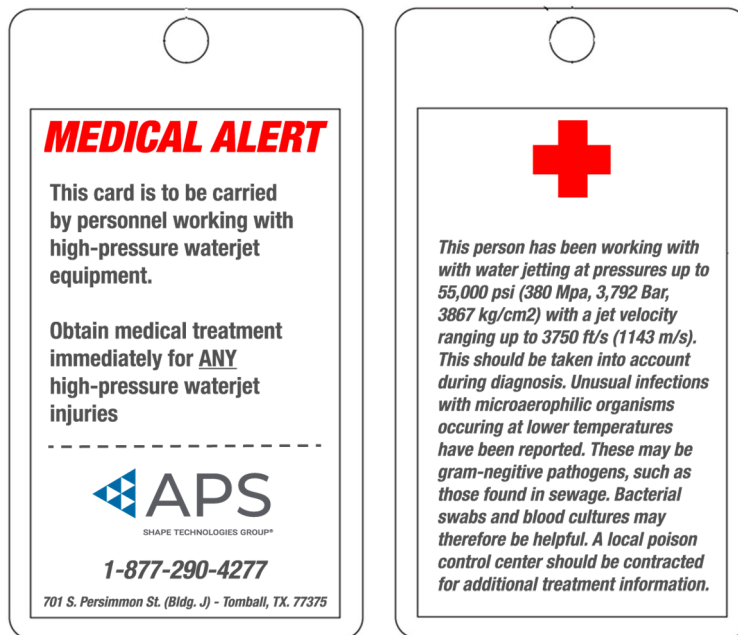
Waterproof garments only protect the operator from spray and flying debris. They do NOT deflect direct jet impact.

Emergency Medical Information



WARNING! Obtain medical treatment immediately for ANY high-pressure waterjet injuries.

It is vital that medical personnel have information about this type of injury. We recommend that all personnel working with waterjet equipment carry a medical alert card or tag that describes their work and the nature of injuries inherent in using waterjets.



Lockout/Tagout

You can lock out the water supply and electrical systems separately. Under most circumstances, you should lock out both systems.

This lockout/tagout procedure is designed to protect all employees from injuries caused by the unexpected energizing or startup of the machine, or the release of stored energy during service and maintenance.

This is accomplished with energy isolating devices that prevent the transmission or release of energy. An energy source is any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy source that could cause injury to personnel.

A lockout device utilizes a lock and key to hold an energy isolating device in the safe position and prevents the machine from being energized. A tagout device is a prominent warning device that can be securely attached to the machine warning personnel not to operate the energy isolating device. This procedure requires the combination of a lockout device and a tagout device.

Water Supply

1. [Shut down the pump.](#)
2. Look at the gauges on the display to ensure that the fluid end pressure is bled down.
3. Turn off the water supply, and then install a lockout/tagout device.
4. Press the drain button on the top of the water filter canister to drain the filter canister. If the draining water appears to be under pressure, ensure that the inlet water is off.

Electrical

1. [Shut down the system.](#)
2. Disconnect from power source using main power disconnect.
3. Install a lockout/tagout device over the power source.

Operation

Overview

Commissioning requirements and procedures are detailed in this section. These procedures require a thorough understanding of the individual components, safety issues, and the overall operation of the system.

All personnel involved in the operation and/or service of the system must carefully review this manual prior to commissioning and operating the machine.

The Technical Service Department at Advanced Pressure Systems is available to assist in the commissioning and operation process. Service and repair training for maintenance personnel is also available.

Transporting

The weight of the machine is not evenly distributed from one end to the other, particularly on the larger horsepower models. Do not attempt to lift the machine from either end. Note the warnings stamped on the unit. The center of gravity is located at approximately the location of the lifting eye if so equipped. The forklift should be positioned accordingly.

When the machine has been removed from the crate, note the position of the fork pockets on the bottom of the machine if so equipped. The pockets are positioned in relationship to the center of gravity to balance the weight on the forklift.

Before Starting the System

Prior to starting the system review the manufacturer's manuals included in the appendix covering the operation of the motor and drive train.

- 1. Set unit on a level surface to ensure that oil in the power end reaches the crankshaft main bearings.*
- 2. Check oil level in the pump. Refer to section 'Power End Assembly' for information regarding power end lubrication.*
- 3. If the pump has an oil level shutdown switch, set the shutdown trips 1/2 inch above and 1 inch below the dipstick Hi-Lo level marks.*
- 4. Check charge pump drives, if applicable.*
- 5. Ensure the plunger and intermediate rod connections are tight.*
- 6. Verify all bolts are torqued to the specified level.*

7. Verify connections on the manifold is tight and does not leak.

⚠ CAUTION

Do not tighten high pressure connections when the system is pressurized. Remove all pressure from the system before tightening connections.

8. Ensure the supply water and the filters and strainers are clean.
9. Verify the pressure rating stamped on the application tag for the pump matches the pump speed, plunger size, motor horsepower and the accessories to be used with the unit.
10. If supplied, verify the pressure relief valve is set 10 to 15 percent above the specified maximum working pressure.
11. Ensure the supply water line to the pump is airtight. Air entering the suction side, supply line will cause severe knocking and cavitation of the pump.
12. Attach a pressurized supply water line to the pump system inlet connector, 30 psi (1.4 bar) minimum or 80 psi (5.5 bar) minimum for 40,000 psi (2,758 bar) applications. The inlet supply line must be sized to flow at least double the GPM to be pumped from the system.

NOTICE

DO NOT gravity feed the pump. Fluid supplied to the suction side must be pressurized to help protect against cavitation damage.

13. Check to ensure supply water is flowing to the system.

Startup

1. Open the bypass flow regulating valve on electric powered units, if equipped. Open the regulator valve for the charge pump, if applicable.
2. Remove the nozzles or disconnect the pump for the work to allow maximum flow to be pumped without pressure for one minute.
3. Turn on the pressurized supply line water.
4. Start the electric motor.
5. Close the bypass flow regulating valve, if equipped.
6. With the nozzles removed, pump fluid through the system for at least one minute.
7. Stop the motor and replace the nozzles.
8. Start the motor and gradually increase flow through the system to the maximum allowable pressure. Observe the pump pressure gauge to ensure the reading does not rise above the specified allowable working pressure. If applicable, verify the charge pump pressure is at least 30 psi (1.4 bar), or 80 psi (5.5 bar) for 40,000 psi (2,758 bar) applications.
9. Set the by-pass flow regulating valve on electric motor driven systems to obtain the specified allowable working pressure, if equipped.
10. With the pump operating at its rated full speed the maximum working pressure should be reached easily. If the maximum working pressure cannot be reached at full speed, check the

nozzle size or the system plumbing for leakage. Refer to section 'Troubleshooting' if the issue is not resolved.

11. Ensure the suction and discharge valves remain fully open during operation.



Never close the suction or discharge valves while the pump is running.

12. Check the plunger packing for leakage.

Proper Operation

In most jetting operations it is common practice to employ a minimum of two persons as a team. The nozzle operator holds a gun, lance or delivery hose and controls the motion and direction of the jet(s). The pump operator monitors and controls the pressurizing pump during jetting operation.

1. The nozzle and pump operators should be aware of the working pressure for the job and pump and nozzle orifice sizes should be selected to match these conditions.
2. The pump operator should not start the unit until told to do so by the nozzle operator. Before the bringing the system up to pressure, the pump operator should ensure the jetting nozzle is either directed at the work piece; that the nozzle operator has a secure stance and control of the nozzle; and each team member is in the proper position to perform their task.
3. The pump operator should slowly raise the pressure of the system to allow the nozzle operator to adjust to the changing reaction force from the nozzle. Once the operating pressure has been reached, the pressure should not be further adjusted without the operator's awareness. When the pressure is reduced at shutdown, the pressure should also be lowered slowly to prevent the sudden lack of force from causing the operator to lose their balance.



The reaction force experienced by the nozzle operator can suddenly change when the trigger on a gun activates a dry shutoff or dump valve.



The operator should be familiar with the change in thrust at various pressures, including the working pressure for the job. The operator's stance should allow them to withstand these changes.

4. Both before and after bringing the system up to pressure the pump operator should visually examine the hose and connections to the jetting gun or nozzle for leaks.

Decommissioning

All local regulations must be adhered to for recycling and decontamination before the pump is decommissioned and taken out of service for any reason.

System Storage

If the system will be idle for an extended period, it must be prepared for storage as detailed below.

1. Drain and clean the power end. Leave the drain open to permit air circulation and prevent condensation buildup.

NOTICE Fluids can be removed from the pump by blowing compressed air through the manifold.

2. Coat all bearings and machined surfaces inside the crankshaft with a rust inhibiting oil.
3. Rotate the crankshaft once each month.
4. Read the motor maintenance manual for instructions regarding storage.

Cold Weather Storage

The following additional steps should be taken when the system is taken out of service in temperatures below freezing.

1. If compressed air is available, connect an appropriately secured compressed air line to the inlet connection on the suction manifold and evacuate fluids from the pump and associated plumbing.
2. If compressed air is not available, introduce anti-freeze into the suction line and rotate the pump to mix any fluid remaining in the system with anti-freeze.
3. Read the motor maintenance manual for instructions regarding cold weather storage.

Startup After Storage

A system that is removed from storage must be thoroughly inspected for damage before it is returned to service. Verify that all component parts are in working order.

CAUTION Failure to observe the following instructions can result in equipment damage.

1. Open the covers on the power end, motor, and drive train.
2. Verify the bearings are clean and in good condition.
3. Verify the plungers, valves and packing are properly installed and in good condition.
4. Verify proper tightness of bolts, nuts, studs, and fluid connections.
5. Fill the power end to the proper level with clean oil of the proper viscosity.
6. Pour oil into the crosshead reservoir and work into all the bearings, if applicable.
7. Follow the startup and operations instructions in this section.

Operation Safety Guidelines

Overview

Advanced Pressure Systems products are sold with the understanding that the purchaser agrees to thoroughly train all operating and maintenance personnel in the correct and safe installation, operation, and maintenance of waterblast equipment and to provide adequate supervision of personnel at all times.

Waterblast operators must be made aware that the cleaning nozzle's discharge jet can inflict serious bodily injury.

Additional safety information and updates may be obtained from the Waterjet Technology Association website at www.wjta.org.


General Safety Guidelines

Advanced Pressure Systems high pressure pump systems are designed to produce specifically related flows and pressures. Use caution when selecting nozzles and adjusting pressures to match the flow and working pressure of the specific pump model.

 **CAUTION** Never over-pressurize the system.

1. Use only products intended for high pressure water blasting. No product should be altered without the written consent of the manufacturer.
2. Read and follow all manufacturers' instructions prior to using any waterblast product. Contact the manufacturer should questions remain.
3. Inspect the condition of all components prior to use. Do not use an item in questionable condition.
4. Place barricades with warning signs or barricade tape around the work area.

Operational Safety

 **DANGER** Never direct high-pressure fluid jets toward anyone or to any part of your body. High pressure water will penetrate all parts of the human body. The liquid stream and the material ejected by the extreme pressure can result in severe injury.

1. The operator handling the cleaning device and nozzle **must always** have control of the water pressure.

A surface cleaner operator should operate a trigger style, control gun capable of instantaneously stopping pressure to the nozzle.

A tube cleaning lance operator should operate a foot gun capable of instantaneously stopping pressure to the lance.

2. *Before attaching a nozzle to the control gun or tube cleaning lance operate the pump at low speed to purge dirt and debris from the system.*



Dirt and debris can clog the nozzle orifice(s) and cause excessive system pressures that could lead to a lance failure.

3. *With the nozzle installed, operate the pump at a low pressure to test the system. If system repairs or adjustments are necessary, stop the pump and relieve all pressure before making required repairs or adjustments.*
4. *With the system operating properly, increase pump pressure slowly until the operating pressure is reached and adjusted. Pressure adjustments should always be made slowly.*
5. *Use the minimum pressure required for cleaning. Do not exceed the operating pressure of the system's lowest pressure rated component. All equipment pressure rating markers and warning tags should be left intact.*
6. *If equipment or system malfunction is suspected, immediately stop cleaning activities and relieve the pressure in the system before attempting any repairs. Always follow the manufacturer's repair instructions.*
7. *Following any repairs, operate the pump at a low pressure to test the system. Bring the system up to the operating pressure slowly.*
8. *If the system is shutdown, even for brief periods, in freezing conditions, drain the water from all components. Prior to startup in freezing conditions, the operation of all components must be carefully checked to ensure they are not frozen and will operate properly.*

Pressure Relief Devices

A waterblast system should include both primary and secondary pressure relief protection.



Properly adjusted and maintained pressure relief devices are imperative for the protection of both the operator and the equipment against dangerous over pressurization.

- *For primary protection a spring load relief valve is set at 1.25 times the maximum operation pressure. A relief valve is set at 12,500 psi (862 bar) if the maximum operating pressure is 10,000 psi (689 bar).*
- *For secondary protection a rupture disc assembly containing a manufacturer's approved disc with a burst rating of 1.5 times the maximum operating pressure is recommended.*

If a rupture disc assembly is used for primary pressure relief protection, it should contain a manufacturer's approved disc with a burst rating of 1.25 times the maximum operating pressure.



Only use a rupture disc holder that will not permit the use of coins or other objects in place of discs.



Never adjust relief valves to open at more than 15 percent above the maximum working pressure of the pump.



Never adjust relief valves while the pump is operating under pressure.

1. Relief devices should **never** be mounted so the discharge could strike personnel.
2. **Never** install a shut-off valve between the pump and the relief device.
3. **Set pressure must be prominently displayed on all relief devices.** Never install a relief device unless its set pressure is known.
4. The operation of relief valves and the accuracy of the set pressure should be field checked in accordance with manufacturer's instructions at regular intervals, **at least every 40 operating hours.**
5. Do not attempt to correct a leaking relief valve by increasing spring tension. This will increase the set pressure.
6. Do not use a pressure relief valve as a combination relief and throttling device.
7. Keep relief valves dry during freezing conditions.

High Pressure Hose and Lance Assemblies

The minimum burst rating for high pressure hoses must be a minimum of 2.5 times the operating pressure. For example, when operating at 10,000 psi (689 bar), the hose must have a minimum burst rating of 25,000 psi (1,724 bar). **Do not** use a high-pressure hose with an unknown burst rating or manufacturer's operating pressure rating.

- Use of a safety shroud where the hose connects to the control gun is strongly recommended.
- Position the wrench on the wrench flats when making threaded connections. **Do not** position wrench on the fitting ferrule (collar).
- Protect the hose from contact with sharp objects, abrasive surfaces and foot or wheel traffic.
- Support hoses, pipes and fittings to prevent excessive sway and/or wear created by vibration or stress on the end connections.
- Inspect hoses for damage, wear or imperfections prior to and periodically during operation.
- Disconnect, drain, coil and store hoses properly after use.



Never attempt to repair or re-couple hoses in the field. High pressure hose fittings are permanently crimped and can only be properly installed with hydraulic crimping equipment.

Hoses must be removed from service if the:

- cover is damaged and reinforcing wires are exposed to rust and corrosion.

- cover is loose, has blisters or bulges.
- hose has been crushed or kinked.
- end fittings show evidence of damage, slippage, or leakage.
- hose has been exposed to pressures greater than 50% of burst rating.
- hose is three or more years old, regardless of condition.

Control Gun and Control Device Safety

1. Prior to use, thoroughly inspect the control gun or device for smooth and proper operation. Control guns and devices should also be inspected for proper operation before each operating shift. **Do not** use any device that has not been inspected before your operating shift.
2. A control gun operator using a hand-held gun should position and brace their body for the gun's rearward reaction force before depressing the gun trigger. The rearward reaction force is high and is usually 40 to 50 pounds of force. The operator should maintain firm, solid footing to counter the rearward reaction.



Do not use a hand-held control gun if the nozzle discharge can accidentally strike the operator's body. A 48-inch-long discharge barrel **must** be used on hand-held control guns to prevent nozzle discharge from accidentally striking the operator's feet, legs or body.

3. The use of a safety shroud and a safety whip hose is strongly recommended for operator protection against a possible burst in the high-pressure hose connected to the gun. Use of a hand grip and a shoulder stock with hand-held guns will provide greater comfort and thus increase cleaning production.
4. Fall protection should be provided when blasting on scaffolding or sloping surfaces. Do not operate a hand-held control gun while standing on slippery surfaces.
5. The control gun operator should always start blasting with a **low system pressure** and **slowly increase** blasting pressure. When operating pressure is reached **depress and release the control gun trigger/pedal several times to check the gun's operation before starting cleaning operation.**
6. A dump-type control gun should **always** open fully and reduce the system pressure to near zero **immediately** when the trigger/pedal is released. If the gun does relieve system pressure immediately or pressure does not fall below to 200 psi (14 bar) when the trigger/pedal is released, do not use the control gun.
7. The operator should **never** pass a control gun to another operator without first stopping the pump and water flow to the gun. Failure to do so is dangerous because of possible accidental trigger actuation.
8. **Do not** use a control gun or control device that has malfunctioned, or you suspect malfunctioned without having it repaired and/or thoroughly checked for proper operation by a qualified high-pressure maintenance mechanic or your supervisor.

9. **Do not** use a control gun that does not have a trigger guard.
10. **Never** tie, wedge or clamp a control gun's trigger in the blast position.
11. Hand-operated control guns **should never** be used as foot-operated devices.
12. Any hose used for transporting dump water back to the pump should have a large enough diameter and short enough length to keep potentially dangerous back pressure low. Protect the hose from traffic.
13. All electric throttle control cords should be rated for wet conditions. All cord connectors and switches should be kept out of water.

Rigid Tube Cleaning Lance Safety

Do not use a rigid lance with a burst rating less than 3.0 times the operating pressure. A rigid lance operating at 10,000 psi (689 bar) must have a minimum burst rating of 30,000 psi (2,068 bar). Do not use a rigid lance with an unknown burst or manufacturers' operating pressure rating.

1. **Clearance** between the lance and tube **must be enough** to permit the unrestricted backflow of water and debris. With tubes containing hard deposits, this clearance should be a **minimum** of 1/8 inch on the diameter, or 1/16 inch per side, of the lance. With tubes containing soft, pliable deposits, this clearance should be greater. **Insufficient side clearance may cause lance to blow back toward the operator.**
2. Where practicable, a safety shield should be installed around the lance to prevent a lance nozzle from inadvertently being withdrawn and possibly causing injury.
3. **Ensure the nozzle, lance and adapter thread sizes are compatible** before installing the nozzle and adapter on the lance. Do not use a rigid lance that has damaged or missing threads.
4. When a pipe wrench is used to connect the lance, **avoid deep wrench marks** that may weaken the lance or lance connectors.
5. A rigid lance over 4 feet long requires two operators for support and safe operation. The **operator at the tube entrance should use a foot control gun** so they can instantly relieve system pressure in case of emergency.
6. When using and moving the lance support it in a manner to avoid stress and possible breakage at the inlet end connection.
7. **Never 'ramrod' the lance** into tube blockage.
8. Transport and store lances in tubes or racks to avoid bending, corrosion or other damage. Damaged lances (bends, marks, etc.) should be removed from service.

Flexible Tube Cleaning Lance Safety

The following lance accessories are strongly recommended for safer lance operation:

- A lance flex guard helps prevent fitting failure on the inlet end of the lance.

- A lance stinger provides greater control of the nozzle, establishes a safety zone so the operator knows when the nozzle is about to exit the tube and eliminates the possibility of nozzle and lance 'double back' toward the operator in large diameter pipe.
- A safety grip prevents the lance from exiting the tube unexpectedly.



Serious injury may occur if a lance with a live nozzle exits the tube.

Do not use a flex lance with a burst rating less than 2.5 times the operating pressure. A rigid lance operating at 10,000 psi (689 bar) must have a minimum burst rating of 25,000 psi (1,724 bar). **Do not** use a flex lance with an unknown burst or manufacturers' operating pressure rating.

1. **Do not use a flex lance that is kinked, worn, frayed** or when its ability to hold pressure is questionable.
2. **Do not** use a flex lance with damaged or missing threads.
3. **Clearance** between the lance and tube **must be enough** to permit the unrestricted backflow of water and debris. With tubes containing hard deposits this clearance should be a **minimum** of 1/8 inch on the diameter, or 1/16 inch per side, of the lance. With tubes containing soft, pliable deposits this clearance should be greater. **Insufficient side clearance may cause lance to blow back toward the operator.**
4. Use only nozzles designed for use with flex lances. For example, a nozzle drilled with enough rearward orifices, so nozzle pulls the lance through the tube.
5. Where the length of the nozzle and rigid coupling is less than the inside diameter of the pipe, a length of rigid pipe, not less than the diameter of the pipe being cleaned, should be fitted directly behind the nozzle, or a suitable safety shield should be provided to protect the operator.
6. If end fittings do not have wrench flats, use properly adjusted pipe wrenches to connect the nozzle onto the lance and to connect the lance to a pressure source. When installing the nozzle on the lance apply the wrench on the end fitting directly behind the end fitting thread, **not on the fitting ferrule or collar**. Do not clamp the lance hose in a vice when installing the nozzle.
7. Avoid rough handling, stretching or straining of the lance.
8. **Never attempt to 'ramrod' the lance** into tube blockage or to repair or re-couple lances.
9. After use, drain, coil and restore the lance properly. Ensure safety tags remain intact.

Nozzles

Do not use a nozzle with a burst rating of less than 3.0 times, or a manufacturers' pressure rating of a least, the nozzle's operating pressure.

1. Prior to installation make sure the nozzle has no clogged orifices. Blocked orifices can cause excessive system pressure and failure. If an orifice appears clogged or partially blocked with dirt or debris, immediately remove the nozzle from the control gun or lance and clean.

2. Use Teflon tape when connecting nozzles with male pipe (NPT) threads. Do not let the tape overlap the thread end, tape fragments may enter the water stream and clog the orifices in the nozzle.

Pipe thread connections should be hand-tight plus two (2) full wrench turns. Do not tighten past two (2) turns. All pipe thread connections must have a minimum engagement of four (4) threads.



Use wrench flats when available or a properly adjusted pipe wrench for tightening nozzle. Avoid deep wrench marks that may weaken the nozzle.

3. Special nozzles requiring a thread locking pin **must** have the pin installed prior to use or the nozzle may unscrew from the lance while in service, causing the lance to blow back toward the operator.
4. With nozzles requiring adjustment, always read applicable instructions.

Personal Protective Equipment

Proper safety apparel should be provided to all operators. It is strongly recommended that instructions be given regarding when and how specific clothing and other types of protective devices shall be worn.



Protective equipment may not prevent injuries to operators and other workers caused by the direct impact of high-pressure waterjets or from debris that may be thrown out by the impact of the jet.

- **Head Protection**

All operators shall be issued suitable head protection which shall be worn at all times while at the worksite. Where possible, head protection should include a full-face shield.

- **Eye Protection**

Eye protection shall be provided to, and worn by, all high-pressure waterjet equipment operators and all visitors to waterjet operations while they are in the working area. Eye protection must provide the protection needed and must fit properly. Eye protection shall meet appropriate ANSI requirements for that type of eye protection. Side shields to glasses and goggles should prevent liquids from getting through.



In some cases, liquids may be in use that can cause eye damage. In those cases, a combination visor and goggles or a full hood with shield should be used.

- **Hearing Protection**

Waterjets generate considerable noise; both in the air and under water. All operators and all visitors shall be issued and shall wear hearing protection while in the working area. Hearing protectors should be regularly inspected and properly maintained and should comply with federal and/or state OSHA standards.

All personnel, operators and others in the vicinity of waterjet equipment should be taught how to fit and properly use ear protection so that their exposure to noise does not exceed OSHA or other regulatory limits.

- **Body Protection**

Protective clothing should be waterproof and have an outer layer that repels casual rebounding water. Protective clothing should also provide some protection from the impact of rebounding debris from the jet impact point where this may be a hazard to the operator.



Waterjets can penetrate clothing, most protective suits, skin, and cause serious injury.

- *Everyone working around a waterjet operation should be provided with, and should wear, sufficient waterproof clothing to provide protection from the type of exposure to water and debris that the work might create. Garments should completely cover the operator, including their arms.*

Liquid or chemical resistant suits shall be worn when there is a reasonable chance such equipment can prevent an injury.

- **Hand Protection**

All operators should be provided with adequate means to protect their arms and hands. This protective equipment shall be worn when there is a reasonable chance it can prevent an injury.

- **Foot Protection**

All operators and workers in the vicinity of a jetting operation should be supplied with, and shall wear, waterproof boots that have been fitted with steel toe caps. A metatarsal guard should also be worn by jetting gun operators.

- **Respiratory Protection**

A respiratory program shall be implemented where there is a reasonable chance it can prevent an injury.

Maintenance

Overview

In order to keep the equipment in optimum operating condition, routine and preventive maintenance is essential.

*Only trained personnel should be authorized to perform maintenance or repairs to the equipment. All manufacturers' repair instructions, including tool, torque, clearance, and lubrication recommendations should be followed. **Do not attempt to install or use a part whose dimensions, clearances, function, or use are suspect.***

Repaired equipment must be thoroughly and carefully tested before it is returned to service. Do not put any piece of repaired equipment in service if its performance is questionable.

Maintenance Precautions

Observe these precautions whenever you maintain the equipment.

- *Protect all machined and lapped mating surfaces against nicks, scratches, and burrs.*
- *Carefully clean and blow out all parts to be reassembled. Do not use paper towels. Do not create airborne dust.*
- *Do not use any substitutes for the fluids, sealants, and lubricants recommended by Advanced Pressure Systems.*
- *Lubricate threads for all high-pressure connections with blue lubricant before assembly.*
- *Lubricate new bearings before installation.*

General Precautions

Observe the following general precautions at all times.

Mechanical

- *Do not make any unauthorized alterations to the equipment or components.*
- *Use only high-pressure fittings, hoses, valves, and tubing with a minimum burst rating of 2.5 times the system operating pressure when making alterations or additions to the high-pressure water system.*
- *Repair any leaks in fittings or connections immediately. Do not over-torque fittings to stop leakage. Refer to the Torque specifications table below.*
- *Torque all fittings to the manufacturer's specifications.*
- *Follow the tubing manufacturer's recommendations for high-pressure tubing bending radii.*

- When pressurizing any new, rebuilt, or serviced high pressure components, remove all personnel from the immediate area until the system pressure has been applied for three minutes and has been cycled on and off at least three times. Gradually increase pressure [maximum of 1380 bar (20,000 psi) per minute].
- High-pressure water may remain in the system for a prolonged period after closing the high-pressure water source. Bleed the system pressure off before servicing any part of the pump.
- Follow the manufacturer's recommendations for servicing the pump and use only original manufacturer replacement parts.
- Visually examine the entire system before placing it in operation. If you detect any fault or malfunction, correct it.

Tools

- Use only approved test equipment. Examine the equipment regularly for correct operation and calibration.
- Use the correct tools for the job. Use of incorrect tools can result in injury to personnel or costly damage to the equipment.
- Remove all tools and rags from around the machine after you service and before you start the pump.
- Use only approved work platforms. Never climb on or around the equipment on makeshift devices.

Protective Clothing

- See Personal Protective Equipment (PPE) for more information.

Torque Specification

If a torque value for a gland nut is not specified, reference this table to determine torque value. Always leave 3–4 threads showing between the end of the high-pressure tubing and gland nut collar.

TUBING O.D.	TORQUE [FT. LB. (Nm)]
1/4"	15 – 25 (20 – 34)
3/8"	47 – 60 (35 – 45)
9/16"	60 – 70 (80 – 100)

Daily Inspection

The following inspection procedures should be performed each day before use. If problems are detected, they should be remedied before placing the equipment in service.

- Prior to startup, check power end and inspect oils for dirt or contamination.



Do not check the oil while the pump is running.

- Check all system connections to ensure they are tight and leak proof.
- Check suction and discharge supply line valves to ensure they are fully open.
- Review relevant sections of motor and drive train manuals.
- As the machine is started and water pressure increases, listen for unusual sounds.
- Check for plunger packing leakage.
- Check for leakage between the barrels and suction manifold.
- Check the intermediate rod and main bearing oil seals for leakage.
- Review relevant sections of engine and drive train manuals.

Monthly Maintenance

A number of factors can contribute to component failure: poor water quality, operating conditions, or improper maintenance procedures. Maintaining a service log can be a useful method of tracking component life and maintenance trends. Analyzing service intervals will assist in preparing a preventive maintenance schedule tailored to your specific requirements. Periodic maintenance, at regularly scheduled intervals, will minimize unscheduled downtime and premature component failure.

Improper assembly can lead to the premature failure of components. Maintenance procedures must be followed carefully; components must be properly cleaned prior to assembly and tightened to the correct torque specifications.

- Degrease, wash and clean the system monthly.
- Drain and refill the power end every 500 hours or as often as required to maintain clean, sludge free oil of the proper viscosity.
- Clean the pump with a non-explosive solvent.
- Check studs, nuts and bolts for tightness and tighten as required.
- Check gaskets for leaks and replace as required.

To avoid unsafe conditions and the risk of equipment damage, operating personnel and service technicians must carefully read and follow the procedures in this manual.

High Pressure Fittings and Connections

The minimum burst rating for high pressure fittings must be a minimum of 2.5 times the system operating pressure.

- All fittings shall be cleaned before installing in the system.
- **Never** use a damaged or corroded fitting, or one with damaged or missing threads.
- Check the condition of thread connections prior to the makeup of any high-pressure connection. **Do not** use a component with missing or damaged threads on high pressure connections.

- Use Teflon tape on male pipe threads (NPT) for sealing purposes. Do not let the tape overlap the pipe thread end. Tape fragments may enter the system water stream and clog nozzle orifices.
- Properly tighten all high-pressure connections. All pipe connections **must have a minimum engagement of four (4) threads**. Pipe connections should be hand-tight plus two (2) full wrench turns. **Do not** tighten pipe threads past two wrench turns.
- Position the wrench on the wrench flat when making threaded connections. Do not position the wrench on the fitting ferrule. If wrench flats are not available, use a properly adjusted pipe wrench to tighten fittings. Deep wrench flats weaken fittings.

Filters and Strainers

Regular checks should be made of all fluid filters to ensure they are not blocked or damaged. Care should be taken when examining, changing, or cleaning filters to ensure that no solid particles escape into the supply lines to the pump and nozzle. Solid particles can damage valves and nozzles and make the pump run poorly.

All fluid filters should be checked at regular intervals, especially when the supply water is of a poor quality.

Nozzles, Holders, and Lance Connections

The system should be flushed with water before installing the nozzle. Nozzles should be checked to ensure they are not blocked or damaged and that they seat properly in the holder or manifold. The condition of the threads holding the nozzle in place should be checked to ensure they are in good condition and not worn. All damage shall be repaired, or the parts replaced, before jetting begins.

Trigger and Valve Controls

Each hand-operated and foot-operated valve shall be manually checked before a unit is placed in operation to ensure it is clean and properly functioning. Valves should be periodically disassembled to examine the condition of the internal components and to replace worn parts. Valve guards should also be inspected and any defects that might interfere with the proper operation of the unit shall be corrected.

High Pressure Hoses

Hose assemblies must be visually inspected prior to each use and thoroughly tested every six (6) months or sooner, regardless of whether they were in use or not.

A visual inspection should be made at periodic intervals to determine if a hose assembly is suitable for continued service.

The visual inspection must include checking for loose covers, kinks, bulges or soft spots that might indicate broken or displaced reinforcement. Couplings or fittings must be closely examined and, if there is an indication of displacement of the hose from the couplings, the hose must be removed from service.

Hydrostatic Testing

A hydrostatic test should be performed at periodic intervals to determine if a hose assembly is suitable for continued service. Hose assemblies must be hydrostatically tested for one minute for 1.5 times of the recommended working pressure every six (6) months.

Water is the usual test medium. During the hydrostatic test, the hose should be straight, not coiled or in a kinked position. A regular schedule for testing hose assemblies must be established and verified with formal Inspection Records maintained in a permanent and accessible file.

Prior to hydrostatic testing the hose assembly must be depressurized and laid out straight for visual inspection.

1. Look for cuts, gouges or worn spots in the hose cover that expose the wire reinforcement. Remove hose with exposed reinforcement from service.
2. Look for bulges in the hose cover, or for sections with mashed flats or kinks. Remove hose showing any of these faults from service.
3. Inspect for hose cover blisters or loose outer cover. Remove hose showing either of these faults from service.
4. Examine the 18-inch length of hose adjacent to the coupling carefully for damage, such as kinks, soft spots, cover cracks or permanent deformation. Remove hose showing any of these faults from service.
5. If possible, inspect the inside of the hose assembly for blisters and soft or gummy spots. Remove hose showing any of these internal faults from service.
6. Check couplings for damage. Replace all damaged couplings and hydrostatically test the hose assembly before returning it to service.
7. Check couplings for worn threads. Replace all damaged couplings and hydrostatically test the hose assembly before returning it to service.
8. Inspect couplings for excessive corrosion or rust. Replace all rusted couplings and hydrostatically test the hose assembly before returning it to service.



Only trained personnel, using proper tools and procedures, should conduct the hose assembly pressure tests.



Before conducting pressure tests on hose assemblies, provisions must be made to ensure the safety of personnel performing the tests and to prevent possible damage to property.

9. *Use only clean water with a maximum temperature of 80° F (27 ° C). Air or other compressible gas must not be used as the test medium.*
10. *Prior to building up water pressure entrapped air should be bled through an outlet valve while the hose is being filled.*
11. *The hose being pressure tested must be restrained by placing it in a series of anchored steel straps close to each end and at approximately 10-foot (3 m) intervals along the length. If failure occurs during the test the anchored straps should not destroy the hose but can prevent a whipping action from causing other damage or injury.*
12. *The outlet end of the hose should be bulwarked so that a blown-out fitting cannot escape.*
13. *Sheet metal or a heavy matting shroud must be placed over the hose end to protect testing personnel from flying objects should a hose and bulwark failure occur during testing.*
14. *Test personnel must never stand in front of or to the rear of the hose ends during testing.*

Proper Hose Storage

Hose assemblies in storage can be affected adversely by temperature, humidity, ozone, sunlight, oils, solvents, corrosive liquids and fumes, insects, rodents, and radioactive materials.

The appropriate method for storing hose depends largely on the diameter and length, the quantity to be stored and the way it is packaged. Hose should not be piled or stacked to the extent that the weight of the stack creates distortions on the lengths at the bottom. Hoses with a very thin wall will not support as much load as hoses with a heavier wall or wire reinforcement. Hose shipped in coils or bales should be stored so the coils lie flat on a horizontal plane.

Hose assemblies should be stored in a container. Containers can provide protection against the deteriorating effects of oils, solvents, and corrosive liquids. Containers also give some protection against ozone and sunlight.

Rodents and insects can damage rubber hose products. Protection from them must be considered.

The ideal temperature for storing hose assemblies ranges from 35° to 80° F (2° to 27° C) with a maximum limit of 100° F (38° C). If stored below 32° F (0° C) some hose will become stiff and will require warming before being placed in service. Hose assemblies should not be stored near sources of heat, such as radiators or space heaters.

Power End Assembly

Overview

This section describes the instructions for repairing the Series 50 power frame. It must be read carefully and understood before performing any repair operations on the power frame. Proper use and adequate maintenance are fundamental for the power frame's functionality and longevity. Advanced Pressure Systems declines any responsibility for damage caused by the misuse, or the disregard of the instructions described in this section.

Improper assembly can lead to the premature failure of components. Maintenance procedures must be followed carefully. Components must be properly cleaned prior to assembly and tightened to the correct torque specifications.

Repair/Assembly Instructions



Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance.



Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.

Crankcase Repair

1. Crankcase repair operations may be carried out after draining the oil from the crankcase. To drain the oil, remove the oil dipstick (item 1, figure 1) and then the drain plug (item 2 figure 1).

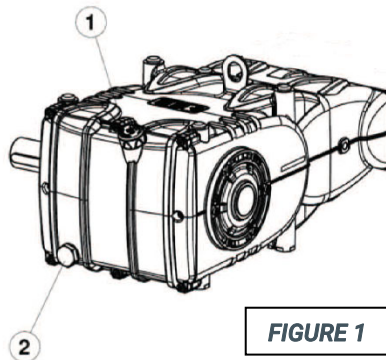


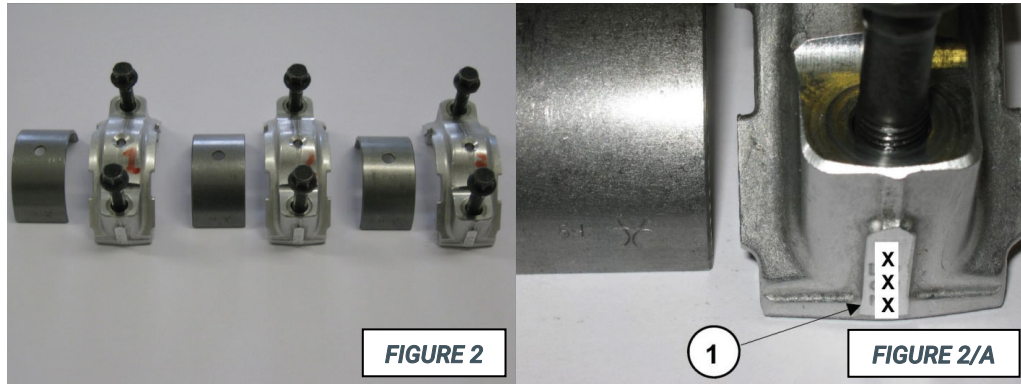
FIGURE 1

NOTICE

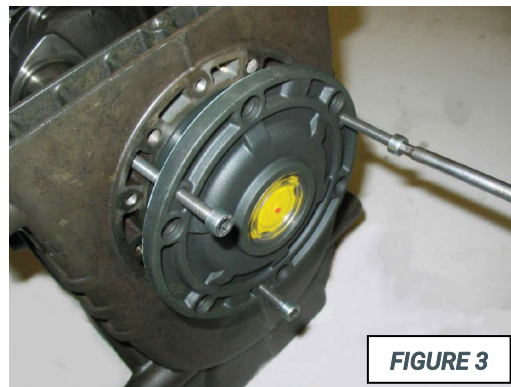
Used oil must be collected in an appropriate container and disposed of in authorized locations. In absolutely no case may it be disposed of into the environment.

Crank Mechanism Removal

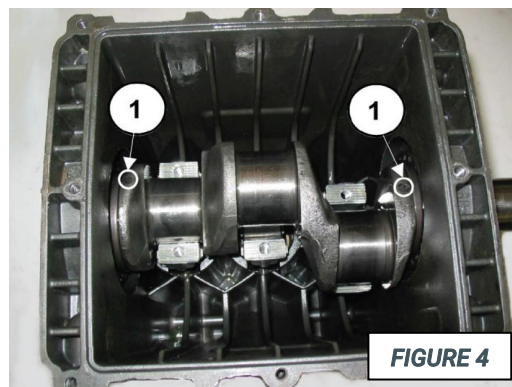
1. Remove the pump shaft key and rear cover, place these items to the side.
2. Separate the connecting rod cap by removing the 2 bolts in each half. Remove the connecting rod caps and journal bearing halves (figure 2). Note the number marking during disassembly (figure 2/A).



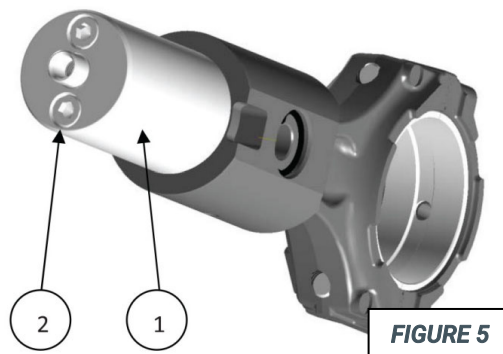
3. Remove the side cover using 3 fully threaded M6 x 50mm screws, inserting them in the threaded holes as shown (figure 3).



4. Push the plunger guides and connecting rods forward in order to extract the crankshaft laterally. Two marks are visible on the crankshaft as shown (figure 4, item 1). They must be turned towards the operator in order to remove the crankshaft.



5. Remove the crankshaft carefully.
6. To extract the plunger guide, the ceramic plunger and wiper must be removed first.
7. Remove the remaining connecting rod halves and plunger guides.
8. After removal, inspect the plunger guides for wear (figure 5, item 1). Replace the part at the sign of excessive wear. Remove the two M6 screws (figure 5, item 2) to separate the plunger guide from the connecting rod.

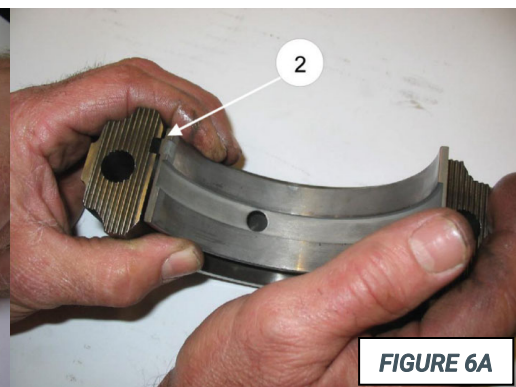
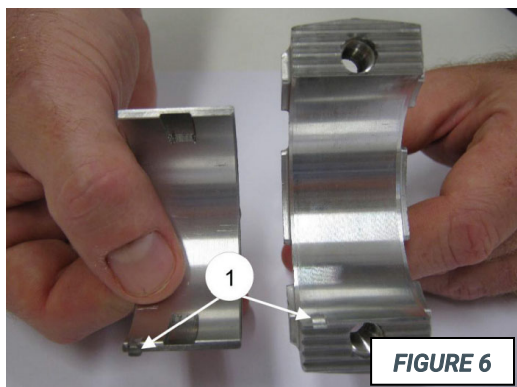


9. Disassemble the crankshaft oil seals and the plunger guides using standard tools.

Crank Mechanism Assembly

After cleaning the crankcase, reassemble the crank mechanism as follows:

1. Assemble the upper and lower bearing halves into the connecting rod and connecting rod half. Make sure that the reference marks on the upper bearing half (figure 6, item 1) and lower bearing half (figure 6A, item 2) are positioned in their respective seats.



2. If the plunger guides have been disassembled, check the condition and placement of the o-ring (figure 6B, item 1) before reassembly. Replace as necessary.
3. If the plunger guides have been disassembled, install them onto the connecting rod using the two M6 screws previously removed (figure 5, item 2). Torque to the proper specification found in the section 'Torque Specification' in this section of the manual.

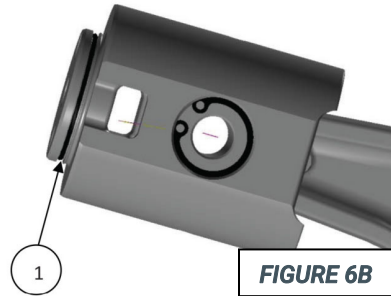


FIGURE 6B

4. Insert the plunger guide into the crank case, making sure the numbering on the connecting rod is towards the top of the crank case.
5. To allow crankshaft installation, push the plunger guides as far forward as possible.
6. Before installing the crankshaft or the cover on the PTO side, check the condition of the lip seal and the relative contact area on the shaft. If replacement is necessary, position the new ring as shown in figure 7 (ring position on first assembly).
7. If the crankshaft shows wear in the relative area of contact with the lip seal, it is possible to reposition the lip seal as shown in figure 7 (ring position to remove shaft if worn).

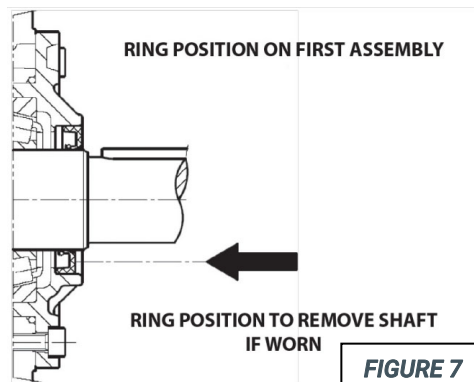


FIGURE 7

8. Before assembling the side covers, ensure there are o-rings on both of them. Ensure there are shim rings on the indicator side cover only.
9. Carefully install the crankshaft.
10. To help the covers fit onto the crankcase, it is advised to use 3 M6 x 40mm screws for positioning (figure 8, item 1), then finish the operation with the supplied M6 x 18mm screws. Torque to the proper specification found in the section 'Torque Specification' in this section.

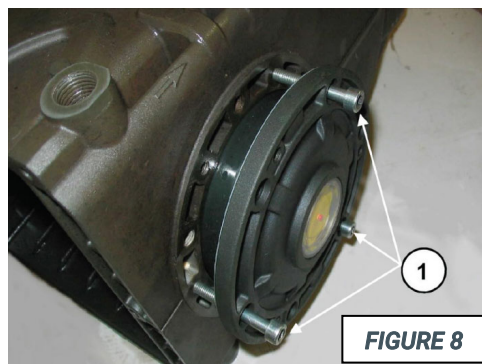
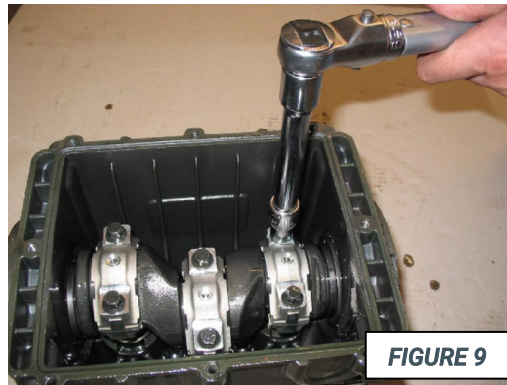


FIGURE 8

11. Install the connecting rod cap, paying attention to the numbering and fasten the corresponding bolts (lubricating both the head and the threaded stem with the same oil used for the crankcase) proceeding in three different steps (figure 9).

- I. Manually install screws until they are hand tight.
- II. Fastening torque 22 ft-lbs. (30 Nm)



12. Install the rear cover positioning the oil dipstick hole upward.

13. Fill the crankcase with 1 gallon (3.8 liters) of oil.

Disassembly / Assembly of Bearings and Shims

The type of bearings used (tapered roller bearings), eliminates axial play on the crankshaft. The shims are to be used to reach this point. To assemble / disassemble, or to replace them if needed, carefully follow the indications below:

Disassembly / Assembly of Crankshaft

Without Bearing Replacement

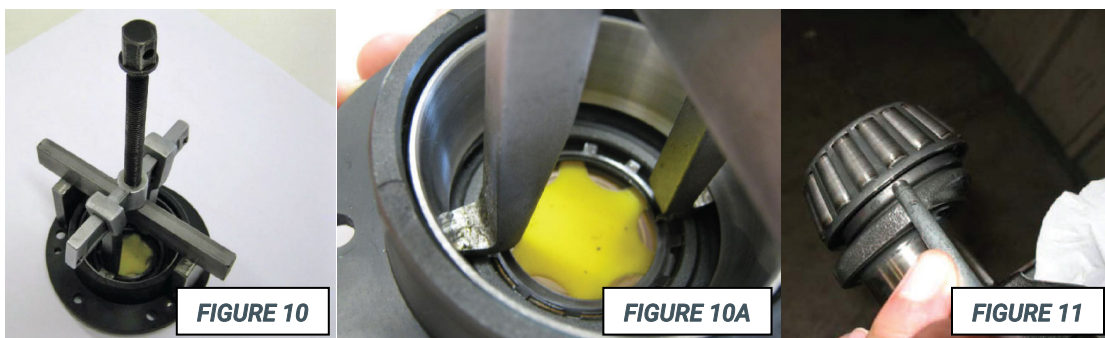
After removing the side covers, as indicated in 'Crank Mechanism Disassembly', check the rollers and their races for wear. If all parts are in good condition, fully clean the components with a suitable degreaser and grease them again evenly using the same oil in the crankcase.

The same shims can be used again, being careful to fit them under the cover on the site glass side. After installing the complete unit (sight glass side flange and motor side flange), check that the shaft's rolling torque - with the connecting rods free - is at least 3 ft-lbs., max 5 ft-lbs. To position the two side covers on the crankcase, use three M6 x 40mm screws as shown (figure 8), and then fasten the screws.

The shafts rolling torque (with connecting rods coupled) must not exceed 6 ft. lbs.

With Bearing Replacement

After disassembling the side covers as indicated in 'Crank Mechanism Disassembly', remove the outer ring nut of the bearings from their covers and the inner ring nut. Remove the remaining part of the bearing, from the two shaft extremities using a standard pin extractor or similar tool as indicated (figure 10 and 11).



The new roller bearing can be mounted at room temperature with a press. It is necessary to lay them on the lateral side of the relevant ring nuts with opposite rings. The driving operation can be facilitated by heating the relevant parts to a temperature ranging between 250 - 300F, (120 - 150C), making sure that the ring nuts are correctly fitted in their seats.

⚠ CAUTION Never invert the parts of the two bearings.

Determining the Shim Pack

Perform the operation while the plunger/con-rod guides are assembled, the con-rod caps are disconnected, and the con-rods are pushed forward. Insert the pump crankshaft without key into the crankcase, making sure the PTO shank comes out the correct side.

Secure the PTO side flange to the casing, with the lip seal seated as described previously and tighten the screws to the recommended torque.

Install the flange on the indicator side without shims and start to move it closer, manually screwing the M6 x 40 service screws in equally, with small rotations. At the same time, check that the shaft rotates freely by turning it manually.

Continuing the procedure in this way, an increase in resistance during shaft rotation will be experienced. At this point, stop the forward moment of the cover and loosen the fixing screws completely. Using a feeler gauge, measure the clearance between the side cover and pump crankcase (figure 12).



To determine the shim pack, use the table below:

Measurement	Shim Type	No. of Pieces
From: 0.05 to 0.010	-	-
From: 0.11 to 0.20	0.1	1
From: 0.21 to 0.30	0.1	2
From: 0.31 to 0.35	0.25	1
From: 0.36 to 0.45	0.35	1
From: 0.46 to 0.55	0.35 0.10	1 1
From: 0.56 to 0.60	0.25	2
From 0.61 to 0.70	0.35 0.25	1 1

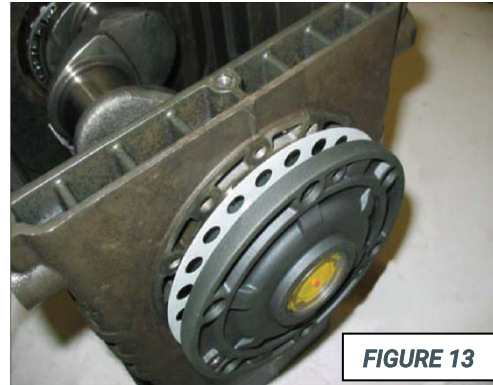


FIGURE 13

Once the type and number of shims have been determined using the table, proceed by assembling the shim pack on the indicator side cover centering (figure 13), secure the cover to the crankcase, following the procedure in 'Crank Mechanism Assembly' and tighten the screws to their recommended torque.

Check that the shaft rotation stall torque is between 3 ft-lbs. (4 Nm) and 4.5 ft-lbs. (6 Nm). If the torque is correct, connect the con-rods to the crankshaft. If it's not, add or remove shims to the shim pack, repeating the above operations.

Check the oil level by using the appropriate oil level dipstick with minimum and maximum value notches (figure 14, item 1). Refill if needed. Correct oil level inspection is done with the pump at room temperature; oil is changed with the pump at working temperature, by removing the rear plug (figure 14, item 2). Oil is to be changed every 1000 hours of operation. The amount required is ~1 gal. (3.8 liters).

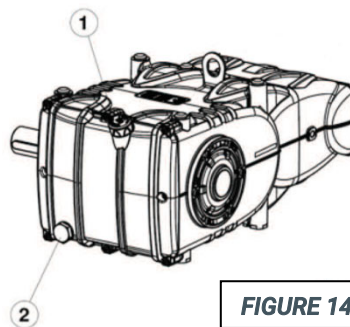


FIGURE 14

CAUTION

Oil must be changed at least once a year since it may deteriorate by oxidation.

For room temperatures that differs from normal, follow the indications contained in the diagram below, keeping in mind that the oil must have a minimum viscosity of 180 cSt.

CAUTION

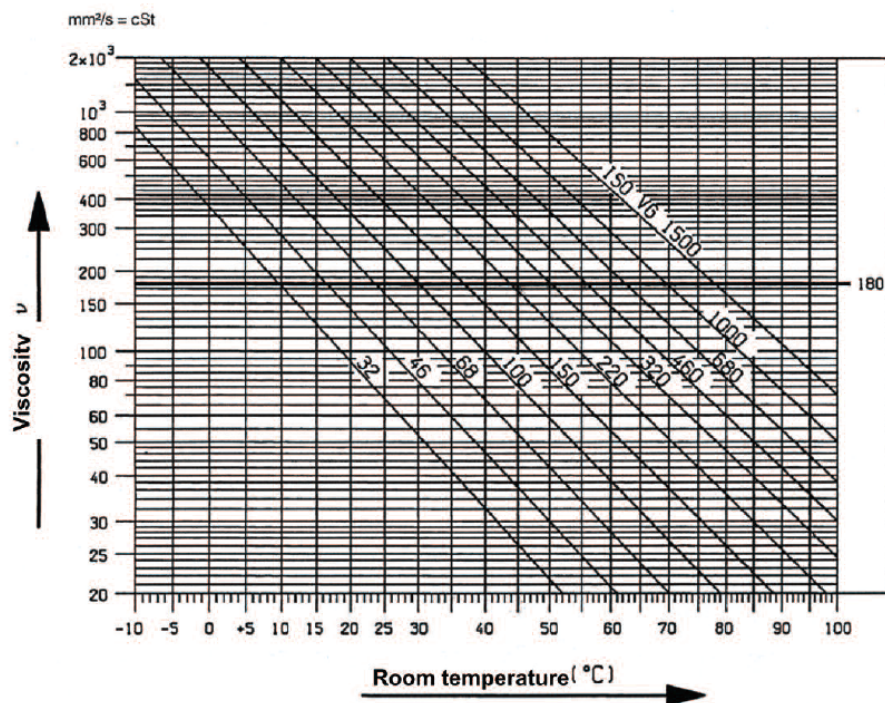
Used oil must be collected in an appropriate receptacle and disposed of in appropriate locations. In absolutely no case may it be dispersed into the environment.

Recommended Lubricant Oil Types & Manufacturers

The pump is delivered with lubricant oil, compliant with room temperatures ranging between 0° and 30°C (32° and 89.6° F). Some recommended lubricant types are indicated in the table below; these lubricants are treated with additives in order to increase corrosion protection and resistance to fatigue. As an alternative, Automotive SAE 85W-90 gearing lubricants may also be used.

BRAND	TYPE
GENERAL PUMP	SERIES 220
ARAL	Aral Degol BG220
BP	ENERGOL HLP 220
CASTROL	Hyspin VG 220, Magna 220
ELF	POLYTELIS 220
ESSO	NUTO 220
FINA	Cirkan 220
FUCHS	RENOLIN 220
MOBIL	DTE OIL BB
SHELL	TELLUS C 220
TEXACO	RANDO HD 220
TOTAL	CORTIS 220

VISCOSITY/ROOM TEMPERATURE DIAGRAM



In case of disassembly, to avoid letting dirt inside the front part of the crankcase, close the threaded hole with the appropriate cap, supplied.



Replace the crankcase cap with the oil dipstick and check oil level. The oil dipstick must always be accessible, even when the unit is assembled.

Torque Specification

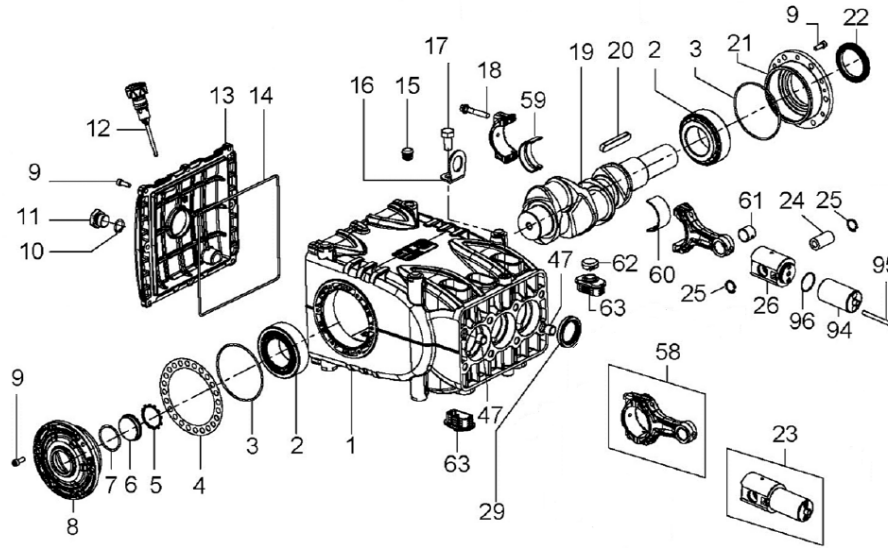
Description	Exploded View Position (From Owner's Manual)	Fastening Torque (Ft. Lbs.)	Fastening Torque (Nm)
Cover fastening screws	19	7.4	10
Oil discharge plug	11	29.5	40
Lifting bracket fastening screw	17	73.8	100
Conrod caps fastening screw	18	28	38*
Support fastening screw	44	11	15****
Hydraulic motor flange screw	59	29.5	40
<p>* The conrod caps fastening screws must be tightened respecting the phases indicated in "Point D" of page 4-19</p> <p>****The support fastening screws must be tightened in a single step</p>			

Maintenance Log

HOURS & DATE

OIL CHANGE							
GREASE							
PACKING REPLACEMENT							
PLUNGER REPLACEMENT							
VALVE REPLACEMENT							

Power End Exploded View and Parts List



ITEM NO.	PART NO.	DESCRIPTION
1	33-100-007.1	Pump Crankcase
2	33-100-007.2	Roller Bearing
3	33-100-007.3	O-ring, Ø 94.92 x 2.62
4	33-100-007.4.1	Shim, .25 mm
4	33-100-007.4.2	Shim, .1 mm
5	33-100-007.5	Retainer Clip, Ø 45
6	33-100-007.6	Oil Level Indicator
7	33-100-007.7	O-ring, Ø 39.34 x 2.62
8	33-100-007.8	Oil Level Indicator, Side Bearing Cover
9	33-100-007.9	Screw, M6 x 18
10	33-100-007.10	O-ring, Ø 17.13 x 2.62
11	33-100-007.11	Plug, G 1/2" x 13
12	33-100-007.12	Dipstick
13	33-100-007.13	Crankcase Cover
14	33-100-007.14	O-ring, Ø 215 x 3
15	33-100-007.15	Plug for Ø 15 Port
16	33-100-007.16	Lifting Eye Bolt
17	33-100-007.17	Screw, M16 x 1.5 x 25
18	33-100-007.18	Connecting Rod Screw, M8 x 48
19	33-100-007.19	Crankshaft
20	33-100-007.20	Crankshaft Key
21	33-100-007.21	Motor Side Bearing Cover
22	33-100-007.22	Oil Seal, Ø50 x 65 x 8
23	33-100-007.23	Plunger Guide
24	33-100-007.24	Wrist Pin, Ø 20 x 38
25	33-100-007.25	Seal, Ø 20
26	33-100-007.26	Plunger Guide
29	33-100-007.29	Seal, Ø 38 x 52 x 7/8.5
47	33-100-007.47	Center Bushing
58	33-100-007.58	Connecting Rod Assembly
59	33-100-007.59.1	BABBIT BEARING, NON-LOAD SIDE, SMOOTH, NOMINAL
59	33-100-007.59.2	BABBIT BEARING, NON-LOAD SIDE, SMOOTH, NOMINAL, +0.25
59	33-100-007.59.3	BABBIT BEARING, NON-LOAD SIDE, SMOOTH, NOMINAL, +0.50
60	33-100-007.60.1	BABBIT BEARING, LOAD BABBIT BEARING, LOAD SIDE
60	33-100-007.60.2	BABBIT BEARING, LOAD BABBIT BEARING, LOAD SIDE, +0.25
60	33-100-007.60.3	BABBIT BEARING, LOAD BABBIT BEARING, LOAD SIDE, +0.50
61	33-100-007.61	Bushing, Bronze
62	33-100-007.62	Cap, Vented
63	33-100-007.63	Plug, Drain
94	33-100-007.94	Plunger Guide Pin
95	33-100-007.95	Screw, M6x65
96	33-100-007.96	O-ring, Ø 30.00 x 1.5

LP Fluid End Assembly

Maintenance Overview

The following table provides a listing of low-pressure fluid end assemblies included in this portion of the manual.

LOW PRESSURE FLUID END ASSEMBLIES		
PART NO.	PLUNGER SIZE	DESIGN PRESSURE*
25-110-013	13/16" (.81)	10,000 PSI (689 BAR)
25-110-014	7/8" (.88)	10,000 PSI (689 BAR)
25-110-016	1" (1.0)	10,000 PSI (689 BAR)
25-110-020	1-1/4" (1.25)	10,000 PSI (689 BAR)

*Fluid end designed for stated pressure, rod load not to exceed 4,500 lbs.

Never perform any type of maintenance on the fluid end assembly while it is pressurized. Always turn the power off and bleed the high-pressure water before servicing.

Improper assembly can lead to the premature failure of components. Maintenance procedures must be followed carefully; components must be properly cleaned prior to assembly and tightened to the correct torque specifications.

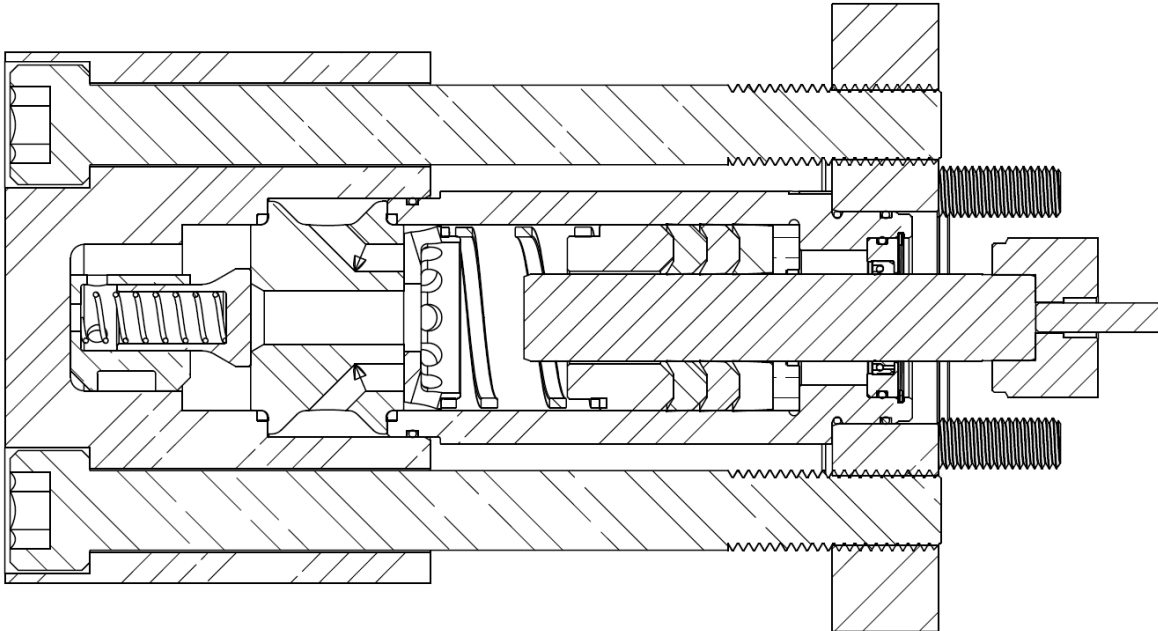


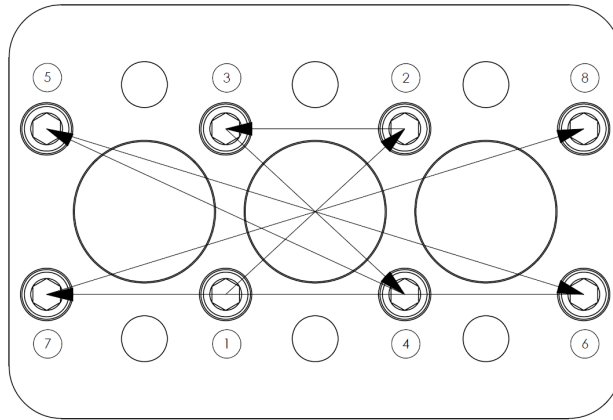
Figure 1: Fluid End Assembly

NOTICE

Refer to fluid end drawing for a complete listing of replacement parts and part numbers.

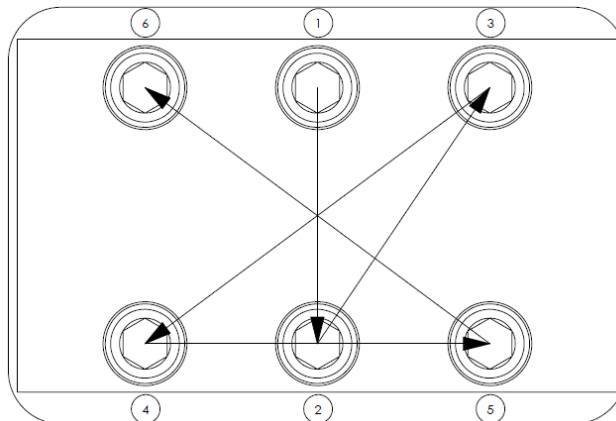
Torque Specification

- Subplate:



1. Apply silver grade anti-seize to threads and torque to 62 ft. lbs.
2. Tighten bolts in order indicated by numbers.

- Manifold:



1. Apply silver grade anti-seize to threads and torque to 120 ft. lbs.
2. Tighten bolts in order indicated by numbers.

- Plunger Assembly

1. Apply silver grade anti-seize to threads and torque to 10 ft. lbs.

Valve Assemblies

The fluid end valves are spring loaded, flat disc and seat type. Both the discharge and suction valves and seat can be removed from the front of the fluid end.

Valves and seating surfaces encounter high wear during operation. Frequent inspection, maintenance and/or replacement are required to ensure proper operation. Poor suction and water quality can reduce valve life and result in rapid mechanical wear of the power end components.

- Valve springs should be replaced after 2,000 hours of operation to reduce the possibility of a fatigue break; or when the coils have flat wear spots due to rubbing during normal operation.
- The valve seat provides a seating surface for both the discharge and suction valve. Valve seat surfaces are flat and can be restored by surface grinding to a 4 to 16 RMS surface finish.
- Mating surfaces of the valve seat and the valves must be smooth and free from nicks and scratches.



Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance.



Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.

1. Disconnect all piping to the manifold.
2. Remove the cap screws and washers attaching the manifold to the subplate. Use a flat screwdriver or other suitable tool to pry the manifold from each barrel, leaving the barrels in position.

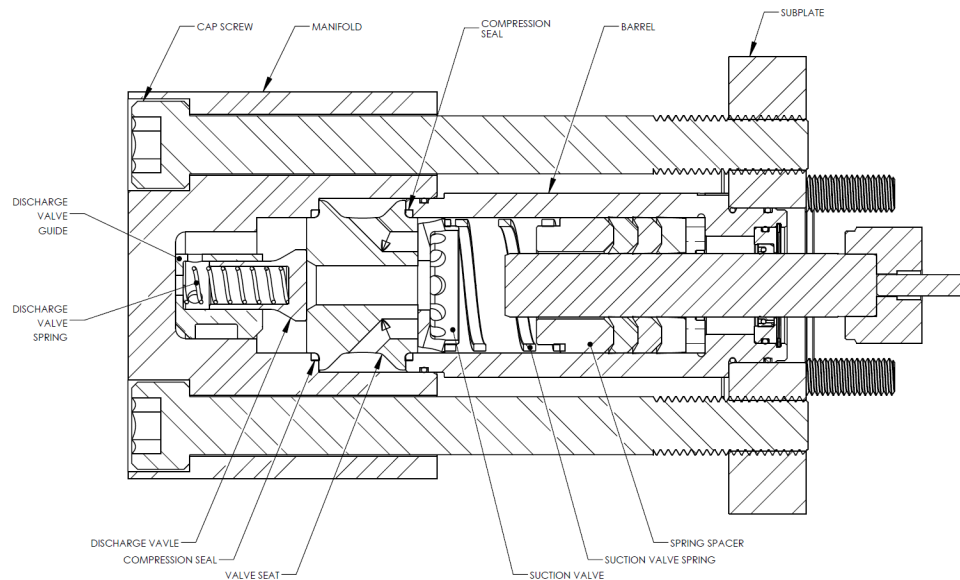


Figure 2: Valve Removal

3. Lift the manifold off, separating it from the barrels. Place the manifold on a solid horizontal surface with the valve seats facing up.
4. Place a rod through the center bore of the valve seats and pry the seats from the manifold. Remove the discharge valves, valve springs and discharge valve guides from the manifold.
5. Remove the suction valves, valve springs and spring spacers from the barrels by sliding them out the front.
6. Install the compression seal in the counter-bore in the manifold with the radius facing up.
7. Install the discharge valve guides in the manifold, followed by the discharge valve springs and discharge valves.



CAUTION Do not damage the smooth sealing surface of the valve seat.

8. Clean the holes in the valve seats and position the valve seats in the manifold ensuring all of the holes are facing the correct direction.
9. Use a brass rod to tap the valve seat into the manifold. One swift strike should be sufficient. Repeat for the remaining valve seats.
10. Install the compression seal in the face of the barrels.
11. Install the spring spacers, suction valve springs and suction valves in the barrels.
12. Apply a thin layer of FML-2 grease to the O-rings on the end of the barrels. Lift the manifold and position it onto the barrels.
13. Apply Loctite 76764 anti-seize or equivalent to the threads on the cap screws and install the screws. Torque the screws to the specifications in section 'Torque Specifications'.
14. Rotate the crankshaft at least three revolutions to ensure no parts are binding.

Barrel Assemblies



Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance.



Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.

1. Disconnect all piping to the manifold.
2. Remove the cap screws attaching the manifold to the transfer block. Use a flat screwdriver or other suitable tool to pry the manifold from each barrel, leaving the barrels in position.
3. Lift the manifold off, separating it from the barrels. The valve seats may or may not remain in the manifold. If not, remove the valve seats from the barrels.

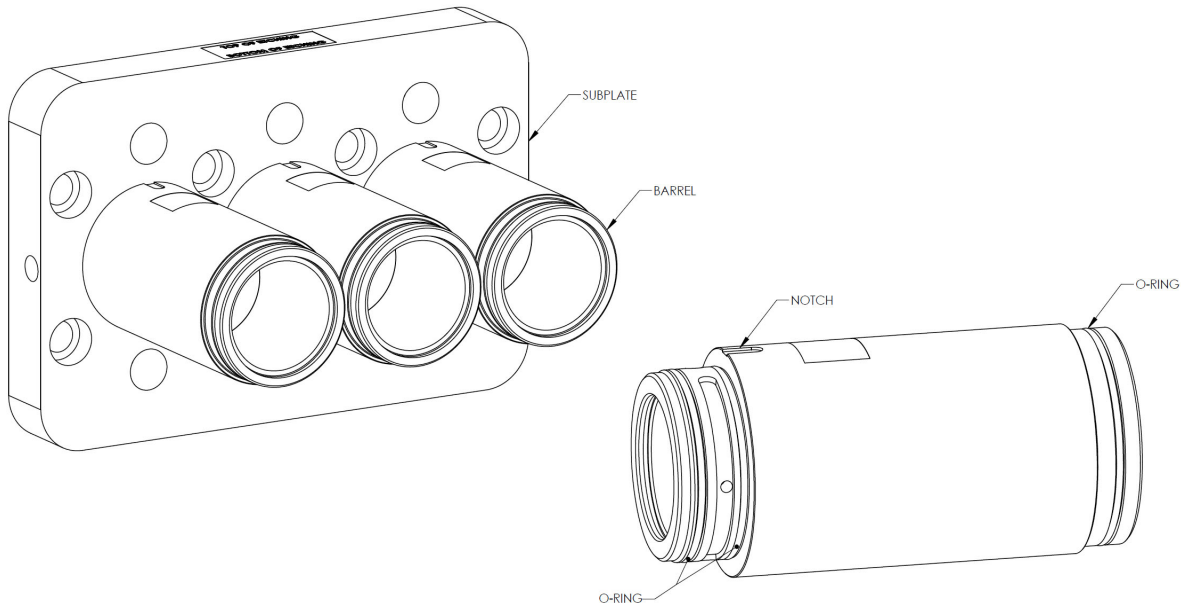


Figure 3: Barrel Assembly

4. Grasp the barrel firmly and pull it from the power end. Remove the remaining barrels in the same manner.

CAUTION

Use caution to not break the plungers when removing the barrels.

5. Apply FML-2 grease to the O-rings and insert them into the appropriate grooves on the barrel. Apply a light coat of Loctite 76764 anti-seize or equivalent to the transfer block bores.
6. Carefully push the barrel into the transfer block. Use two spring spacers to apply pressure to the packing as the barrel is being pushed into the block. This prevents the packing from separating when it goes over the plunger.
7. Align the notch in the barrel with the top of the pump.
8. Install the remaining barrels in the same manner.
9. Position the manifold onto the barrels.
10. Apply Loctite 76764 anti-seize or equivalent to the threads on the cap screws and install the screws. Torque the screws to the specifications in section 'Torque Specifications'.
11. Rotate the crankshaft at least three revolutions to ensure no parts are binding.

Packing Assemblies

Before the packing assembly can be removed for service, the barrels must be removed from the power end. Follow the procedure, Barrel Assemblies, and then proceed with Step 1 below.



Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance.



Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.

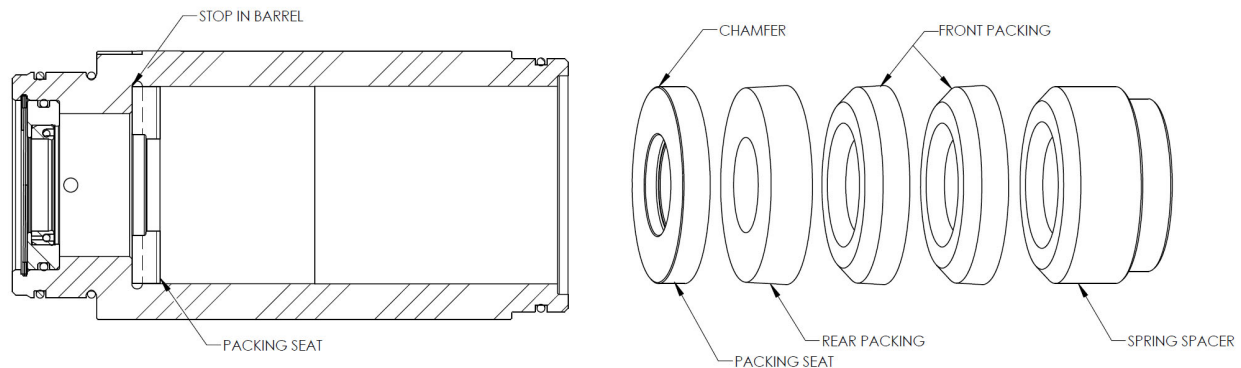


Figure 4: Packing Installation

1. Remove suction valve, compression spring and spring spacer from the barrel.
2. Use a wooden dowel or brass bar to press the packing seat and the rear and front packing out of the barrel.
3. Install the new packing seat ensuring the chamfered edge rests against the stop in the barrel.
4. Slide the rear packing and the two front packing rings into the barrel. Install the spring spacer and use it to correctly position the packing.
5. Install the compression spring and the suction valve.
6. Replace the remaining packing assemblies and install the barrels following the procedure 'Barrel Assemblies'.

Low Pressure Seal Assemblies

Before the low-pressure seal assembly can be removed for service, the barrels must be removed from the power end. Follow the procedure, Barrel Assemblies, and then proceed with Step 1 below.

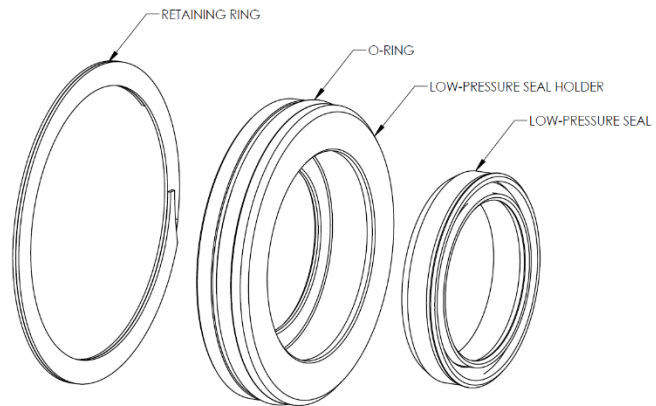


Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance on the system components.



Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.

1. Remove the retaining ring securing the low-pressure seal holder.
2. Remove the holder from the barrel.
3. Remove the low-pressure seal and the o-ring from the holder, being sure not to damage the seal bore in the holder.
4. Install a new low-pressure seal in the seal holder and install a new o-ring on the holder.
5. Apply a small amount of FML-2 grease to the o-ring and insert the holder into the barrel. Secure the holder in position with the retaining ring.
6. Replace the remaining low-pressure seals and install the barrels following the procedure 'Barrel Assemblies'.



Plungers

The following procedure is used to replace the plungers.

1. Slowly rotate the crankshaft until a wrench can be inserted onto the back of the plunger.
2. Unscrew the plunger and remove it from the pump.
3. Inspect the plunger for wear or damage and replace if necessary.
4. To replace, apply Loctite 76764 and screw the plunger into the intermediate rod in the power end and torque to the specifications in section 'Torque Specifications'.

HP Fluid End Assembly

Maintenance Overview

The following table provides a listing of high-pressure fluid end assemblies included in this portion of the manual.

LOW PRESSURE FLUID END ASSEMBLIES		
PART NO.	PLUNGER SIZE	DESIGN PRESSURE*
25-120-007	7/16" (.44)	20,000 PSI (1,379 BAR)
25-120-008	1/2" (.50)	20,000 PSI (1,379 BAR)
25-120-009	9/16" (.56)	20,000 PSI (1,379 BAR)
25-120-010	5/8" (.63)	20,000 PSI (1,379 BAR)
25-120-011	11/16" (.69)	20,000 PSI (1,379 BAR)
25-120-012	3/4" (.75)	20,000 PSI (1,379 BAR)

*Fluid end designed for stated pressure, rod load not to exceed 4,500 lbs.

Never perform any type of maintenance on the fluid end assembly while it is pressurized. Always turn the power off and bleed the high-pressure water before servicing.

Improper assembly can lead to the premature failure of components. Maintenance procedures must be followed carefully; components must be properly cleaned prior to assembly and tightened to the correct torque specifications.

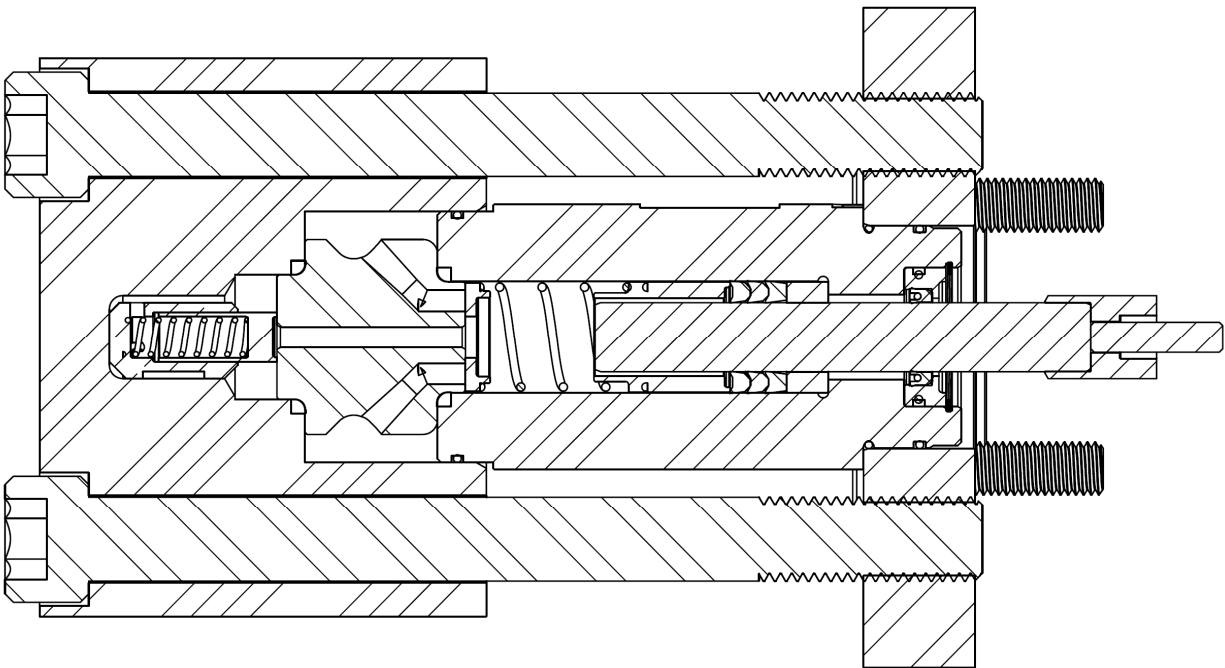
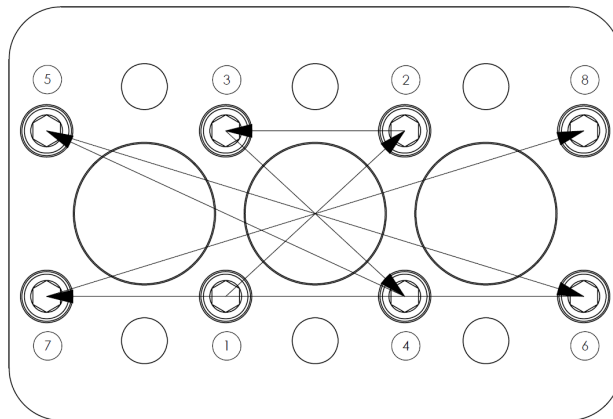


Figure 1: Fluid End Assembly

NOTICE Refer to fluid end drawing for a complete listing of replacement parts and part numbers.

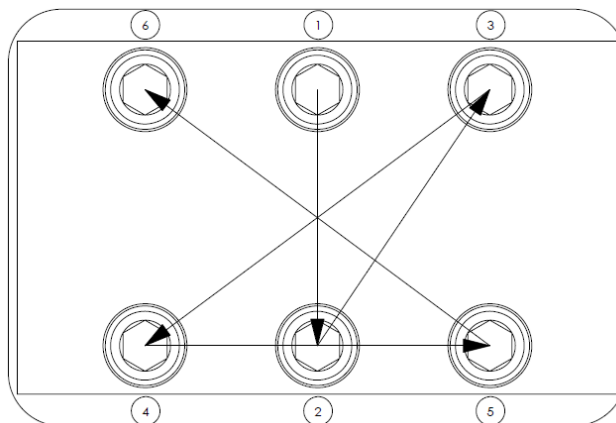
Torque Specification

- Subplate:



1. Apply silver grade anti-seize to threads and torque to 62 ft. lbs.
2. Tighten bolts in order indicated by numbers.

- Manifold:



1. Apply silver grade anti-seize to threads and torque to 160 ft. lbs.
2. Tighten bolts in order indicated by numbers.

- Plunger Assembly

1. Apply silver grade anti-seize to threads and torque to 10 ft. lbs.

Valve Assemblies

The fluid end valves are spring loaded, flat disc and seat type. Both the discharge and suction valves and seat can be removed from the front of the fluid end.

Valves and seating surfaces encounter high wear during operation. Frequent inspection, maintenance and/or replacement are required to ensure proper operation. Poor suction and water quality can reduce valve life and result in rapid mechanical wear of the power end components.

- Valve springs should be replaced after 2,000 hours of operation to reduce the possibility of a fatigue break; or when the coils have flat wear spots due to rubbing during normal operation.
- The valve seat provides a seating surface for both the discharge and suction valve. Valve seat surfaces are flat and can be restored by surface grinding to a 4 to 16 RMS surface finish.
- Mating surfaces of the valve seat and the valves must be smooth and free from nicks and scratches.



Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance.



Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.

1. Disconnect all piping to the manifold.
2. Remove the cap screws and washers attaching the manifold to the subplate. Use a flat screwdriver or other suitable tool to pry the manifold from each barrel, leaving the barrels in position.

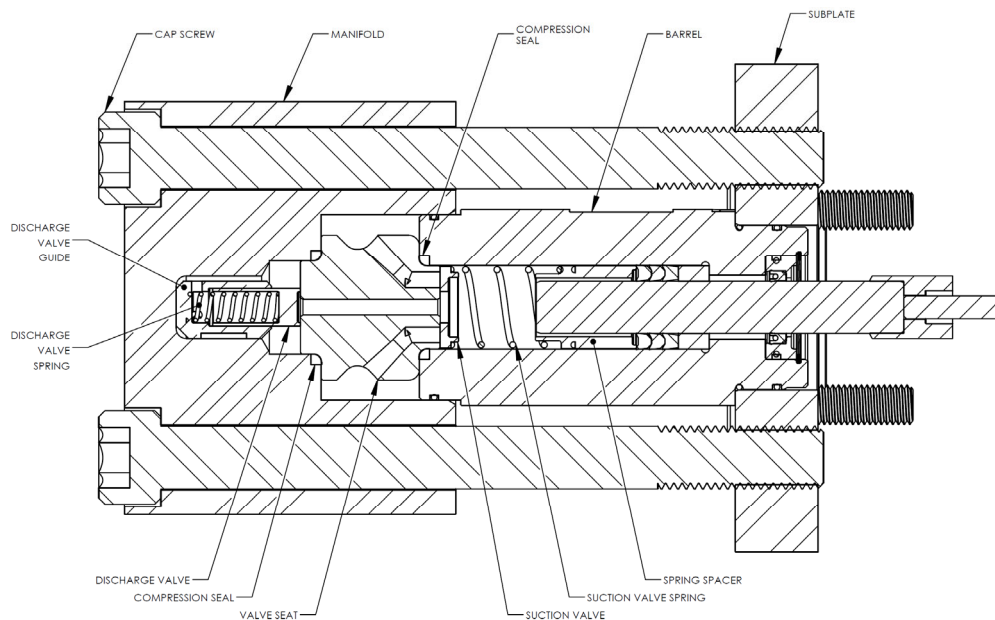


Figure 2: Valve Removal

3. Lift the manifold off, separating it from the barrels. Place the manifold on a solid horizontal surface with the valve seats facing up.
4. Place a rod through the center bore of the valve seats and pry the seats from the manifold. Remove the discharge valves, valve springs and discharge valve guides from the manifold.
5. Remove the suction valves, valve springs and spring spacers from the barrels by sliding them out the front.
6. Install the compression seal in the counter-bore in the manifold with the radius facing up.
7. Install the discharge valve guides in the manifold, followed by the discharge valve springs and discharge valves.



CAUTION Do not damage the smooth sealing surface of the valve seat.

8. Clean the holes in the valve seats and position the valve seats in the manifold ensuring all of the holes are facing the correct direction.
9. Use a brass rod to tap the valve seat into the manifold. One swift strike should be sufficient. Repeat for the remaining valve seats.
10. Install the compression seal in the face of the barrels.
11. Install the spring spacers, suction valve springs and suction valves in the barrels.
12. Apply a thin layer of FML-2 grease to the O-rings on the end of the barrels. Lift the manifold and position it onto the barrels.
13. Apply Loctite 76764 anti-seize or equivalent to the threads on the cap screws and install the screws. Torque the screws to the specifications in section 'Torque Specifications'.
14. Rotate the crankshaft at least three revolutions to ensure no parts are binding.

Barrel Assemblies



Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance.



Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.

1. Disconnect all piping to the manifold.
2. Remove the cap screws attaching the manifold to the transfer block. Use a flat screwdriver or other suitable tool to pry the manifold from each barrel, leaving the barrels in position.
3. Lift the manifold off, separating it from the barrels. The valve seats may or may not remain in the manifold. If not, remove the valve seats from the barrels.

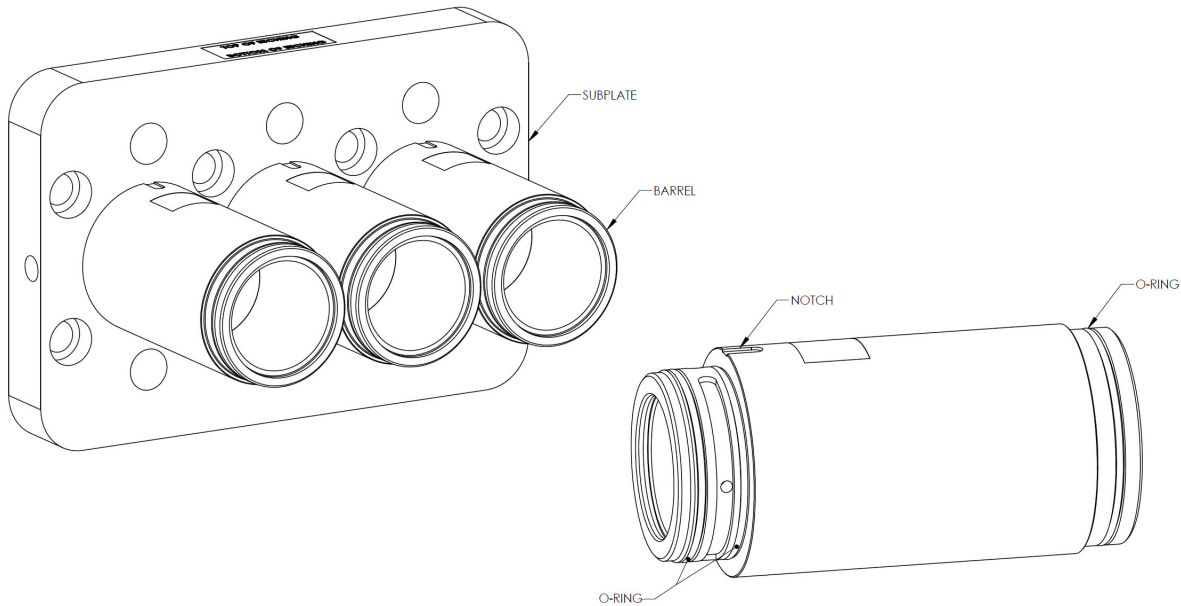


Figure 3: Barrel Assembly

4. Grasp the barrel firmly and pull it from the power end. Remove the remaining barrels in the same manner.

CAUTION

Use caution to not break the plungers when removing the barrels.

5. Apply FML-2 grease to the O-rings and insert them into the appropriate grooves on the barrel. Apply a light coat of Loctite 76764 anti-seize or equivalent to the transfer block bores.
6. Carefully push the barrel into the transfer block. Use two spring spacers to apply pressure to the packing as the barrel is being pushed into the block. This prevents the packing from separating when it goes over the plunger.
7. Align the notch in the barrel with the top of the pump.
8. Install the remaining barrels in the same manner.
9. Position the manifold onto the barrels.
10. Apply Loctite 76764 anti-seize or equivalent to the threads on the cap screws and install the screws. Torque the screws to the specifications in section 'Torque Specifications'.
11. Rotate the crankshaft at least three revolutions to ensure no parts are binding.

Packing Assemblies

Before the packing assembly can be removed for service, the barrels must be removed from the power end. Follow the procedure, Barrel Assemblies, and then proceed with Step 1 below.



Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance.



Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.

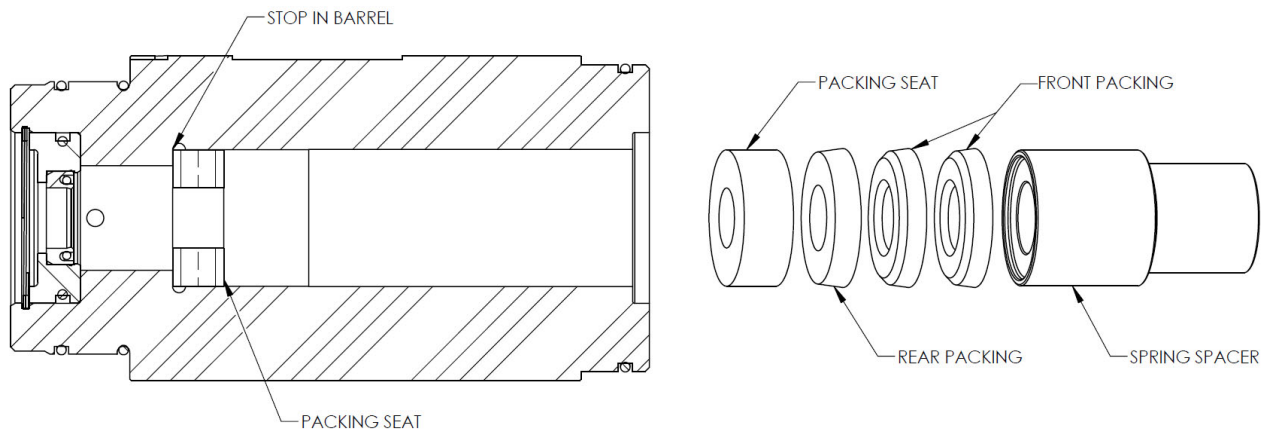


Figure 4: Packing Installation

1. Remove suction valve, compression spring and spring spacer from the barrel.
2. Use a wooden dowel or brass bar to press the packing seat and the rear and front packing out of the barrel.
3. Install the new packing seat ensuring the edge rests against the stop in the barrel.
4. Slide the rear packing and the two front packing rings into the barrel. Install the spring spacer and use it to correctly position the packing.
5. Install the compression spring and the suction valve.
6. Replace the remaining packing assemblies and install the barrels following the procedure 'Barrel Assemblies'.

Low Pressure Seal Assemblies

Before the low-pressure seal assembly can be removed for service, the barrels must be removed from the power end. Follow the procedure, Barrel Assemblies, and then proceed with Step 1 below.

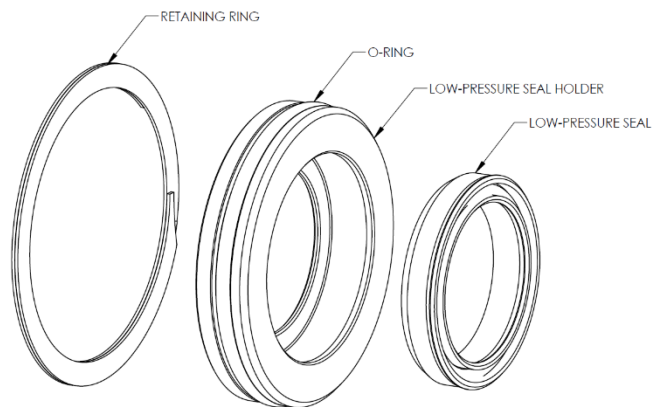


Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance on the system components.



Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.

1. Remove the retaining ring securing the low-pressure seal holder.
2. Remove the holder from the barrel.
3. Remove the low-pressure seal and the o-ring from the holder, being sure not to damage the seal bore in the holder.
4. Install a new low-pressure seal in the seal holder and install a new o-ring on the holder.



5. Apply a small amount of FML-2 grease to the o-ring and insert the holder into the barrel. Secure the holder in position with the retaining ring.
6. Replace the remaining low-pressure seals and install the barrels following the procedure 'Barrel Assemblies'.

Plungers

The following procedure is used to replace the plungers.

1. Slowly rotate the crankshaft until a wrench can be inserted onto the back of the plunger.
2. Unscrew the plunger and remove it from the pump.
3. Inspect the plunger for wear or damage and replace if necessary.
4. To replace, apply Loctite 76764 and screw the plunger into the intermediate rod in the power end and torque to the specifications in section 'Torque Specification'

UHP Fluid End Assembly

Maintenance Overview

The following table provides a listing of ultra-high-pressure fluid end assemblies included in this portion of the manual.

LOW PRESSURE FLUID END ASSEMBLIES		
PART NO.	PLUNGER SIZE	DESIGN PRESSURE*
25-140-005	5/16" (.32)	40,000 PSI (2,758 BAR)
25-140-006	3/8" (.38)	40,000 PSI (2,758 BAR)

*Fluid end designed for stated pressure, rod load not to exceed 4,500 lbs.

Never perform any type of maintenance on the fluid end assembly while it is pressurized. Always turn the power off and bleed the high-pressure water before servicing.

Improper assembly can lead to the premature failure of components. Maintenance procedures must be followed carefully; components must be properly cleaned prior to assembly and tightened to the correct torque specifications.

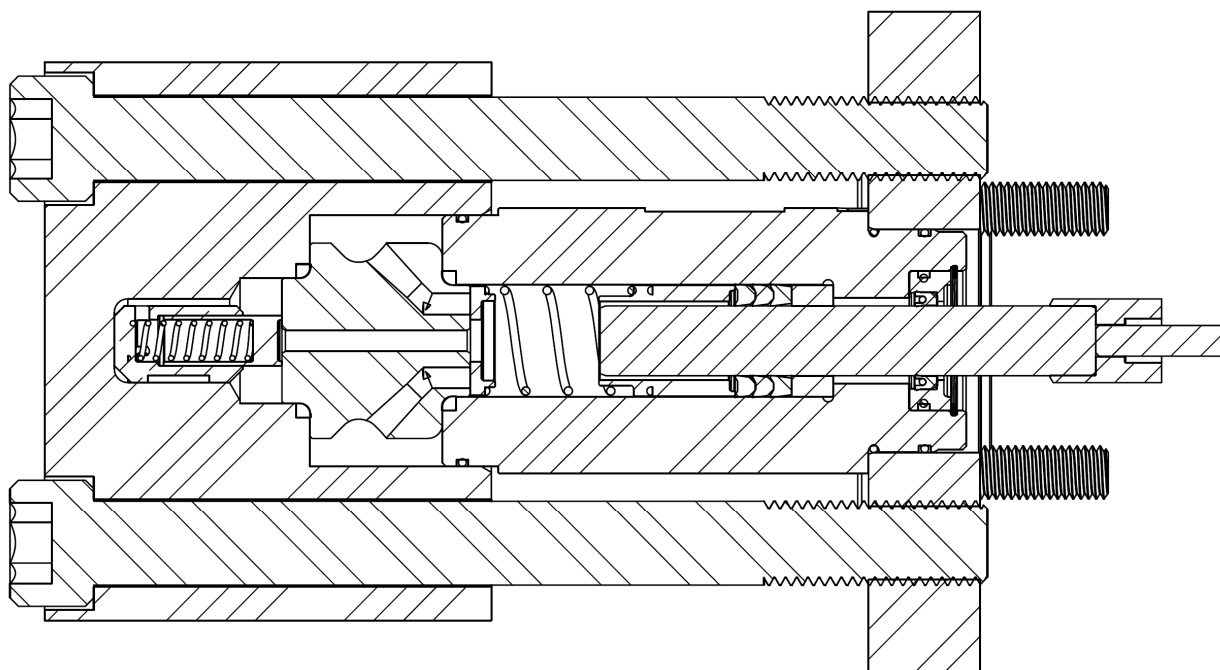
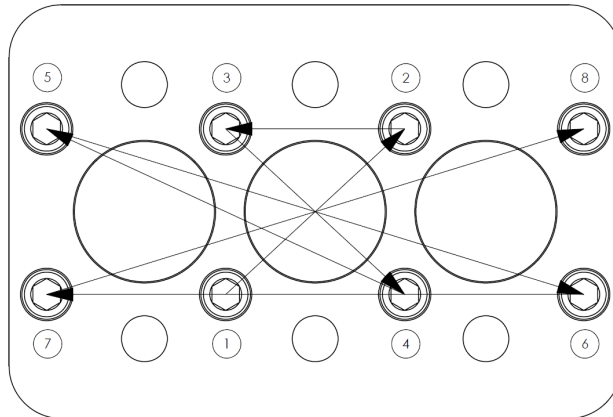


Figure 1: Fluid End Assembly

NOTICE Refer to fluid end drawing for a complete listing of replacement parts and part numbers.

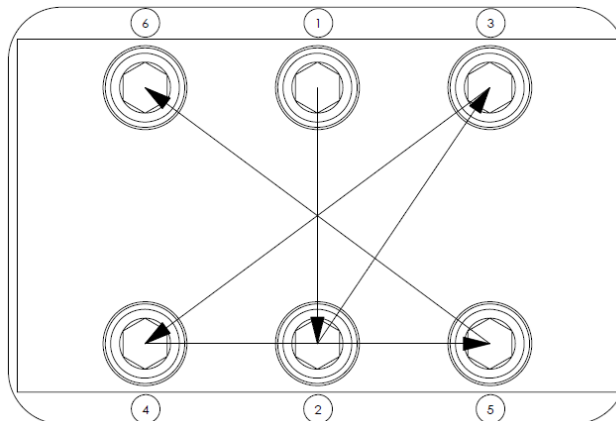
Torque Specification

- Subplate:



1. Apply silver grade anti-seize to threads and torque to 62 ft. lbs.
2. Tighten bolts in order indicated by numbers.

- Manifold:



1. Apply silver grade anti-seize to threads and torque to 160 ft. lbs.
2. Tighten bolts in order indicated by numbers.

- Plunger Assembly

1. Apply silver grade anti-seize to threads and torque to 10 ft. lbs.

Valve Assemblies

The fluid end valves are spring loaded, flat disc and seat type. Both the discharge and suction valves and seat can be removed from the front of the fluid end.

Valves and seating surfaces encounter high wear during operation. Frequent inspection, maintenance and/or replacement are required to ensure proper operation. Poor suction and water quality can reduce valve life and result in rapid mechanical wear of the power end components.

- Valve springs should be replaced after 2,000 hours of operation to reduce the possibility of a fatigue break; or when the coils have flat wear spots due to rubbing during normal operation.
- The valve seat provides a seating surface for both the discharge and suction valve. Valve seat surfaces are flat and can be restored by surface grinding to a 4 to 16 RMS surface finish.
- Mating surfaces of the valve seat and the valves must be smooth and free from nicks and scratches.



Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance.



Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.

1. Disconnect all piping to the manifold.
2. Remove the cap screws and washers attaching the manifold to the subplate. Use a flat screwdriver or other suitable tool to pry the manifold from each barrel, leaving the barrels in position.

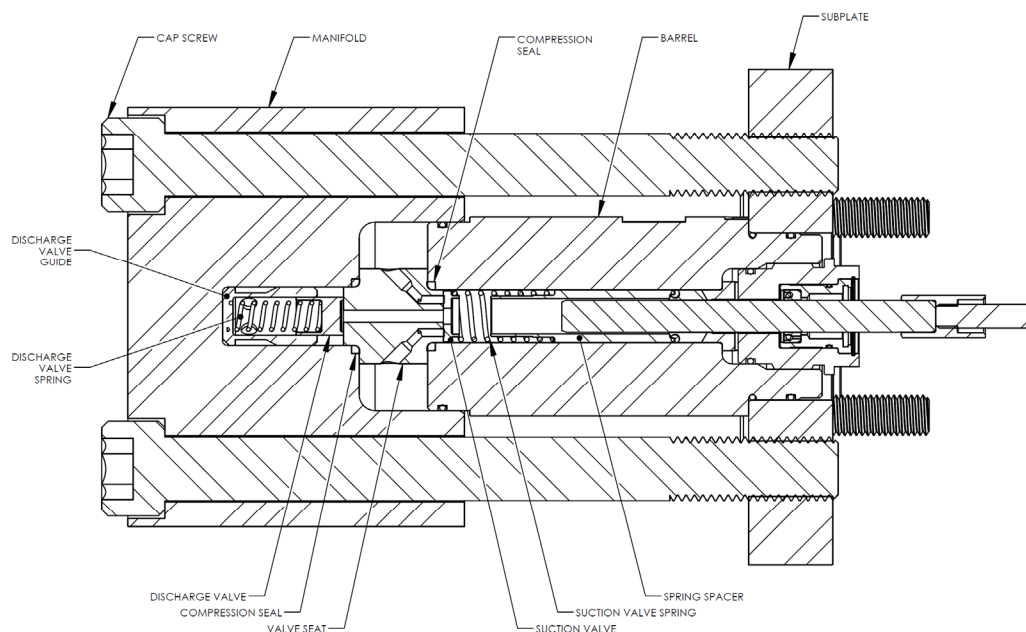


Figure 2: Valve Removal

3. Lift the manifold off, separating it from the barrels. Place the manifold on a solid horizontal surface with the valve seats facing up.
4. Place a rod through the center bore of the valve seats and pry the seats from the manifold. Remove the discharge valves, valve springs and discharge valve guides from the manifold.
5. Remove the suction valves, valve springs and spring spacers from the barrels by sliding them out the front.
6. Install the compression seal in the counter-bore in the manifold with the radius facing up.
7. Install the discharge valve guides in the manifold, followed by the discharge valve springs and discharge valves.



CAUTION Do not damage the smooth sealing surface of the valve seat.

8. Clean the holes in the valve seats and position the valve seats in the manifold ensuring all of the holes are facing the correct direction.
9. Use a brass rod to tap the valve seat into the manifold. One swift strike should be sufficient. Repeat for the remaining valve seats.
10. Install the compression seal in the face of the barrels.
11. Install the spring spacers, suction valve springs and suction valves in the barrels.
12. Apply a thin layer of FML-2 grease to the O-rings on the end of the barrels. Lift the manifold and position it onto the barrels.
13. Apply Loctite 76764 anti-seize or equivalent to the threads on the cap screws and install the screws. Torque the screws to the specifications in section 'Torque Specifications'.
14. Rotate the crankshaft at least three revolutions to ensure no parts are binding.

Barrel Assemblies



Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance.



Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.

1. Disconnect all piping to the manifold.
2. Remove the cap screws attaching the manifold to the transfer block. Use a flat screwdriver or other suitable tool to pry the manifold from each barrel, leaving the barrels in position.
3. Lift the manifold off, separating it from the barrels. The valve seats may or may not remain in the manifold. If not, remove the valve seats from the barrels.

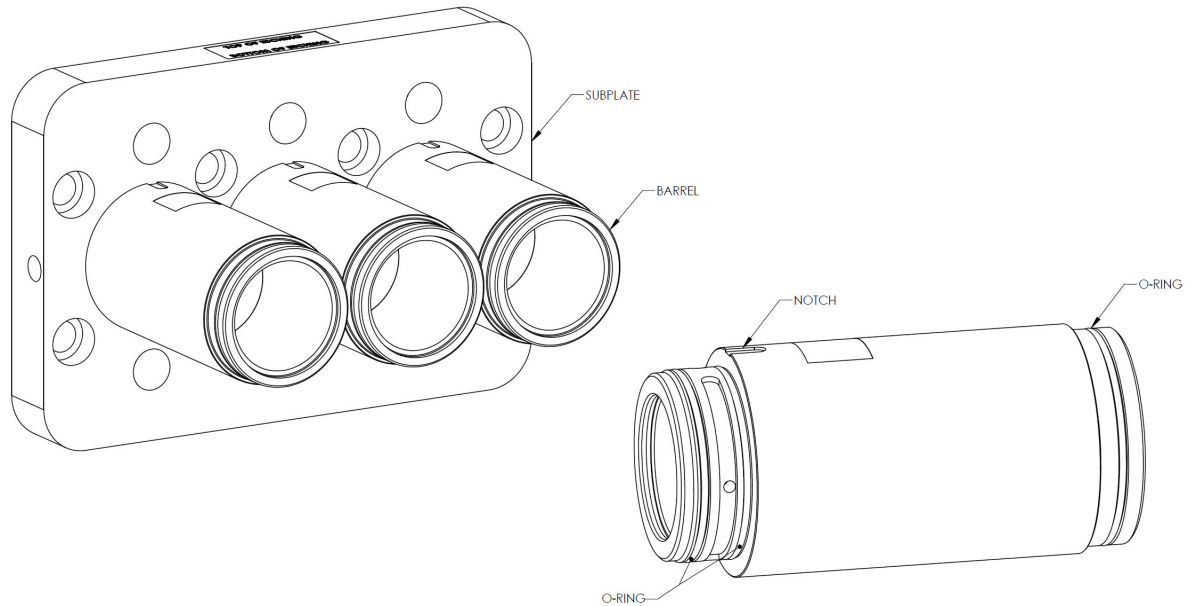


Figure 3: Barrel Assembly

4. Grasp the barrel firmly and pull it from the power end. Remove the remaining barrels in the same manner.

CAUTION

Use caution to not break the plungers when removing the barrels.

5. Apply FML-2 grease to the O-rings and insert them into the appropriate grooves on the barrel. Apply a light coat of Loctite 76764 anti-seize or equivalent to the transfer block bores.
6. Carefully push the barrel into the transfer block. Use two spring spacers to apply pressure to the packing as the barrel is being pushed into the block. This prevents the packing from separating when it goes over the plunger.
7. Align the notch in the barrel with the top of the pump.
8. Install the remaining barrels in the same manner.
9. Position the manifold onto the barrels.
10. Apply Loctite 76764 anti-seize or equivalent to the threads on the cap screws and install the screws. Torque the screws to the specifications in section 'Torque Specifications'.
11. Rotate the crankshaft at least three revolutions to ensure no parts are binding.

Packing Assemblies

Before the packing assembly can be removed for service, the barrels must be removed from the power end. Follow the procedure, Barrel Assemblies, and then proceed with Step 1 below.



Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance.



Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.

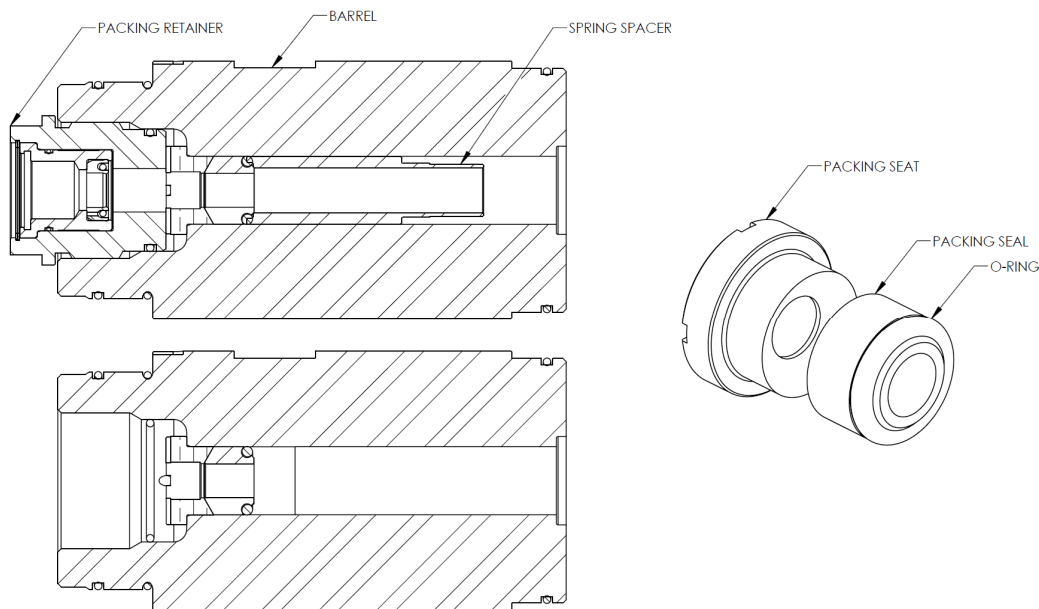


Figure 4: Packing Installation

1. Remove suction valve, compression spring and spring spacer from the barrel.
2. Place the barrel in a vice and unscrew the packing retainer from the barrel.
3. Install the spring spacer and use a wooden dowel or brass bar to press against the spacer, forcing the packing seat and the packing seal out of the barrel.
4. Install a new o-ring on the new packing seal.
5. Apply a small amount of FML-2 grease to the o-ring and install the packing seal and the new packing seat into the back end of the barrel.
6. Inspect the o-ring on the packing retainer and replace if necessary. Thoroughly coat the threads on the packing retainer and on the barrel with Loctite 76764 anti-seize or equivalent. Place the barrel in a vice and thread the packing retainer into the barrel.
7. Install the spring spacer, compression spring and the suction valve.
8. Replace the remaining packing assemblies and install the barrels following the procedure, Barrel Assemblies.

Low Pressure Seal Assemblies

Before the low-pressure seal assembly can be removed for service, the barrels must be removed from the power end. Follow the procedure, *Barrel Assemblies*, and then proceed with Step 1 below.

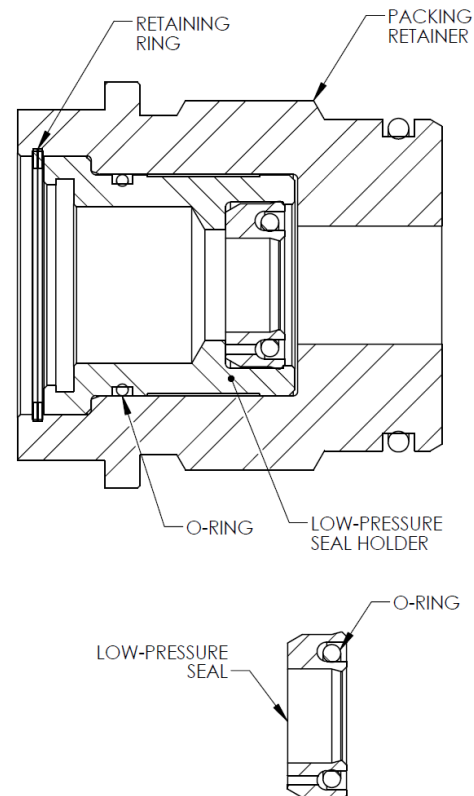


Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance on the system components.



Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.

1. Place the barrel in a vice and unscrew the packing retainer.
2. Remove the retaining ring securing the low-pressure seal holder.
3. Remove the holder from the packing retainer.
4. Remove the low-pressure seal and the o-ring from the holder, being sure not to damage the seal bore in the holder.
5. Install a new low-pressure seal in the seal holder and install a new o-ring on the holder.
6. Apply a small amount of FML-2 grease to the o-ring and insert the holder into the packing retainer. Secure the holder in position with the retaining ring.
7. Inspect the o-ring on the packing retainer and replace if necessary. Thoroughly coat the threads on the packing retainer and on the barrel with Loctite 76764 anti-seize or equivalent. Place the barrel in a vice and thread the packing retainer into the barrel.
8. Replace the remaining low-pressure seals and install the barrels following the procedure, *Barrel Assemblies*.



Plungers

The following procedure is used to replace the plungers.

- 1. Slowly rotate the crankshaft until a wrench can be inserted onto the back of the plunger.*
- 2. Unscrew the plunger and remove it from the pump.*
- 3. Inspect the plunger for wear or damage and replace if necessary.*
- 4. To replace, apply Loctite 76764 and screw the plunger into the intermediate rod in the power end and torque to the specifications in section 'Torque Specification'*

Troubleshooting

Overview

The troubleshooting guide will help identify the probable cause of a system malfunction and assist in providing corrective action. In addition to this manual, you may also need the manufacturer's manuals provided with your pump. The following symptoms are discussed in this section:

- High pressure line pulsation
- Knock in power end
- Water hammer
- Valve wear
- Packing failure
- Plunger failure
- Oil wiper seal leakage
- Packing seal leakage
- Crankshaft oil seal leak

Before starting any procedure:

- Look for obvious problems.
- Read and understand each procedure.
- Make sure that you have the appropriate tools available.
- Make sure that you have the appropriate parts available.

Troubleshooting Guide

Listen to the machine and observe it in operation. Learn to recognize the normal sounds and operating conditions of the system. Carefully define the symptom of the problem. Locate the symptom on the troubleshooting guide that most closely corresponds to the problem.

If the symptoms in the guide do not correspond to the malfunction, or if the problem is not resolved by the recommended corrective action, contact the APS Service Department for assistance.

	Malfunction	Indication	Check
1.	High pressure line pulsation	Suction supply line has been affected	Debris or scale back
			Partially closed valve in suction line
			Air entering the suction supply line through a loose connection or a ruptured pipe
			Low supply line water pressure
		High pressure fluid loss	Worn or broken suction or discharge valves
			Loose packing retainer nut
			Damaged or broken plunger
			Damaged suction or discharge valve spring
			Damaged discharge valve guide
			Worn packing assembly and/or packing seat

	Malfunction	Indication	Check
2.	Knock in power end	Loosely connected components	Tightness of intermediate rod in crosshead
			Plunger collet is fully compressed
			Connecting rod wrist pin bearings
			Crankshaft journal bearing wear
			Crankshaft main roller bearings and shims
		Fluid end effects	Cavitation in fluid end
			Damaged suction or discharge valve or seats
			Damaged suction or discharge valve springs
3.	Water hammer/wheezing	Cavitation effects	Damaged plunger / Worn packing
			Low supply line water pressure
		Plumbing design defects	Stuck suction valve
			Flow separation at elbows and fittings
4.	Valve wear	Contaminated supply water	Variable fluid acceleration in the suction supply plumbing
			Supply water quality or chemistry
		Cavitation effects	Filters are not correctly rated
			Worn valve guides / Damaged valve springs
5.	Packing failure	Contaminated supply water	Packing installation
			Supply water quality or chemistry
		Cavitation effects	Filters are not correctly rated
			Cavitation due to insufficient or low supply water pressure
		Installation damage	Packing lubrication holes in barrel blocked
6.	Plunger failure	Cavitation effects	Lack of cooling
			Packing installation
			Packing lubrication holes in barrel blocked
		Mechanical damage	Low supply line water pressure
			Air entering supply water line
		Contaminated supply water	Air entering the barrel through worn packing
			Chipping from physical impact of foreign material entering the pump well
7.	Oil wiper seal leakage	Foreign material entering the pump well	Supply water quality or chemistry
			Filters are not correctly rated
		Running the pump without oil	Deformation and wear of packing seat
			Pump well cover is kept closed
		Scored intermediate rod	Dirt does not settle on the intermediate rod
			Oil level is correctly set
			Oil quality is correct
8.	Packing seal leakage	Pump run without water	Oil wiper seal is contacting a smooth surface
			Oil wiper seal is not nicked from intermediate rod damage
		Dirt accumulation	Supply water pressure
			Plunger coolant holes in barrels are not blocked
9.	Crankshaft oil seal leak	Dirt accumulation	Packing damaged from dirt entering the pump well
			Packing installed backward
		High oil level in the power end	Seal surface is clean
			Crankshaft contact point for seal lip wear into the shaft
			Oil level is not over the high mark
			Water or condensation has overfilled the power end

Specifications

Standard Operating Parameters

OUTPUT PRESSURE	3,000 PSI TO 40,000 PSI
OUTPUT FLOW RATE (60HZ)	1.53 GPM TO 24.42 GPM

High Pressure Pump

TYPE	POSITIVE DISPLACEMENT TRIPLEX
HYDRAULIC LUBRICATION	SPLASH LUBRICATION
STROKE	1.97 IN.
PLUNGER DIAMETER	SEE 'LP, HP, UHP FLUID END ASSEMBLY' SECTION
OIL	SEE 'POWER END ASSEMBLY' SECTION
LUBRICANT CAPACITY	1 GALLON (3.8 LITERS)

Lubrication Specification

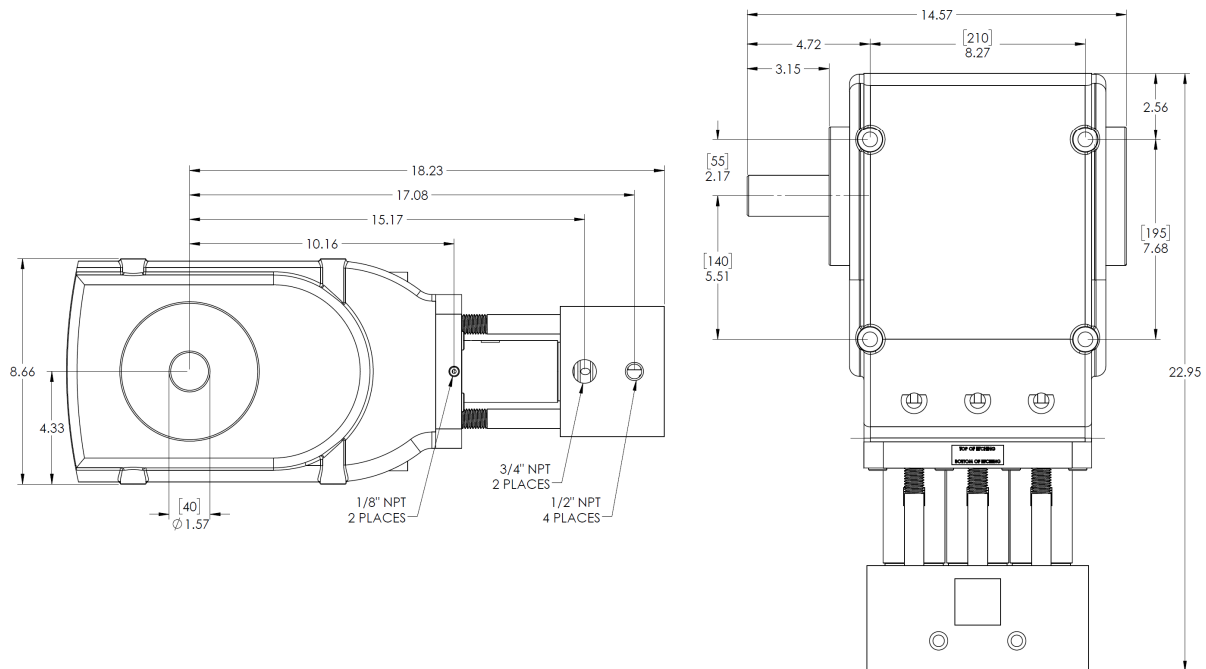
Series 50 pumps are splash lubricated by circulating oil or other specified lubricants in the power end. To ensure proper power end lubrication, the oil must pour freely at lowest ambient operating temperatures. Refer to section 'Power End Assembly', for recommended power end lubricants and maintenance intervals.

Service Connections

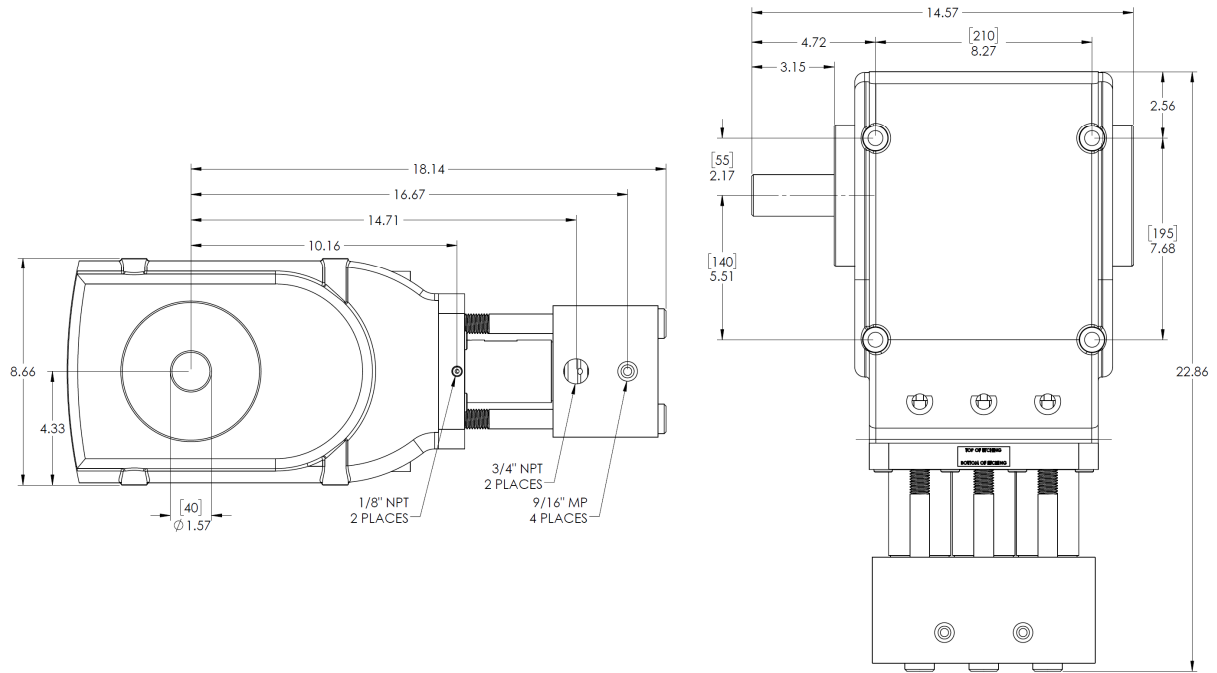
	LOW PRESSURE (10,000 PSI)				HIGH PRESSURE (20,000 PSI)						ULTRA-HIGH PRESSURE (40,000 PSI)	
PART NO.	25-110-013	25-110-014	25-110-016	25-110-020	25-120-007	25-120-008	25-120-009	25-120-010	25-120-011	25-120-012	25-140-005	25-140-006
PLUNGER SIZE	13/16"	7/8"	1"	1-1/4"	7/16"	1/2"	9/16"	5/8"	11/16"	3/4"	5/16"	3/8"
INLET	3/4" NPT										1/2" NPT	
OUTLET	1/2" NPT				9/16" MP						3/8" HP	
COOLING LOOP	1/8" NPT											

Installation Dimensions

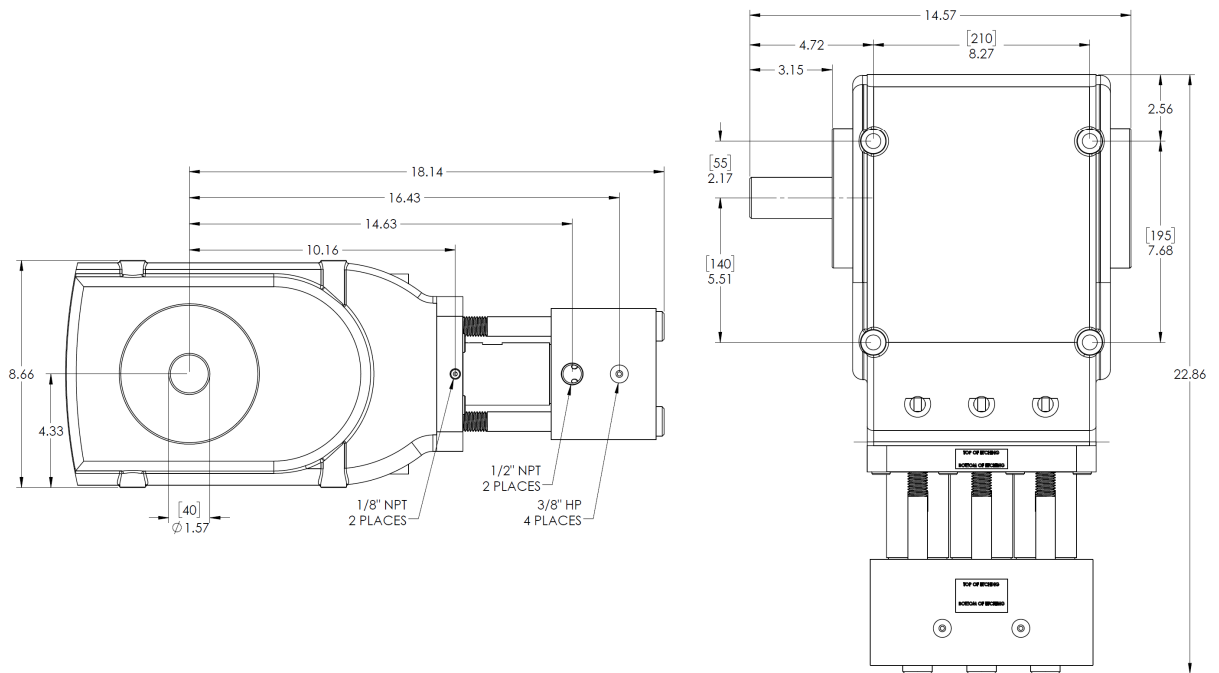
LOW PRESSURE



HIGH PRESSURE



ULTRA-HIGH PRESSURE



Inlet Water

The quality of the inlet water supply is one of the most important factors affecting component life and performance. Water treatment requirements can be determined by a water analysis.

The cutting water supply must meet the following standards. A high concentration of dissolved solids, especially calcium, silica and chlorides will affect high pressure component life.

Water Condition

The inlet water source must meet the minimum required levels for the following parameters.

GENERAL PROPERTIES		
CLARITY	-	CLEAR
COLOR	-	COLORLESS
ODOR	-	NONE PRESENT
ELECTRICAL CONDUCTIVITY	-	100-400 μ S/cm
pH	-	6-8.5

WATER QUALITY GUIDELINES		
TDS	LOW TDS (<100 PPM)	GOOD QUALITY WATER (MAY USE SOFTENING)
TDS	MODERATE TDS (100-200 PPM)	CAN BE TREATED BY SOFTENING OR TDS REDUCTION (REVERSE OSMOSIS OR DEIONIZATION)
TDS	HIGH TDS (>200 PPM)	POOR QUALITY WATER, SHOULD BE TREATED WITH REVERSE OSMOSIS OR DEIONIZATION
SILICA	HIGH CONTENT (>15 PPM)	TREAT WITH DUAL STRING BASE DEIONIZATION

Inlet Water Temperature

Higher than specified water temperature causes more wear of internal seals and components.

Ideal inlet water temperature should not exceed 77°F (25°C).

If the temperature of the inlet water to the pump is not within the parameters as specified in this manual, a chiller may be required to achieve the expected pump maintenance cycles. Horsepower, application, and site-specific conditions determine the capacity of a chiller. Contact APS Technical Service for more information.

Inlet Water Pressure

WATER SUPPLY PRESSURE	100 PSI. MAX.
WATER SUPPLY FLOW RATE	10 GPM (HP & UHP FLUID ENDS) 25 GPM (LP FLUID ENDS)

Inlet Water Filtration

10 micron absolute

Carbide Nozzle Size Selector Chart

NOZZLE FLOW RATING IN GPM															
NOZZLE #	ORIFICE IN (MM)	ACTUAL NOZZLE PRESSURE [KSI (BAR)]													
		4 (276)	5 (345)	6 (414)	7 (483)	8 (552)	9 (621)	10 (689)	12 (827)	15 (1034)	20 (1379)	25 (1724)	30 (2068)	35 (2413)	40 (2758)
0.1	.008 (.207)	0.12	0.13	0.14	0.15	0.17	0.18	0.19	0.20	0.23	0.26	0.29	0.32	0.35	0.37
0.2	.012 (.293)	0.26	0.29	0.32	0.35	0.37	0.40	0.42	0.46	0.51	0.59	0.66	0.72	0.78	0.83
0.3	.014 (.358)	0.36	0.40	0.44	0.47	0.51	0.54	0.57	0.62	0.69	0.80	0.90	0.98	1.06	1.13
0.4	.016 (.414)	0.47	0.52	0.57	0.62	0.66	0.70	0.74	0.81	0.91	1.05	1.17	1.28	1.39	1.48
0.5	.018 (.463)	0.59	0.66	0.73	0.78	0.84	0.89	0.94	1.03	1.15	1.33	1.48	1.62	1.75	1.87
0.6	.020 (.507)	0.73	0.82	0.90	0.97	1.03	1.10	1.16	1.27	1.42	1.64	1.83	2.00	2.16	2.31
0.7	.022 (.547)	0.89	0.99	1.08	1.17	1.25	1.33	1.40	1.53	1.71	1.98	2.21	2.42	2.62	2.80
0.8	.023 (.585)	0.97	1.08	1.19	1.28	1.37	1.45	1.53	1.68	1.87	2.16	2.42	2.65	2.86	3.06
0.9	.024 (.621)	1.05	1.18	1.29	1.39	1.49	1.58	1.67	1.83	2.04	2.36	2.63	2.89	3.12	3.33
1.0	.026 (.654)	1.24	1.38	1.51	1.64	1.75	1.86	1.96	2.14	2.39	2.77	3.09	3.39	3.66	3.91
1.1	.027 (.686)	1.33	1.49	1.63	1.76	1.89	2.00	2.11	2.31	2.58	2.98	3.33	3.65	3.95	4.22
1.2	.028 (.717)	1.43	1.60	1.76	1.90	2.03	2.15	2.27	2.48	2.78	3.21	3.59	3.93	4.24	4.54
1.3	.029 (.746)	1.54	1.72	1.88	2.04	2.18	2.31	2.43	2.66	2.98	3.44	3.85	4.21	4.55	4.87
1.4	.030 (.774)	1.65	1.84	2.02	2.18	2.33	2.47	2.60	2.85	3.19	3.68	4.12	4.51	4.87	5.21
1.5	.032 (.801)	1.87	2.09	2.29	2.48	2.65	2.81	2.96	3.24	3.63	4.19	4.68	5.13	5.54	5.92
1.6	.033 (.827)	1.99	2.23	2.44	2.64	2.82	2.99	3.15	3.45	3.86	4.45	4.98	5.46	5.89	6.30
1.7	.034 (.853)	2.11	2.36	2.59	2.80	2.99	3.17	3.34	3.66	4.10	4.73	5.29	5.79	6.26	6.69
1.8	.035 (.878)	2.24	2.51	2.74	2.96	3.17	3.36	3.54	3.88	4.34	5.01	5.60	6.14	6.63	7.09
1.9	.035 (.902)	2.24	2.51	2.74	2.96	3.17	3.36	3.54	3.88	4.34	5.01	5.60	6.14	6.63	7.09
2.0	.036 (.925)	2.37	2.65	2.90	3.14	3.35	3.56	3.75	4.11	4.59	5.30	5.93	6.49	7.01	7.50
2.5	.041 (1.034)	3.08	3.44	3.77	4.07	4.35	4.61	4.86	5.33	5.96	6.88	7.69	8.42	9.10	9.73
3.0	.045 (1.133)	3.70	4.14	4.54	4.90	5.24	5.56	5.86	6.42	7.17	8.28	9.26	10.15	10.96	11.72
3.5	.048 (1.224)	4.22	4.71	5.16	5.58	5.96	6.32	6.66	7.30	8.16	9.43	10.54	11.54	12.47	13.33
4.0	.052 (1.308)	4.95	5.53	6.06	6.54	7.00	7.42	7.82	8.57	9.58	11.06	12.37	13.55	14.63	15.64
4.5	.055 (1.388)	5.53	6.19	6.78	7.32	7.83	8.30	8.75	9.59	10.72	12.37	13.84	15.16	16.37	17.50
5.0	.058(1.463)	6.15	6.88	7.54	8.14	8.70	9.23	9.73	10.66	11.92	13.76	15.39	16.85	18.21	19.46
5.5	.060 (1.534)	6.59	7.36	8.07	8.71	9.31	9.88	10.41	11.41	12.75	14.73	16.47	18.04	19.48	20.83
6.0	.063 (1.602)	7.26	8.12	8.89	9.61	10.27	10.89	11.48	12.58	14.06	16.24	18.15	19.89	21.48	22.96
6.5	.066 (1.668)	7.97	8.91	9.76	10.54	11.27	11.95	12.60	13.80	15.43	17.82	19.92	21.82	23.57	25.20
7.0	.068 (1.731)	8.46	9.46	10.36	11.19	11.96	12.69	13.38	14.65	16.38	18.92	21.15	23.17	25.02	26.75
7.5	.071 (1.791)	9.22	10.31	11.30	12.20	13.04	13.83	14.58	15.97	17.86	20.62	23.06	25.26	27.28	29.16
8.0	.073 (1.850)	9.75	10.90	11.94	12.90	13.79	14.62	15.42	16.89	18.88	21.80	24.37	26.70	28.84	30.83
8.5	.075 (1.907)	10.29	11.51	12.60	13.61	14.55	15.44	16.27	17.82	19.93	23.01	25.73	28.18	30.44	32.54
9.0	.077 (1.962)	10.85	12.13	13.28	14.35	15.34	16.27	17.15	18.79	21.01	24.25	27.12	29.71	32.09	34.30
9.5	.079 (2.016)	11.42	12.77	13.98	15.10	16.15	17.13	18.05	19.78	22.11	25.53	28.54	31.27	33.77	36.11
10.0	.081 (2.069)	12.00	13.42	14.70	15.88	16.98	18.01	18.98	20.79	23.24	26.84	30.01	32.87	35.51	37.96
11.0	.085 (2.170)	13.22	14.78	16.19	17.49	18.69	19.83	20.90	22.89	25.60	29.56	33.05	36.20	39.10	41.80
12.0	.089 (2.266)	14.49	16.20	17.75	19.17	20.49	21.74	22.91	25.10	28.06	32.40	36.23	39.69	42.87	45.83
12.5	.091 (2.313)	15.15	16.94	18.56	20.04	21.43	22.73	23.95	26.24	29.34	33.88	37.88	41.49	44.81	47.91
13.0	.093 (2.359)	15.82	17.69	19.38	20.93	22.38	23.74	25.02	27.41	30.64	35.38	39.56	43.33	46.81	50.04
14.0	.096 (2.448)	16.86	18.85	20.65	22.30	23.84	25.29	26.66	29.20	32.65	37.70	42.15	46.17	49.87	53.32
15.0	.100 (2.533)	18.30	20.45	22.41	24.20	25.87	27.44	28.93	31.69	35.43	40.91	45.74	50.10	54.12	57.85

References

Engineering Drawings

Engineering drawings are supplied with your pump in the appendix of this manual.

Spare Parts

Fluid End Parts

	LOW PRESSURE (10,000 PSI)				HIGH PRESSURE (20,000 PSI)						ULTRA-HIGH PRESSURE (40,000 PSI)			
PART NO.	25-110-013	25-110-014	25-110-016	25-110-020	25-120-007	25-120-008	25-120-009	25-120-010	25-120-011	25-120-012	25-140-005	25-140-006		
PLUNGER SIZE	13/16"	7/8"	1"	1-1/4"	7/16"	1/2"	9/16"	5/8"	11/16"	3/4"	5/16"	3/8"		
PLUNGER	4012113	4012114	61155888	4012120	61145111	61134153	61127627	4010110	61143773	4010112	61158830	61146352	3*	
HP PACKING	25-100-213	25-100-214	25-100-216	25-100-220	25-100-207	25-100-208	25-100-209	25-100-210	25-100-211	25-100-212	25-100-205	25-100-206	6*	
LP PACKING	25-100-313	25-100-313	25-100-316	25-100-320	25-100-307	25-100-308	25-100-309	25-100-310	25-100-311	25-100-312	25-100-305	25-100-306	6*	
SPRG SPACER	4012013	4012014	61155864	4012020	61145210	61134120	61134757	4006310	61143755	4006312	61146302		3*	
SUBPLATE	61145600													
MANIFOLD	61155773				61126932						61146227			
BARREL	61155815				61141955						61146243			
VALVE SEAT	61155872				61152500						61168707		3*	
COMP. SEAL	61155955				61117316						61117309		3*	
COMP. SEAL	N/A				61117267						61117423		3*	
DISCH VLV	61121942				61121927						61157144		3*	
DISCH SPR	61120339				61120274						61120274		3*	
DISCH GDE	61155913				61135756						61146310		3*	
SUCT VLV	61122827				61135748						61122322		3*	
SUCT SPR	61120529				61120199						61120308		3*	
RTN RNG	91-002-150.SS				91-002-125.SS						91-001-088.SS		3*	
PKG NUT	N/A												61146458	
PKG NUT O-RING	N/A												30-002-022	6*
MFLD O-RING	30-002-034													6*
SUBPLT O-RING	30-001-032													6*
SUBPLT BOLTS	10-412-145.SS													
MFLD BOLTS	90-122-800													

* Recommended spare parts quantities

Lubricants

Silver Anti-Seize	Part # 24-002-001
Blue Lubricant	Part # 24-001-001
Loctite 242	Part # 24-001-026
LubriMatic® White Lithium Grease	Part # 24-001-016

Water Quality Test Kit

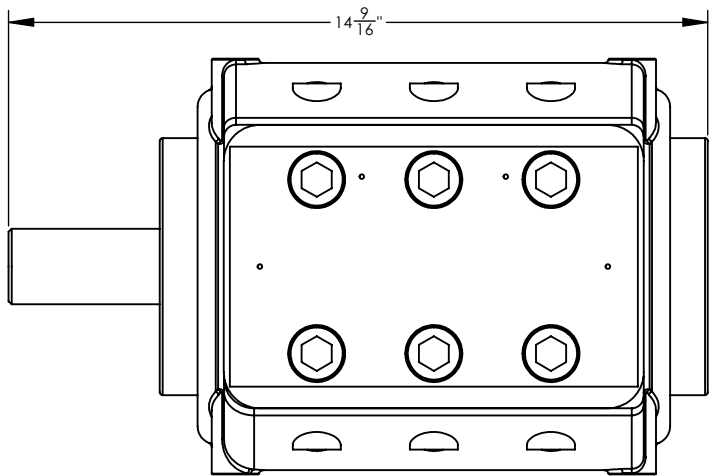
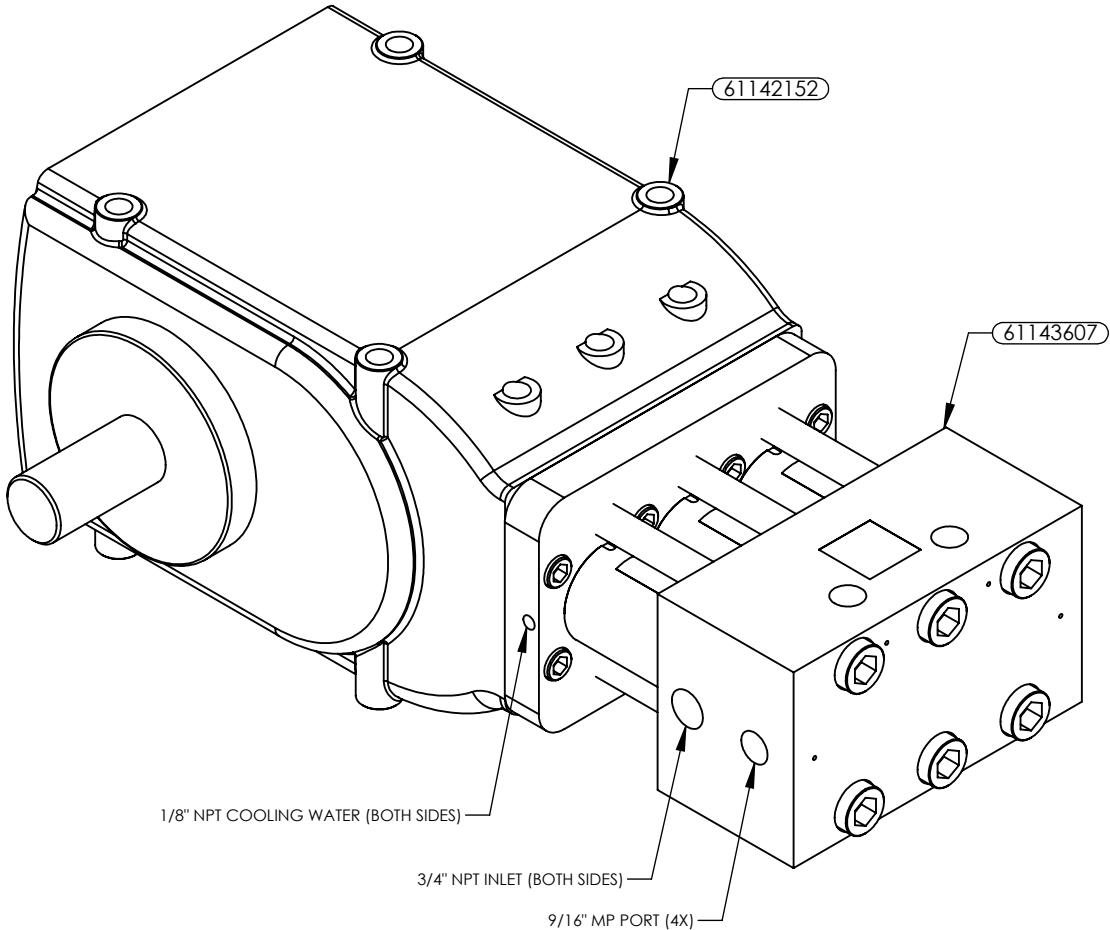
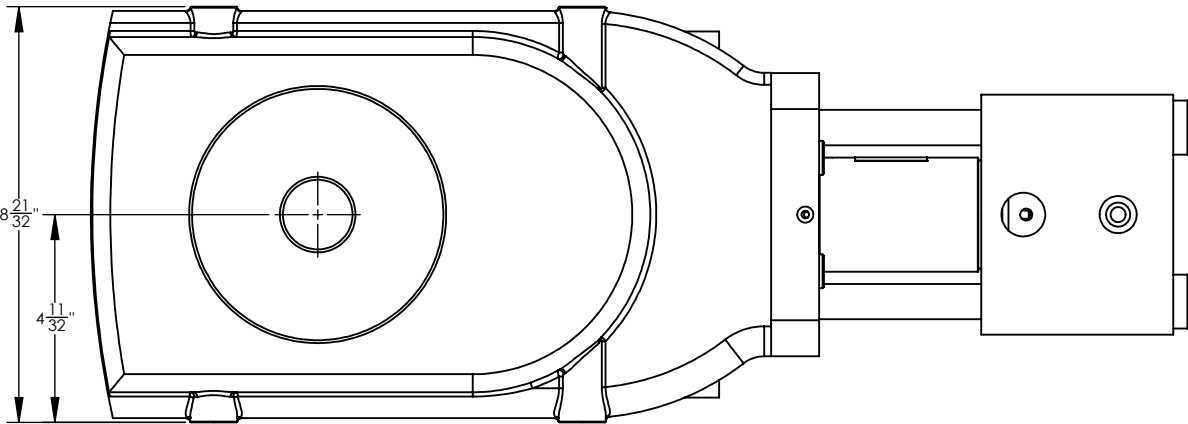
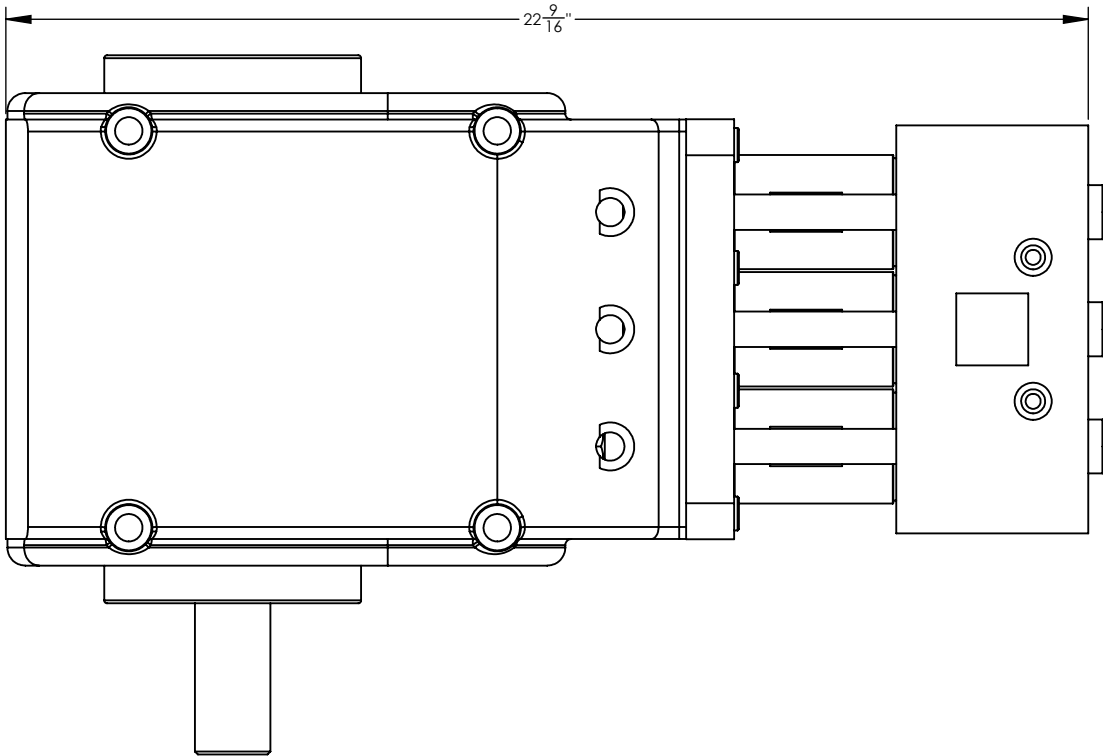
Water Test Kit	Part # 007851-1
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Appendix


ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	61142152	PWR END ASSY-VF SERIES, MOD, DRAIN
2	1	61143607	FL END ASSY-SERIES 50, HP, 20KSI, .69 PLGR

NOTES:

1. MAXIMUM FLOW: 7.35 GPM
2. MAXIMUM RPM: 775 RPM
3. MAXIMUM WORKING PRESSURE: 20,000 PSI
4. TEST PUMP AT 20,000 PSI FOR 5 MINUTES; CHECK FOR LEAKS
5. TORQUE ALL BOLTS AND FITTINGS ACCORDING TO FLUID END DRAWING



REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	0	INITIAL RELEASE	8/31/2022	K. SMITH

	ADVANCED PRESSURE SYSTEMS 701 S. PERSIMMON DR. TOMBALL, TX 77375		TITLE: TRPLX-SERIES 50, 10KSI, .69 PLGR	
	UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN INCHES, INTERPRET PER ANSI Y14.5-2009 DIMS IN MM ARE FOR REFERENCE ONLY BREAK SHARP EDGES AND DEBURR .015 TOLERANCES (EXCEPT AS NOTED)		THIRD ANGLE PROJECTION	THIS DOCUMENT CONTAINS CONFIDENTIAL INFORMATION WHICH MAY BE CONTROLLED AND IS NOT TO BE DISCLOSED TO OTHERS FOR ANY PURPOSE NOR USED FOR MANUFACTURING PURPOSES WITHOUT WRITTEN PERMISSION FROM ADVANCED PRESSURE SYSTEMS.
	MACHINE S.F. $\frac{63}{16}$ MACHINE FILLETS R.02 ANGLE $\pm 1^\circ$		DWG BY K. SMITH	
	DIM TOLERANCES: (in) .X = $\pm .063$.XX = $\pm .015$.XXX = $\pm .005$.XXXX = $\pm .0005$		APRVD BY B. PARKER	
APS AND THE APS LOGO ARE EITHER REGISTERED TRADEMARKS OR TRADEMARKS OF SHAPE TECHNOLOGIES INC. IN THE UNITED STATES AND/OR OTHER COUNTRIES		MATERIAL	DWG. NO. 32-110-000	REV. 00
			HEAT TREAT.	SHT 1 OF 1