MAIN INDEX

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1. INTRODUCTORY DOCUMENTS

1.1 Declaration of Conformity

Declaration of Conformity

Manufacturer,

H2O JET, INC.
1145 85th Ave SE
Tumwater, WA 98501 USA

EU Representative,

Marc Mezger
KMT Waterjet Systems
Auf der Laukert 11
61231 Bad Nauheim, Germany

Importer,

We declare under our sole responsibility that the product described as:

91141X-_____	91142X-_____	91153X-_____
91241X-_____	91242X-_____	91253X-_____

Complies with the requirements of the following directives:

Machinery Directives 2006/42/EC
Low Voltage Directive 2006/95/EC
Electromagnetic compatibility Directive 2004/108/EC

Note: The machine is Category 1 according to the pressure equipment directive 97/23/EC

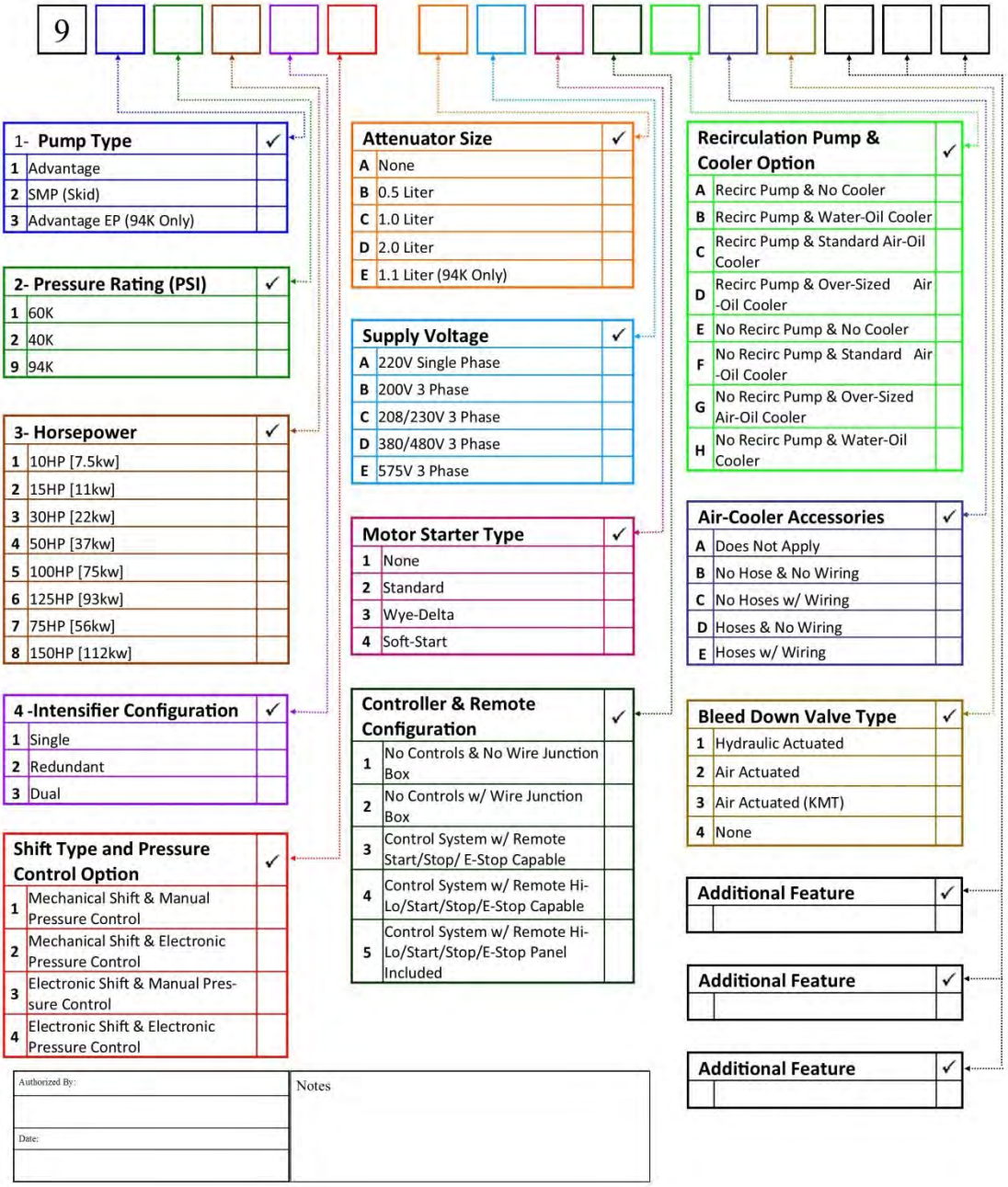
Standards considered:

EN 61000-6-4	February 2001	EN 61000-4-2	May 2001
EN 61000-4-2	August 2002	EN 61000-4-4	March 2005
EN 61000-4-5	May 2001	EN 61000-4-5	May 2001
EN 61000-4-8	May 2001	EN 61000-4-11	November 2004

March, 2015 at Olympia, WA, USA

Hal Arnold, President
H2O JET, Inc.

1.2 Pump Model Numbering Legend



1.3 H2O Jet Inc. Warranty

Warranty

H2O Jet, Inc. warrants all parts of its manufacture furnished under this agreement to be free from defects in workmanship and material for a period of one year from the date of shipment. This warranty does not cover normal wear and tear, consumable items or failures caused by (1) accident or (2) abuse.

This warranty is conditioned upon the following:

(1) Seller being notified in writing by Buyer within one month of the discovery of the defect(s)
(2) The return of all defective article(s) to Seller with transportation charges paid by Buyer
(3) Seller's examination of each such article disclosing to its satisfaction that any such defects were not caused by negligence, misuse, improper maintenance, improper installation, accident or unauthorized repair or alteration.
(4) Any modifications to the PLC program will void the warranty. If service is required to correct any changes that have been made by the customer, the customer is responsible for all labor and expenses

Accessories, equipment or components furnished by H2O Jet, Inc. to the Buyer but manufactured by others shall carry the warranty conveyed by the manufacturer to H2O Jet, Inc. and will be passed on to the Buyer as may apply.

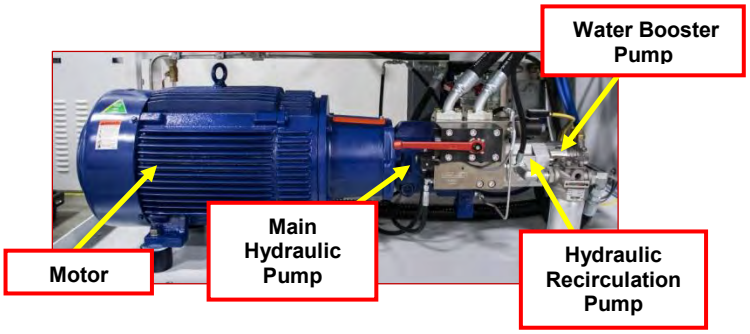
1.4 Basic Description

Feature	Description
Output Water Pressure Ratings	Up to 60,000 [4140 bar] or up to 40,000 psi [2758 bar]
Electric Motor	TEFC (Totally Enclosed Fan Cooled) 50HP on Single and Redundant Models 100HP on Dual Pump Models
Main Hydraulic Pump	Axial Piston, variable displacement, pressure compensated
Intensifier	Single: only one intensifier in the cabinet
	Redundant: two intensifiers in the cabinet. Only one runs at a time. Can be switched over if one stops functioning.
	Dual: Two intensifiers in the cabinet running independently at the same time.
Pump Features:	
Hi-Load Piston	Hydraulic Piston uses three Teflon seal bands for durability and increased service life.
Electric Shift	Piston travel is controlled by shift sensors and solenoids in conjunction with the Programmable Logic Controller
Pressure Controls	Electronic touch screen
Sensors	Automatic shut-down for: idling too long, high oil temperature, low oil level, low water inlet pressure, and high cutting water temperature.
Slow Start	Automatically reduces stress and noise in the pump at start-up without resetting the pressure to a low setting.
Water Booster Pump	Raises pressure of the cutting water supply to maximize system efficiency
Seepage Collection System	Beneath the Intensifier Pump(s) there is a drip pan to collect any oil or water that seeps from the Intensifier(s) or fittings. This pan drains to a collection jug located within the cabinet. This water/oil mixture must be dealt with accordingly.
Filtered Water Auto Shut-off	Any time the E-stop is activated the water flow to the filter is shut off to reduce water waste.
Heat Exchanger	Water to Oil heat exchanger. Cools hydraulic oil to optimize performance. This is internally plumbed in a kidney-loop filtration line.
Inline Oil Filter	Removes particles larger than 2 microns in the hydraulic cooling loop
Bleed-down Valve	When the pump is shut down this valve dumps the high pressure water that is in the system. This valve is either hydraulically actuated or air actuated.
Access Panels	The H20 Jet advantage has doors on all sides to facilitate easy access to all internal components
System Options:	Add-on items for Pumps
Remote On/Off Switch	Enables user to start or stop the pump from a remote panel at the cutting location
Remote: E-Stop	Emergency stops the machine and releases any pressurized water in the lines.
Remote Hi/Low Pressure Switch	For situations where low pressure is necessary for initial piercing. Then quickly toggle to high pressure for cutting once penetration is achieved.

1.5 Operational Principals

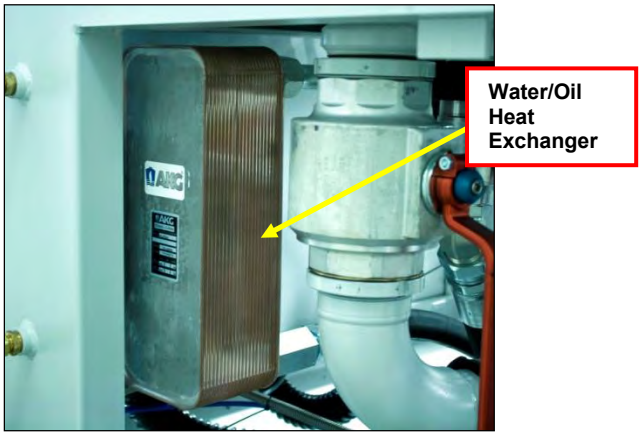
The H20 Jet Intensifier Pump consists of six systems

1. Motor Drive System
2. Cooling Water System
3. Hydraulic Recirculation System
4. Hydraulic Intensifier Drive System
5. High-Pressure Cutting Water System
6. Pump Control System



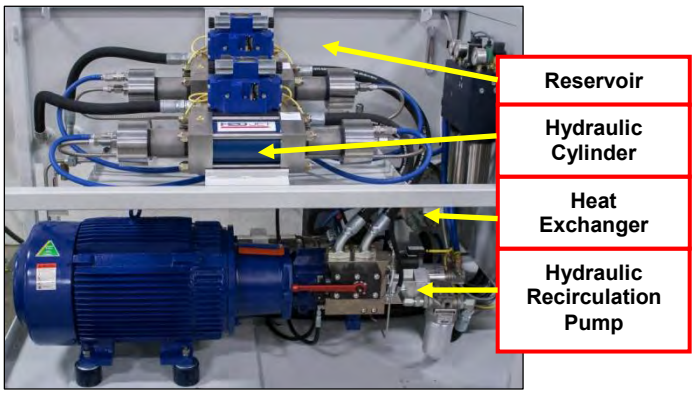
1) Motor Drive System

The Motor / Drive System is housed in the bottom of the cabinet. Here a 50 HP motor (Single and Redundant Systems) or a 100 HP motor (Dual System) drives a series of three ganged pumps: the Main Hydraulic Pump, the Hydraulic Recirculation Pump and the Water Booster Pump. A redundant pump assembly is shown to the left.



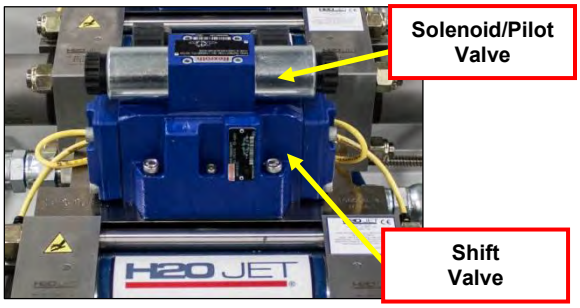
2) Cooling Water System

Cool water enters the H2O Jet pump where it passes through a water/oil plate heat exchanger. This water immediately leaves the machine and goes down a drain. Better water conservation and economy is achieved by the utilization of a user supplied chiller. With a chiller the water is recycled, eliminating the drain and disposal issues. This significantly increases options for physical placement of the H2O Jet pump.



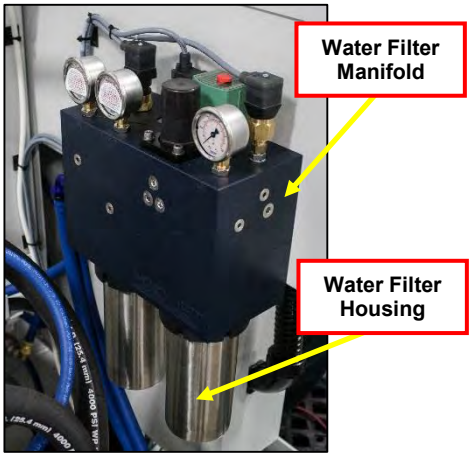
3) Hydraulic Recirculation System

The Hydraulic Recirculation system in the H2O Jet pump cools and filters the hydraulic oil. Here the oil is also monitored for volume and temperature. Oil leaves the reservoir and enters the recirculation pump. From the pump the oil runs through a flat plate water/oil heat exchanger. From the heat exchanger the oil passes though the filter and is returned to the reservoir tank.



4) Hydraulic Intensifier Drive System

The Hydraulic Drive system powers the intensifier pump[s]. Hydraulic oil leaves the reservoir and enters the variable displacement, axial hydraulic drive pump where it is pressurized to as much as 3,000 psi (207 bar). The pressurized hydraulic oil goes to the intensifier where it splits to do two tasks. A small amount is sent to the pilot valve on top of the intensifier pump. The pilot valve is controlled by a pair of solenoids. The pilot valve sends a flow of hydraulic oil to slide the much larger shift valve spool to one side or the other. The spool will direct the rest of the oil into one side or the other of the hydraulic low pressure cylinder, creating the shifting of the piston. The large hydraulic piston has a smaller diameter plunger attached. The plunger is then used to create the water pressure. After the oil has traveled through the intensifier itself, it is returned to the reservoir for filtering and cooling.

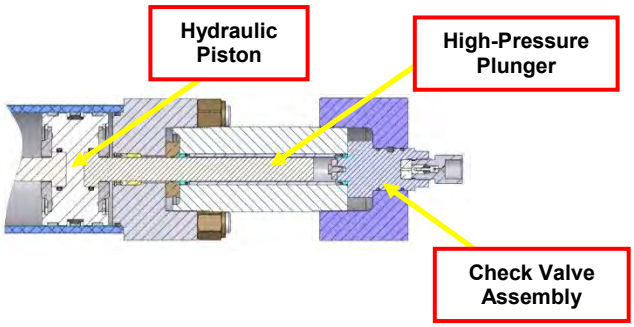


There are three basic intensifier configurations that H2O Jet offers.

Single: This system has only one intensifier on the frame.

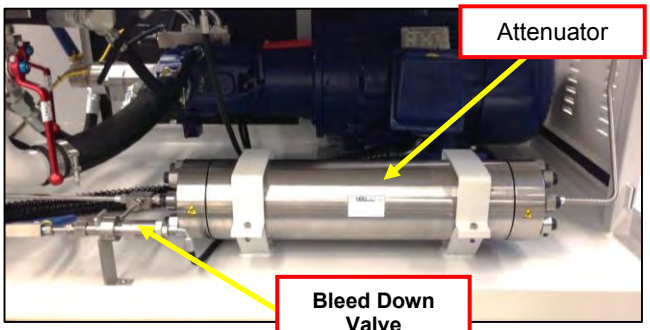
Redundant: This system has two intensifiers on the frame, but only one intensifier is run at a time. The concept behind this that in the event of an intensifier failure, the unit can be switched over to the second intensifier while waiting for the first intensifier to be serviced.

Dual: This system is driven by a 100 HP electric motor. The frame contains two intensifiers as before, but in this system both intensifiers operate at the same time independently of each other. This virtually doubles the cutting water output of the machine and enabled it to run multiple cutting heads.

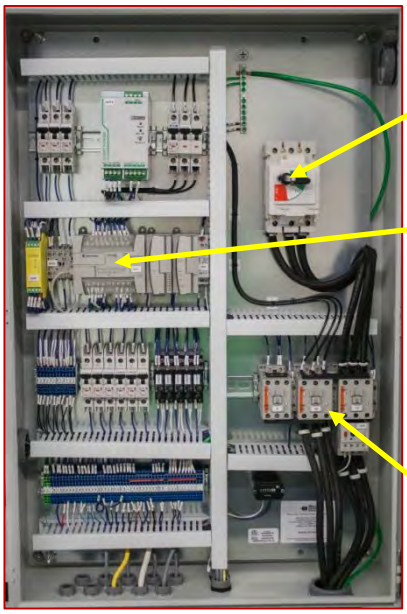


5) Cutting Water System

Clean water for the H2O Jet Pump (your domestic supply may need additional filtering) enters the machine at the Cutting Water Inlet. This water immediately goes through an in-cabinet ten-micron filter and then to the Booster Pump. Following the Booster Pump the water returns to the filter cabinet where it passes

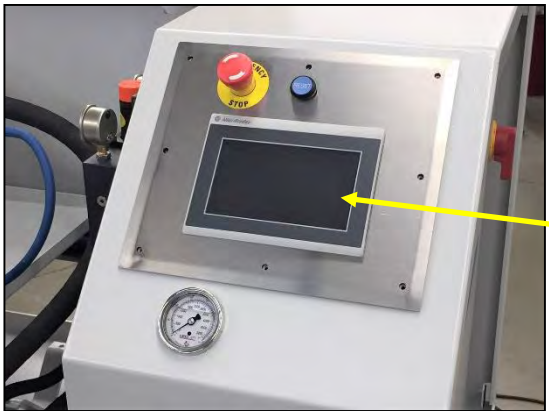


through a one-micron filter. The 10 micron filter assembly is monitored for comparative inlet and outlet pressure to determine filter condition. The water then enters the Intensifier through the Check Valve on the return stroke of the High-Pressure Plunger. Here it pressurizes the Cutting Water to as much as 60,000 psi. [4,137 bar] depending on model. The high-pressure cutting water then enters the Attenuator that functions as a buffer for the pulsing action of the Intensifier Pump(s) and provides a constant, smooth flow of Cutting Water. The outlet of the Attenuator has a Bleed-Down Valve "Tee" that opens and dumps all water pressure in the event of an emergency shut-down or sudden drop in hydraulic oil pressure. Under normal operation the High-Pressure Cutting Water leaves the cabinet by way of a bulkhead fitting and passes on to the various Cutting Jets where abrasive may be added to the cutting stream as required by the application.



6) Pump Control System

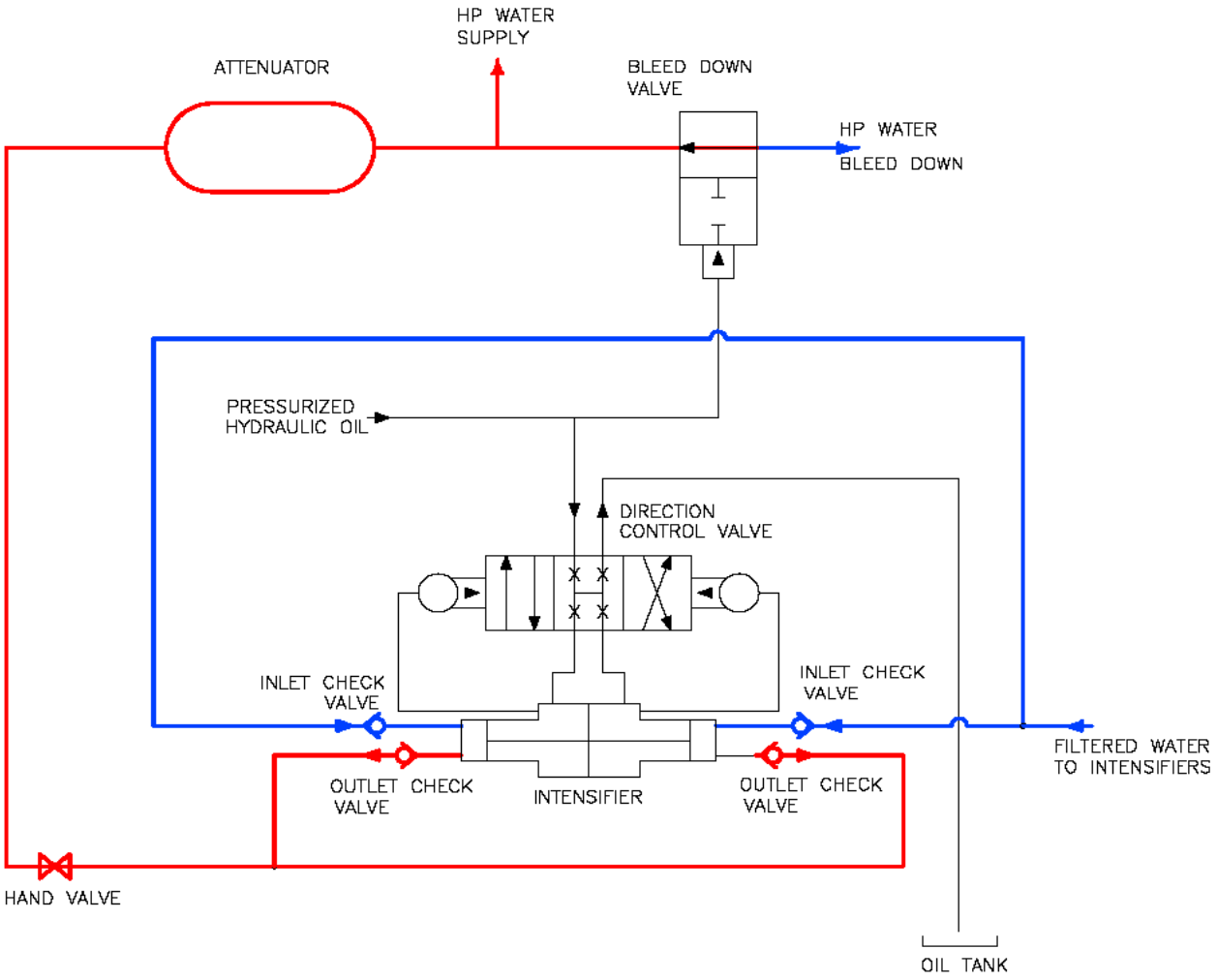
The entire system is monitored and controlled by the Programmable Logic Controller (PLC) and the Operator Interface Terminal (OIT). The OIT also tracks operation hours and a variety of machine parameters. (Wye-Delta Motor Starter is shown in the picture to the left; a standard motor starter is shown on page 20.)



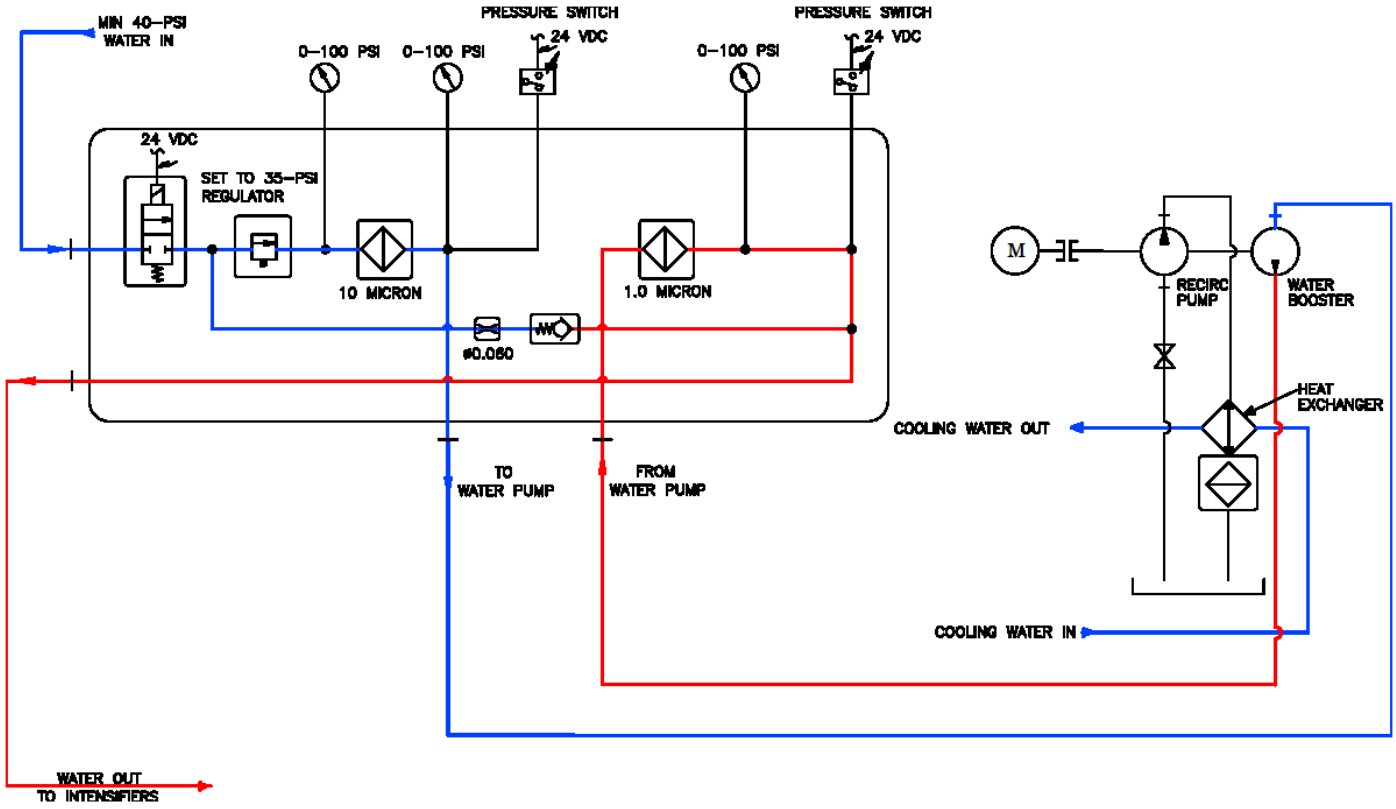
The Hi/Low pressure control option on the H2O Jet Pump is useful in the initial piercing phase if the material is not capable of handling the full force of the water jet. This enables the operator to quickly toggle between the two settings.

1.6 System Schematic

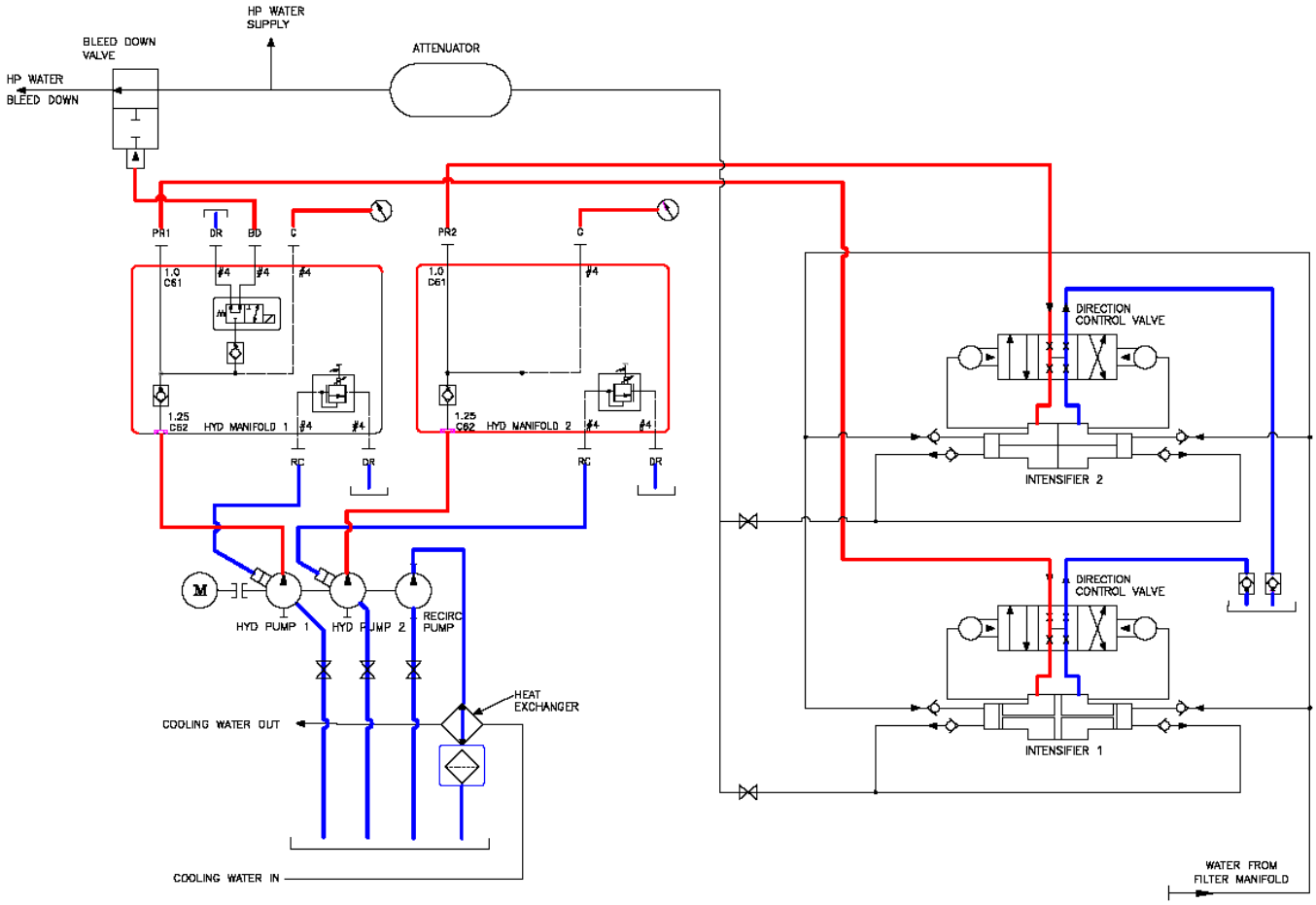
1.6.1. High Pressure Water



1.6.2. Low Pressure Water



1.6.3. Hydraulic Oil System



1.7 Installation Requirements

FOUNDATION	The H20 Jet Pump can be supported by a standard industrial-grade concrete floor.
CLEARANCES	Allow for clearance for doors, panels and lid. Space is also required for maintenance personnel access. See drawings for clearances. Within these clearance limits the intensifier would have to be moved to change out the motor. Limits: w-167", d-132", h-90" [w-424cm, d-132cm, h-229cm]
WATER REQUIREMENTS	System Requirements for water inlets and outlets. External shut-off valves attached or adjacent to the cabinet recommended for all inlet lines
Filtered (cutting) Water Inlet	1/2" NPT female fitting. Filtered flow of 2 gpm at 40psi [7.5L @ 2.76 bar] for single/redundant units. Dual Intensifier units require 4 gpm [15.5 lpm] minimum, ph range 6 - 8. Distance from filters should be as short as possible. Piping must be PVC or equivalent. Metallic pipe introduces minerals in the water that reduces cutting orifice life. (See section 1.8.)
Cooling Water Inlet	1/2" NPT female fitting. Minimum inlet pressure of 40 psi [2.75 bar] at 3 - 5 gpm [11 – 19L] with a maximum temperature of 65° F [18.5°Cf]. If water temperature exceeds this maximum; pump seal life will be reduced.
(Alternative Cooling Water Chiller)	As an alternative to running domestic cool water through the machine and down the drain, the cooling water demand may be accommodated through a user supplied water chiller. The chiller must meet the minimum requirements: 50 HP 35000 BTU/HR @ 3 GPM 100HP 72000 BTU/HR @ 4.5 GPM
Cooling Water Drain	1/2" NPT female fitting. Large enough capacity to accommodate the inlet cooling pressure with no flow restriction. Cooling water may also be recycled through an in-house water cooling system and reused only as cooling water.
Bleed Down Outlet	1/2" NPT female fitting. Hose that leads to an open drain.
COMPRESSED AIR REQUIREMENTS ***Air Bleed Valve Only***	If an Air-Operated Bleed Down Valve is selected (See Page 3 for model numbers), the pump will require clean, dry air regulated at 60-100 psi [4 -7 bar], 1 scfm. The connection on the back of the pump is ¼" NPT Female.
HIGH PRESSURE WATER LINES	3/8" High Pressure "gland nut" fitting. High-pressure Stainless steel tubing certified in excess of 60,000 psi [4000 bar] is required. All lines must be shielded.
HYDRAULIC OIL	Chevron Rando HD 46, Conoco Megaflow AW 46, Mobile DTE-25 Medium, Shell Telus S2 M 46, or Agip Arnica 46 hydraulic oil. The reservoir holds approximately 80 gallons.
ELECTRICAL SPECIFICATIONS	Contract a qualified electrician for the proper sizing of electrical feed circuit. The circuit breaker included in the control panel is oversized to prevent errant tripping during startup. A feed circuit equivalent to the circuit breaker size is not needed.
	U S: 50 HP Motor, 230v, 115 FLA, 60Hz, 3 Phase, 175A Circuit Breaker size
	U S: 50 HP Motor, 480v, 55 FLA, 60Hz, 3 Phase, 175A Circuit Breaker Size
	100 HP Motor, 480v, 110 FLA, 60Hz, 3 Phase, 200A Circuit Breaker Size
	100 HP Motor, 575v, 92 FLA, 60Hz, 3 Phase, 200A Circuit Breaker Size
	CE: 50 HP Motor, 380v, 70 FLA, 50Hz, 3 Phase, 175A Circuit Breaker Size
	Conduit fitting is 2" NPT for electrical feed
ENVIRONMENT	
Lighting	Adequate for safe operation and maintenance of the Pump
Airborne dust/contaminants	Minimal
Radio Frequency Interference	Minimal
Relative Humidity	Up to 95% @ 120°F [49°C] non-condensing
Ambient Temperature	35° to 120°F [2° to 49°C]

1.8 Water Quality Requirements

1.8.1. Overview

The quality of the inlet cutting water supply is one of the most important factors affecting component life and performance. Waterjet components are subject to stress levels that are sensitive to the effect of compounds in water that can lead to localized damage, like corrosion that can lead to crack initiation failure of metallic pressurized components. Scale forming constituents result in material buildup, causing erosion. Dissolved solids are abrasive. High pressure seals and orifices are the primary components affected by poor water quality.

1.8.2. Terminology

Alkalinity	The acid neutralizing capacity of water, usually expressed as M alkalinity. Several ions contribute to alkalinity and is generally assumed to be due to bicarbonate (HCO_{3-}), carbonate (CO_{3+}), and hydroxyl (OH_{-}) ions.
Hardness	Calcium and magnesium salts cause water hardness. Carbonate hardness is usually due to magnesium and calcium bicarbonate; non-carbonate hardness is due to sulfates and chlorides.
pH	An indicator of the acidity or alkalinity of a system represented on a scale of 0-14, with 0-6.9 being acidic, 7 being neutral, and 7.1-14 being basic.
TDS	Total dissolved solids, the sum of all organic and inorganic material dissolved in water.

1.8.3. Water Quality Standards

Table 1 details the recommended requirements for the inlet cutting water supplied to the intensifier.

Water Quality Standards

Constituent (mg/l)	**Minimum Requirement**	**Better**	Best
Alkalinity	50	25	**10**
Calcium	25	5	**0.5**
Chloride	100	15	**1**
Free Chlorine	1	0.5	**0.05**
Iron	0.2	0.1	**0.01**
Magnesium as Mg	0.5	0.1	**0.1**
Manganese as Mn	0.1	0.1	**0.1**
Nitrate	25	25	**10**
Silica	15	10	**1**
Sodium	50	10	**1**
Sulfate	25	25	**1**
TDS*	350	100	**35****
Total Hardness	25	10	**1**
pH	6.5-8.5	6.5-8.5	**6.5-8.5**
Turbidity (NTU)	5	5	**1**

** Note:* **Total dissolved solids**

***Note:* **Do not reduce the TDS beyond this amount or the water will be too aggressive.**

1.8.4. Common Water Impurities

Table 2 provides a list of common water impurities and their characteristics

Water Impurities

Constituent	**Chemical Formula**	Comments
Alkalinity	Bicarbonate (HCO_3) Carbonate (CO_3) Hydrate (OH), expressed as $CaCO_3$	Acid neutralizing capacity of water. Foaming and carryover of solids, causes embrittlement of steel, can produce CO_2, a source of corrosion.
Calcium	Ca	When dissolved makes water hard; contributes to the formation of scale.
Chloride	Cl	Adds to solid content and increases corrosive character of water; in relative percentage presence with oxygen induces stress corrosion cracking.
Free Chlorine	Cl_2	Oxidizing agent; can attack elastomeric seals and damage reverse osmosis (RO) membranes.
Iron	Fe^{++} (ferrous) Fe^{+++} (ferric)	Discolors water or precipitation; source of scale and erosion.
Magnesium as Mg		When dissolved makes water hard; contributes to the formation of scale.
Manganese as Mn	Mn^{++}	Discolors water or precipitation; source of scale and erosion.
Nitrate	NO_3	Adds to solid content; effect is not generally significant industrially.
Silica	SiO_2	Causes scale
Sodium	Na	Found naturally; introduced to water in the ion exchange water softening process.
Sulfate	SO_4	Adds to solid content; combines with calcium to form calcium sulfate scale.
TDS		Measure of the total amount of dissolved matter in water.
Total Hardness	$CaCO_3$	Sum of all hardness constituents in water; typically expressed as their equivalent concentration of calcium carbonate; primarily due to calcium and magnesium in solution, but may include small amounts of metal. Carbonate hardness is usually due to magnesium and calcium bicarbonate; non-carbonate hardness is due to sulfates and chlorides.
pH		Intensity of the acidic or alkaline solids in water.

1.8.5. Water Treatment Guidelines

The operation of this ultrahigh-pressure waterjet is dependent on the quality of your water. Hardness, iron and manganese can form deposits and/or cause erosion, affecting cutting efficiency and unscheduled downtime. Affects are especially evident at the nozzle, and high pressure seals are also impacted.

When the other elements are within acceptable levels, in most cases a sodium ion exchange water softener will satisfy flow rate and capacity requirements. Ion exchange softener systems will require regular regeneration thus you will need to select a system to accommodate the longest duty cycles you will be using. A dual system is normally recommended because it can continuously provide a treated water supply by alternating between the media tanks. Also note, that most water utilities will switch water supplies sources seasonally, and this may cause the hardness of your water supply to have significantly different properties.

- Observe the usual hardness, iron and manganese application criteria.
- Use appropriate accessories when the hardness to iron ration is less than 8:1.
- When iron or manganese is the only problem, use properly sized filtering elements with surface active agents for ore retention.

A high level of dissolved solids and chloride can promote corrosion on wetted metal parts. Silica and TDS can contribute to scaling and erosion.

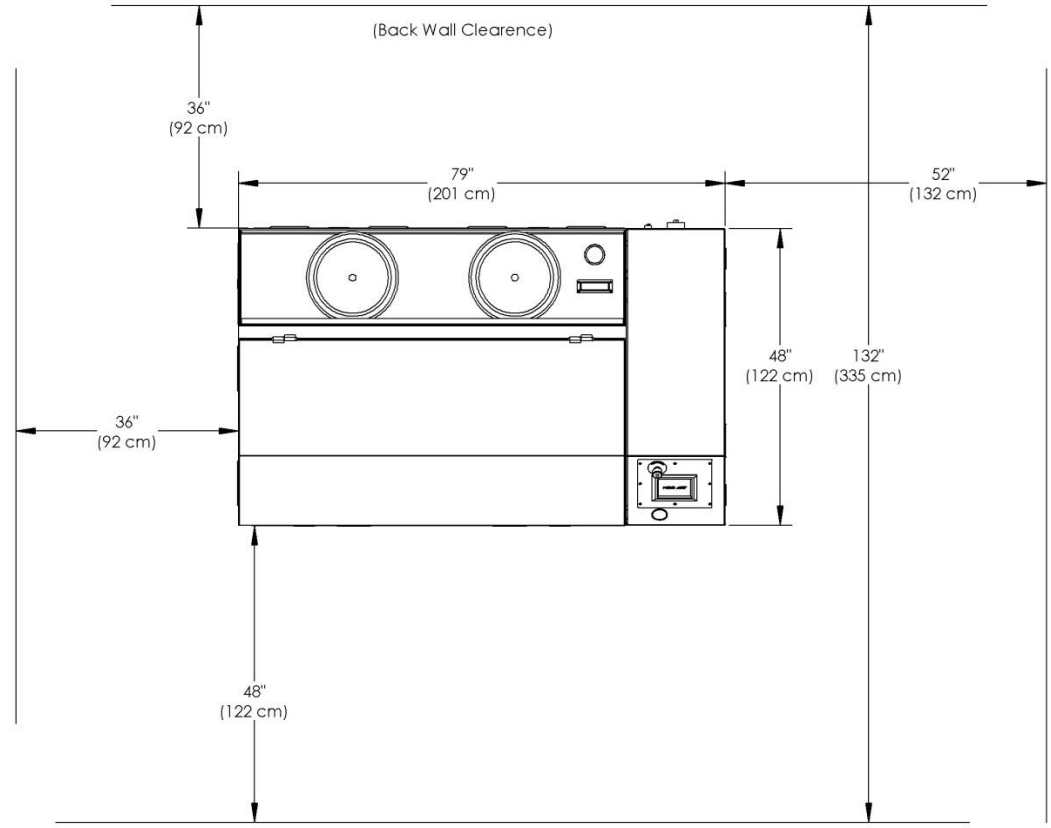
When TDS is at or below maximum allowable amounts, it cannot be reduced by softening.

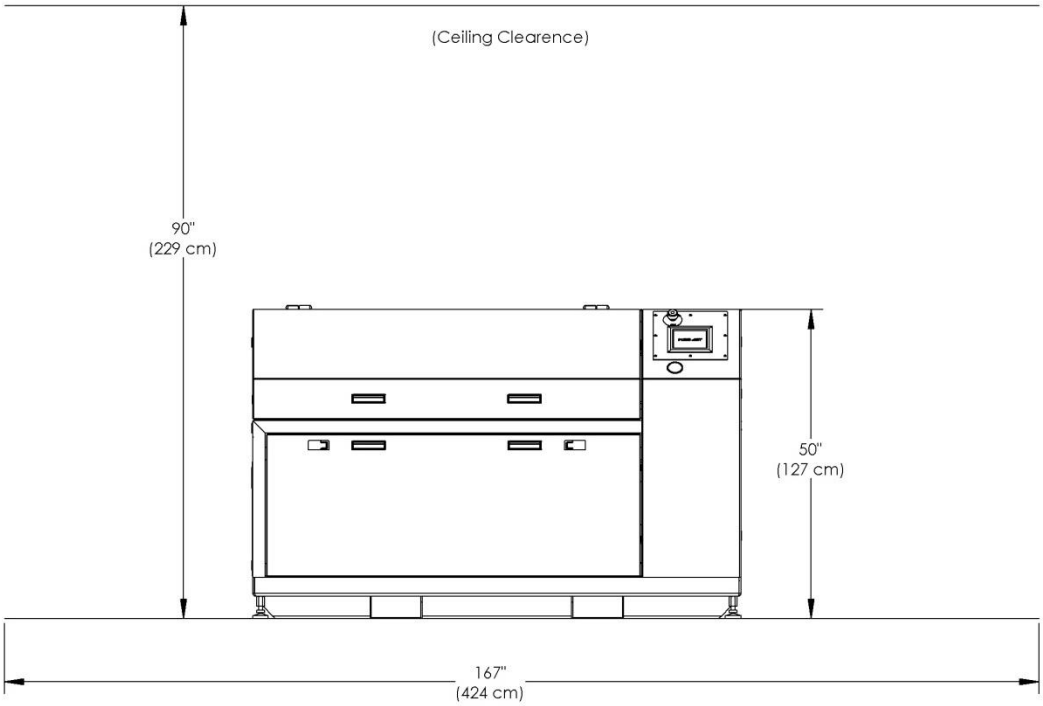
Reverse osmosis (RO) water treatment is recommended when raw water:

- TDS exceeds 350 mg/l or,
- Chloride exceeds 100 mg/l or,
- Silica exceeds 15 mg/l

Treated water from reverse osmosis (RO) or deionization (DI) should not be used without contacting H2O Jet first.

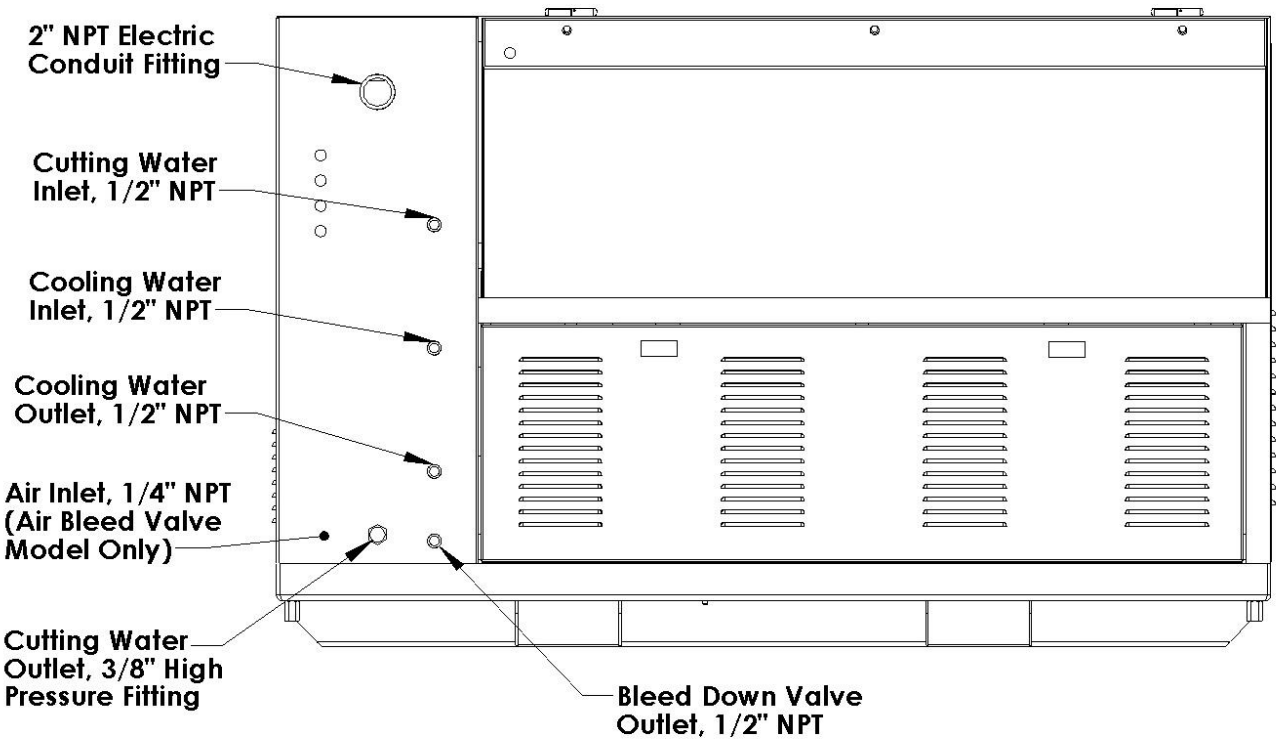
1.9 Installation Clearances and Connections





Service Connections:

INLET/OUTLET PORT CONFIGURATION



1.10 Unpacking the H2O Pump

1. The H2O Jet pump will come bolted to a pallet, inside a cardboard crate. Carefully remove the top and sides of the cardboard crate. The pump will be stretch wrapped inside the crate.

2. Leave the stretch wrap covering the pump until it is in its final location

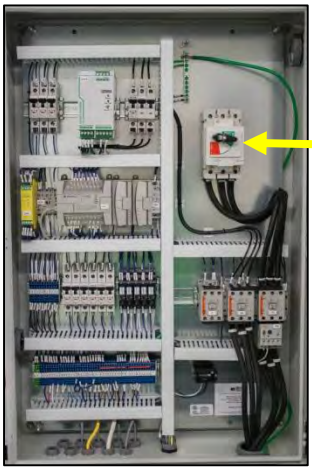
3. The pump is bolted to the pallet by a pair of 2x6 boards running through the forklift slots in the bottom of the frame. Carefully unbolt the 2x6 boards, the hardware may be difficult to remove. Remove the 2x6 boards from the forklift slots.

4. Use a forklift to remove the pump from the pallet and transport to its final location. Make sure to have spotters when moving large equipment, and that everyone has a clear view.

5. When the pump is in place, and before the forklift leaves, check distances and routing of: electrical, cooling water, cutting water, and drain lines.
6. Adjust the four foot pads on the bottom corners of the H2O Jet pump to ensure it has a solid footing.

7. Carefully remove the plastic wrap from the pump. Take care not to scratch the finish on the pump frame if you use a knife.
8. Do not remove any of the caps covering the plumbing connections until it is time to make the connections.

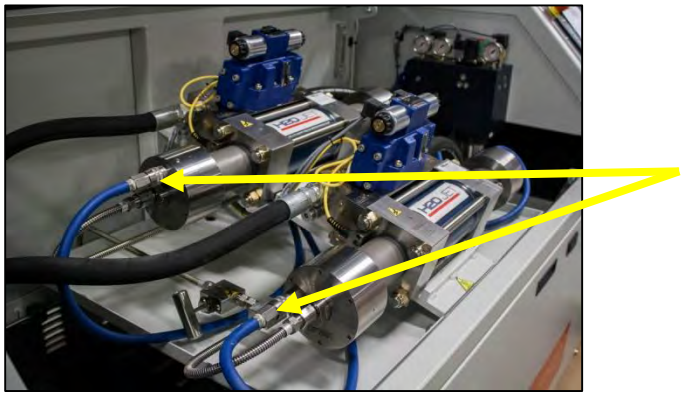
1.11 Shipping and Storage Preparations



1. Shut down the power at the main service disconnect panel and using safety tags follow the necessary lockout/tagout procedures.
2. Disconnect the power inside the pump's electrical cabinet, and remove the power cables from the box.

3. Drain all oil from tank. The drain valve is located under the tank, opposite the electrical panel, behind the rear most door.

4. Drain water filter housings by placing a bucket under each filter bowl and drain the water from inside. Also make sure that all water has drained from the filters as well. Shipping without all of the water removed can cause damage to the components.



5. Drain Heat Exchanger water by blowing air into the cooling water inlet port.
6. Disconnect one quick-connect fitting from an intensifier end cap.

7. Put a quick-disconnect fitting into the hose end you just removed so it will hold the line open, allowing water to flow out.
8. Blow air into the cutting water inlet hose, forcing out all the water in the line. Repeat for all cutting water inlet lines on pump.
9. While the quick-disconnect is off, blow air into the cutting water inlet on the intensifier. This will drain the water from the intensifier cylinder. Repeat for all high pressure cylinders on the pump.

10. Reconnect all quick connect fittings and water lines to the intensifiers.

11. Cap all water inlet and outlet fittings on the pump.
12. Empty the water/oil seepage container located inside the right end of the pump frame, directly below the display panel.;/”

1.12 Revision History

Date	Rev. Id.	Description of Change	Written by	Checked by	Approved by
May 8, 2006	0	First Publication	P. Spencer Norby	JN	HA
Jan. 3, 2012	A	Added Water Quality & Chiller Requirements	L. Jorgensen	MH	HA
Oct 24 2012	B	Added new hydraulic oil specs.	M.Huntley	MH	HA
May 23, 2013	B	Added Air Bleed Option and Connection Req.	M.Huntley	MH	HA
July 23, 2013	D	Updated Pump Figure Numbering Table	S. Wilson	MH	MH
Mar 13, 2015	E	Complete Manual Update	L. Jorgensen	M.H.	

2. SAFETY

2.1. Introduction

This section contains safety precautions that must be followed to ensure safe operation of the equipment. Everyone operating and maintaining the equipment-must read and understand these precautions before they start working with the equipment.

Note that OSHA and state safety agency rules must be complied with in addition to those given in the safety section and elsewhere in this manual. Applicable plant general safety precautions must also be followed.

The user shall practice and promote safety at all times to avoid potential injuries and unnecessary production shutdowns.

H2O JET designed your high-pressure waterjet cutting system with safety in mind. Throughout this manual, safety precautions and warnings are highlighted for specific operations. Safety precautions are also posted on the equipment. Operators and service personnel shall pay particular attention to these precautions at all times.

Operators of this high-pressure waterjet cutting system must treat the system as they would treat any high-speed cutting tool. Although the waterjet may appear harmless, it is a high-energy cutting tool capable of cutting many nonmetallic materials such as composites, plastics, and food products. Misuse of this equipment or carelessness in its application can be extremely hazardous to operating personnel. Always treat the waterjet cutting system with respect.

2.2. Warnings, Cautions, and Notes

Service procedures in the waterjet manuals include safety warnings, cautions, and notes that must be read, understood, and adhered to. These are specific categories of safety notices, and are defined as follows:

WARNING

Highlights an operating condition or service procedure that can result in death or serious injury.

CAUTION

Highlights an operating condition or service procedure that can lead to impaired system operation or equipment damage.

Note: Highlights an operation or service procedure or condition that is considered essential for efficient operation and service.

The label shown below is available in two sizes:

2.3. Lockout/Tagout Procedure

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.

The lockout/tagout procedure applies to any employee who operates and/or performs service or maintenance on the machine. Before any maintenance or repairs are performed, the machine shall be isolated, and rendered inoperative as follows.

1. Shut down the machine by pressing the STOP button, and open the high pressure cutting water valve to bleed the water and hydraulic pressure from the system.
2. Disconnect, lockout and tag the main, customer supplied, power source.
3. Lockout and tag the circuit breaker/disconnect on the electrical enclosure door.
4. Close, lockout and tag the manual shutoff valves for all service connections: cutting water in, cooling water in and out, and air.

2.4. Safety Procedures

Safety procedures must be observed while working on the pump, or any high pressure part of the installation. Service should only be done by qualified personnel.

- Operators must use proper precautions when working with the high pressure water, 4,080 bar (60,000 psi). Users should also use proper SAFETY PROCEDURES and SAFE WORK HABITS.
- The waterjet cutting stream is capable of penetrating many dense or strong materials.
- Untrained personnel should not be allowed into the waterjet cutting area. Barriers and partitions can be used to isolate the work area.
- Safety equipment must always be worn in the waterjet cutting area.
- The **EMERGENCY STOP** button must be regularly checked. The normal operating position is in the pulled out position.
- To check the **EMERGENCY STOP** button, turn the power on and then activate the **EMERGENCY STOP** button by pushing it in to see if the power goes off. Each device should be checked on a regular basis. Each time a device is checked; it must work correctly or be replaced before operating the system.
- Apply Blue Goop (P/N 400001-1) to all threaded high pressure connections. All tubing, fittings and bolted connections should be torqued to recommended specifications. Do NOT tighten or loosen a high pressure water fitting when the circuit is pressurized. See the High Pressure Piping Safety section for more information.
- All high pressure leaks must be repaired immediately.
- All equipment must be inspected on a scheduled basis.
- Before performing any maintenance on the unit, **MECHANICALLY LOCK THE MAIN CONTROL POWER OFF**, and make sure the high pressure has been bled off.
- All personnel who are required to perform any function related to the operation or service of the system shall pay particular attention to all warning signs and notices posted in the plant or on the equipment.

- All protective guards or shields must be in place on the equipment at all times.
- First aid facilities shall be provided by the user in convenient locations throughout the plant. These locations should be well marked and made known to all personnel.
- The work area around the equipment shall be clean and free of debris. Oil spillage results in slippery floors and must be removed immediately.
- Any unfavorable conditions that may result in injuries shall be reported to the plant supervisor without delay.
- As a general practice, it is recommended that safety shoes, glasses and hearing protection be worn by all personnel working around the equipment. Wearing rings, watches, or necklaces is dangerous when operating or servicing any equipment with moving parts.
- Never do any work on the Waterjet unit without making sure the electrical panel disconnect is locked out with a padlock in the OFF position.
- Never work on any high pressure component, or loosen any high pressure fittings without first bleeding the system and assuring there is no high pressure water present.
- Make sure the safety devices are working. To panic stop the pump and bleed the high pressure, the EMERGENCY STOP button must be pushed in. Make sure the Bleed Down Valve has released all the high pressure water from the system.
- Do not attempt to touch or be exposed to high pressure water. The high pressure water will penetrate all parts of the human body without exception.
- The liquid stream or material ejected by these high pressures can injure or kill.

2.5. High Pressure Piping Safety

High pressure piping is to be installed without torsional or bending stresses. Proper supports and guides must be provided. 3/8" outside diameter HP tubing and fittings are recommended between the pump and the cutting station. This large tubing size will reduce vibration, strain and motion between the pump piping and the cutting area. The larger piping diameter also reduces pressure drop, and pressure pulsation.

- Do not repair a leak in a high pressure water fitting when it is pressurized. Shut off the power and bleed the HP water before performing any maintenance on high pressure components. Weep holes are provided to release high pressure water if leakage occurs at a sealing surface. If a fitting becomes loosened with high pressure water present, a stream of high pressure water will exit the closest weep hole with **possible dangerous results**.
- Use extreme caution when handling high pressure equipment. Possible failure from fatigue cracking or over-pressurization may result in a dangerous high pressure leak, or component failure.
- When tightening or loosening high pressure connections, always use a supporting wrench to avoid bending forces or stress on the connection. Do not exceed recommended torque specifications.
- High pressure piping and fitting designed to 4,100 bar (61,000 psi) must always be used. Failure to do so may lead to catastrophic component failure, which can cause equipment damage, injury or even death.

2.6. High Pressure Safety Tips

- High-pressure water remains in the system for a prolonged period of time after shutdown of the high-pressure water source.
- Make sure that the system pressure is bled down before servicing any part of the system.
- Some of the fittings, connections, and parts have weep holes. Do not touch these holes with your bare hands or try to stop water by plugging the holes.
- Remember that the waterjet stream is a "knife". Do not introduce anything into its path that is not designated to be cut.
- Wear face shields whenever the operating instructions require them.
- Do not remove high-pressure tubing protective shields. If protective shields are removed for servicing, make sure they are replaced before starting the system.
- After servicing, torque all fittings to the manufacturer's torque specifications.
- Do not step or lean on high-pressure water tubing. You may break the connection, causing leakage.
- Use only high-pressure fittings, valves, and tubing certified for 60,000 psi (4,080 bar) when making alterations or additions to the high-pressure water system.
- Do not alter or eliminate stress relief tubing coils.
- Follow the tubing manufacturer's recommendations for high-pressure tubing bending radii.
- Do not exceed the specified operating pressure for high-pressure water system components.
- Do not over-torque fittings or subject swivels to excessive bending movement.
- Follow the manufacturer's recommendations for servicing the equipment, and use only original manufacturer replacement parts.
- Follow system startup procedure recommended by the manufacturer to ensure safe operation.
- Use care when lifting the covers during operation.

2.7. Mechanical System Safety

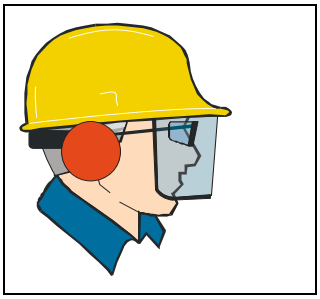
- Before starting the system, be sure you know how to stop it.
- Repair all leaks in pipes, tubing, fittings, or connections immediately.
- Never attempt to perform any maintenance functions or clean around the equipment while the system is in operation.
- Use the proper tools for the specific job. Using the wrong tools can result in injury or costly damage to the equipment.
- Be sure that all tools, parts and rags are cleared from any moving parts after servicing the equipment.
- Never climb on or around the equipment on makeshift devices. Use only approved catwalks, ladders or platforms.
- Keep all pressure settings for pneumatic components at specified levels. Exceeding specified limits may result in injury or damage to the equipment.
- Be alert at all times when working around the equipment.
- During equipment maintenance, take the system out of service. The controls shall be properly locked and marked with a warning sign.

2.8. Electrical System Safety Tips

- Always assume that the power is on in all electrical systems! Make it a practice to check and lock out 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 is on, regardless of whether the E-STOP button is in or out.
- Electronic troubleshooting and servicing of electrical devices shall be performed only by properly trained personnel.
- Personnel shall take extra precautions when servicing the power system in a damp environment.
- Use proper tools. Make sure that tools are well insulated for the job.
- Disconnect circuit breakers and lock them in the OFF position before servicing the electrical system. If this is not possible, have someone stand ready in case of an emergency.
- Use only proper test apparatus; check it regularly for proper operation.
- Capacitors shall be given sufficient time to discharge or discharging shall be done manually and with care.
- Never alter or bypass protective interlocks or devices unless specifically instructed to do so and all precautions are followed.
- Any replacement wires shall conform to the manufacturer’s specifications, including proper color coding, wire numbers, and size.
- Control panel doors or junction box covers must be closed after servicing.
- Do not use jumper wires across fuses or fuse holders.
- Use caution when connecting a test probe to test points.

2.9. Protective Clothing

Workers operating high-pressure water cutting equipment and those working nearby should wear protective clothing and safety devices as described in the following section. H2O Jet recommends that work-site safety personnel approve all safety equipment and clothing for everyone working around waterjet cutting equipment. It is important to remember that waterproof clothing only protects from wet spray. It does not protect from the cutting effect of the water jet. Leather gloves are also recommended though they will not protect from contact with the water jet.



Eye Protection

Operators must wear visors and goggles to guard against spray and flying debris.

Hearing Protection

Operators and others exposed to noise levels of more than 90 dBa for more than 1 hour must wear suitable ear protection. Ear plugs and muffs are usually adequate.

WARNING

NEVER point a waterjet cutting tool at yourself or at any person. Do not aim a waterjet tool at anything you do not intend to cut.

2.10. Emergency Medical Information

An information card to aid treating a waterjet injury is included in the binder or each manual. The card is shown below. Contact the address shown for additional cards.

(Front Side)

Medical Alert

This card is to be carried by personnel working with high pressure waterjet equipment. Obtain medical treatment immediately for ANY high pressure waterjet injuries.

H2O Jet Inc.
1145 85th Ave
Tumwater, WA 98501
866-928-3753

(Back Side)

This person has been working with water jetting at pressures to 60,000 psi (414 MPa, 4137 bar, 4218 Kg/cm^2) with a jet velocity of 3,000 fps (914 mps). Foreign material (sand) may have been injected with water. Unusual infections with microaerophilic organisms occurring at lower temperatures have been reported, such as gram negative pathogens as are found in sewage. Bacterial swabs and blood cultures may therefore be helpful. This injury must be treated as an acute surgical emergency and be evaluated by a qualified surgeon. Circulation may be compromised, therefore, **DO NOT APPLY HEAT TO INJURED PART**. For first aid: (1) Elevate injured part (2) Antibiotics (3) Keep injured person NPO.

2.11. Revision History

Date	Rev. Id.	Description of Change	Written by	Checked by	Approved by
May 8, 2006	0	First Publication	P. Spencer Norby	JN	HA
Mar. 13, 2015	A	Complete Manual Update	L. Jorgensen	M.H.	

3 OPERATING THE INTENSIFIER PUMP

3 OPERATING THE INTENSIFIER PUMP

3.1 Before starting the equipment:

1. Be sure you know how to stop the pump.
2. Read the manual and get instruction from an experienced operator.
3. Follow a written check list at each startup and shutdown. The list must include an inspection for necessary or ongoing service work, damaged or missing parts, leaks and anything that could make the equipment unsafe to operate.
4. Make sure doors and covers are in place.
5. Stand in a place that is protected by safety devices and within reach of an emergency stop switch.
6. Call out “START-UP!”

3.2 Starting the Pump

This procedure is for starting the pump for the first time, or if you have just rebuilt an intensifier, see Section 3.2.2 “Routine Pump Startup” for starting machine under normal operating conditions.

3.2.1 Initial Installation or After Rebuilding

Use this procedure after the equipment is first installed and after an intensifier is disassembled for service.

WARNING

All operators and service personnel must review the safety precautions and operating procedures before starting the pump.

CAUTION

Any debris left in the water supply lines can enter the intensifier and damage the high-pressure components. Such damage is NOT covered by your warranty.

CAUTION

Pumps are shipped without hydraulic oil. You must add oil to the reservoir and the hydraulic pump case(s) before operating the pump or you will SEVERELY damage the system.

OPERATION INSTRUCTIONS

WARNING

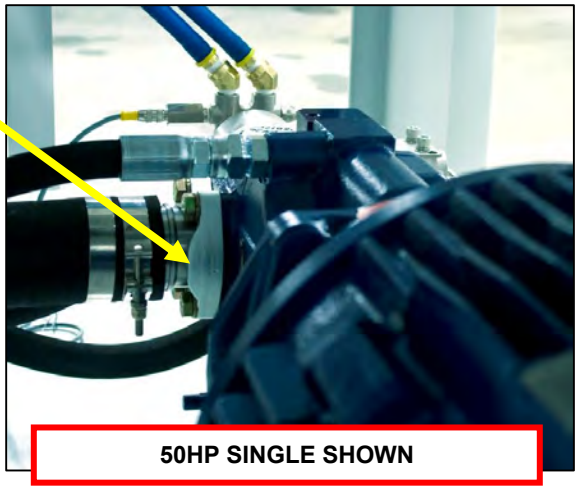
Cutting equipment and nozzles must be installed and working before operating the intensifier pump. Operating the intensifier pump without correct line restriction can damage the intensifier.

1. Close the hydraulic oil reservoir drain valve and fill the reservoir to the proper level. Recommended oils are listed in section 5.5.2. The reservoir holds approximately 80 gallons [303 L]. Note: Oil from a new drum does not meet the cleanliness requirements of the hydraulic system. For this reason, it is important to use an oil transfer pump that will force the oil through a filter into the reservoir.
2. Remove all tools, rags, parts, and debris from around the pump.
3. Open the external cutting and cooling inlet water valves and place the “Main Electrical Disconnect” to ON. Check all connections for leaks.
4. Open the left end door so you can see the electric motor fan grill and watch the motor rotation.
5. Release the E-stop.
6. Press START, then immediately press the STOP button. Make sure the motor shaft rotates in the same direction as the arrow on the hydraulic pump. If it rotates in the opposite direction, reverse the electrical power phase to any two motor leads. **Follow lock-out/tag-out procedures here!**

WARNING

Inspection cover must be in place during pump operation. There is a danger of personal injury if left open.

7. Loosen the suction line flange fitting on the hydraulic pump and crack open the flange(s) until oil leaks out. This ensures all air is bled from the suction line(s).
8. Retighten the flange fittings.
9. Purge trapped air from the hydraulic system before operating the pump continuously. Jog the pump by successively pressing the START AND STOP buttons and then wait a few moments after each jog until an audible change indicates that the pump is filled with oil. If the hydraulic pump fails to pick up pressure after four or five jogs, make sure the oil reservoir is full and the ball valve is open.



50HP SINGLE SHOWN

WARNING

Operating the pump without oil can damage the hydraulic system.

10. Press START. The hydraulic pump should idle at 450-600 psi [31-41 bar], as shown on the control panel system oil pressure gauge. If the pump fails to build pressure, repeat step 18.

NOTE: If any shutdown parameter is exceeded or if the remote start/stop switch is open, the pump will not start. Check for leaks.

WARNING

Do not tighten any loose or leaking connections while the pump is operating or the line is pressurized.

11. Run the pump at idle for 10-15 minutes, and then increase the water pressure to 20,000 psi [1379 bar]. Check for any leaks.
12. Operate the pump at 20,000 psi [1379 bar] for 5 minutes, and then increase the water pressure in 10,000 psi [689 bar] increments until you reach the maximum operating pressure. Check continuously for leaks or other problems.
13. Operate the pump an additional 5 to 10 minutes while checking for leaks.
14. While the hydraulic system is warming up, measure the oil temperature using an infrared laser thermometer in the reservoir. Optimum oil temperature is 105-110° F [40-43° C]; adjust the cooling water flow rate if necessary.
15. Decrease the hydraulic oil pressure to idle and press the STOP button.

16. Check the oil level and add oil as needed.

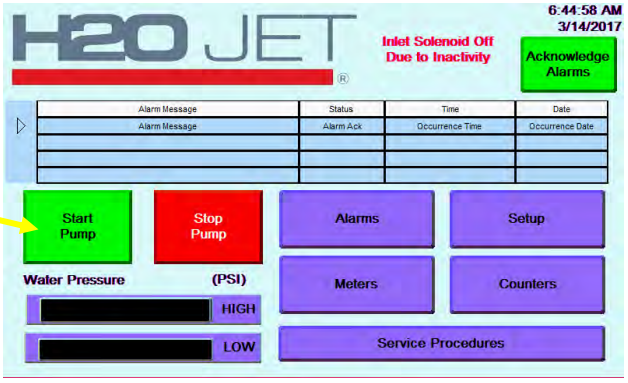
17. Thoroughly inspect the complete installation for any incomplete or low-quality work. Do not sign off the installation until all problems have been resolved and all quality-control inspections have been completed.

NOTE: All operators must carefully read this manual before operating or servicing the pump. H2O Jet's Technical Service Department is available to assist you with installation and training.

3.2.2 Routine Pump Startup

1. Check all around the equipment for needed or ongoing service. Check for damaged parts, leaks, Out of Service tags on the main electrical disconnect, and anything else that could cause an unsafe condition.
2. Check your records for any needed service work; complete as required.
3. Make sure the top cover is down and front and side doors are closed.
4. Push the E-stop.
5. Place the "Main Electrical Disconnect" in the ON position for the intensifier pump and all support equipment.
6. Release the E-stop button.
7. Press E-Stop RESET button.

8. Press "Start Pump" and let the pump idle. If any shutdown conditions are exceeded or the remote start/stop switch is open, the pump will not start and the fault screen will appear. The O.I.T. (Operator Interface Terminal) will describe the shutdown condition.

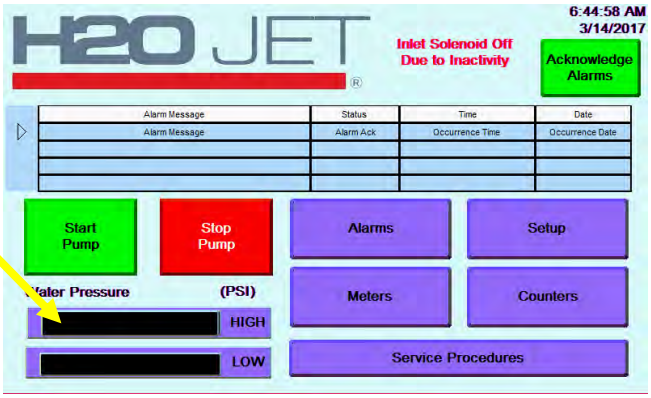


WARNING

Make sure all personnel are clear of the nozzle before startup.

8. Run the pump for 3 to 5 minutes; check for leaks and unusual noises. Increase oil pressure using the touch screen. Select the numeric value displayed and use the “keypad” to enter the normal setting. If leaks are seen, shut down and repair the pump.

9. Enter “10,000” on the keypad and press the return arrow for 10,000 PSI [690 bar].



WARNING

Do not tighten loose or leaking connections while the pump is operating or the line is pressurized.

10. Continue to run the pump for 30 minutes to allow oil to reach operating temperature.

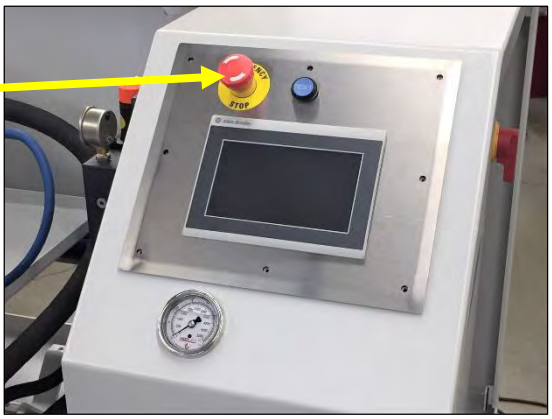
11. Check the hydraulic and high-pressure water gauges for Low values. If values are low, check all high-pressure water lines and check service records to see when nozzles were last serviced.

When all pre-operating checks are completed, the pump is ready for operation.

3.3 Stopping the Pump

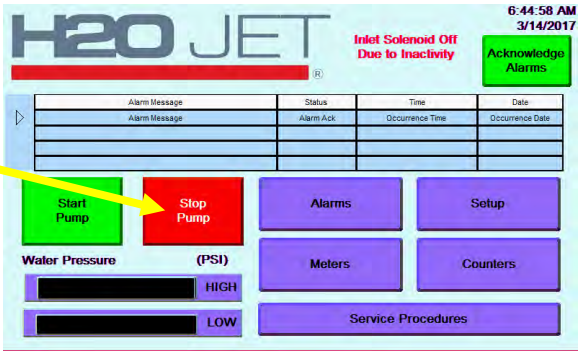
3.3.1 Emergency Shutdown

Press the “E-STOP” button on the main control panel.



3.3.2 Routine Shutdown

Press the “STOP PUMP” button on the control panel.



Note: **If the pump will be out of service for more than a few minutes, place the “Main Electrical Disconnect” in the OFF position and close all water valves.**

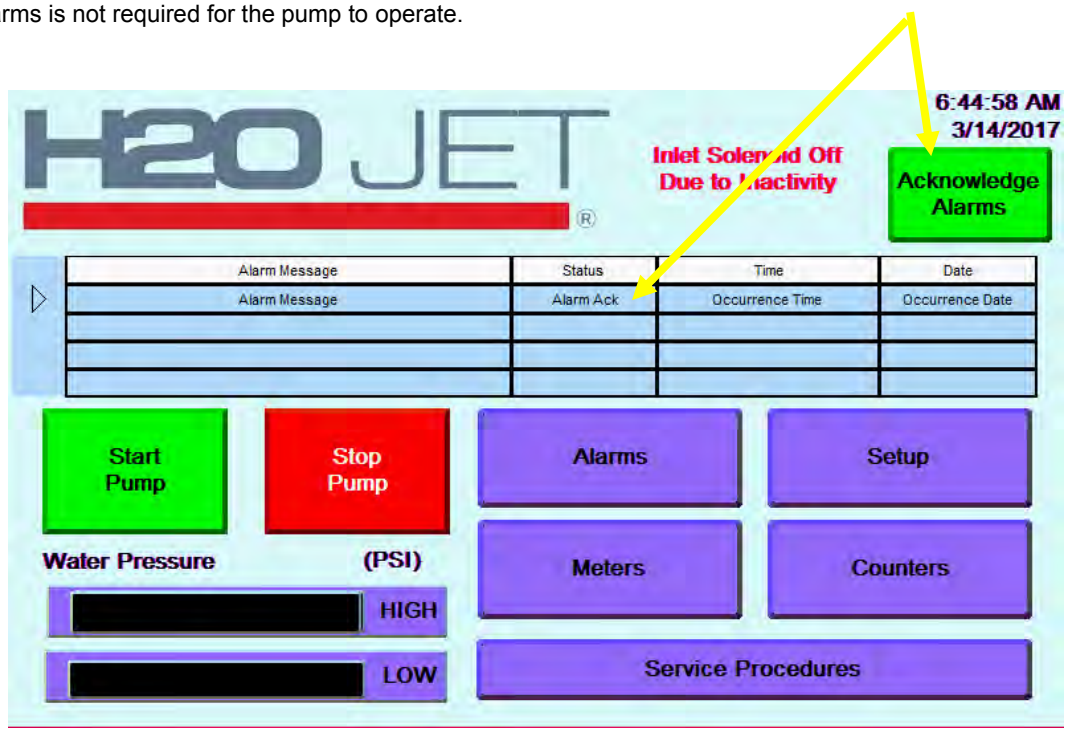
MAIN ELECTRICAL DISCONNECT

WARNING

Pushing the E-Stop does NOT disconnect all electrical circuits in the intensifier pump. High voltages are present in the electrical enclosure at all times when the main electrical disconnect is in the ON position.

3.3.3 Sensor shutdown (Alarms)

Sensors monitor inlet water pressure, oil level, and oil temperature. When a sensor detects a condition that could be harmful to the pump, the pump will shut down automatically, and the display panel will list the alarm condition in red. Once the alarm condition has been removed, the alarm color will change from red to blue, and the pump will be allowed to start. To acknowledge the alarm, press the ACCEPT ALARMS button in the upper right hand corner of the screen. This will allow the operator to keep record of new versus old alarms in the history. Acknowledging the alarms is not required for the pump to operate.

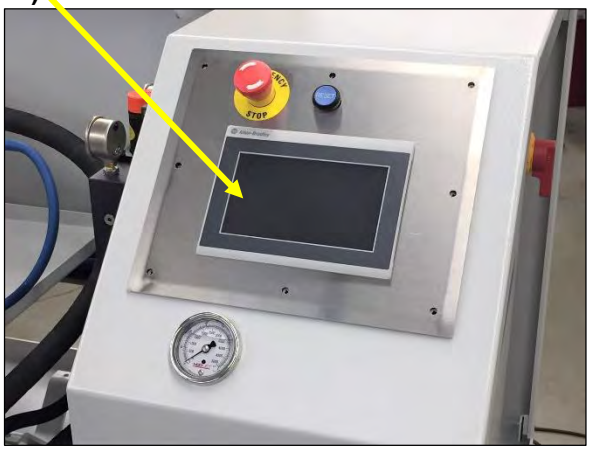


3.4 Pump Controls

The control panel is used to operate the pump and monitor all operating conditions.

3.4.1 Operator Interface Terminal (O.I.T.) Panel

The O.I.T. panel located on the right side of the frame, communicates with the onboard PLC (Programmable Logic Controller).

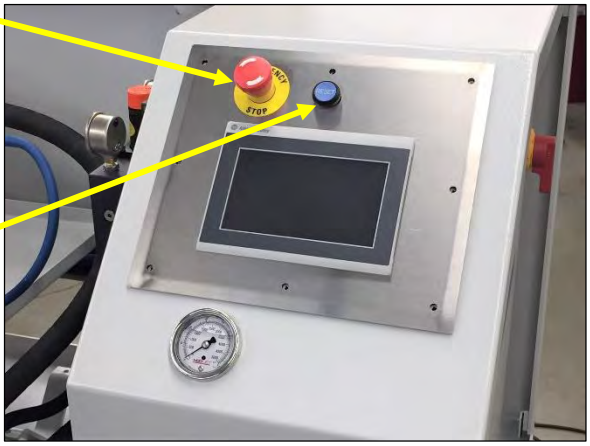


3.4.2 Emergency Stop Button

Pushing the emergency stop (E-Stop) button causes the pump to shut down, and the bleed-down valve opens to release the high-pressure water from the system. The pump cannot be restarted until the emergency stop button is released by turning it clockwise.

E-Stop Reset Button

When the E-Stop is activated, the reset button must be pushed **AFTER** the E-Stop has been reset for the pump to be restarted.

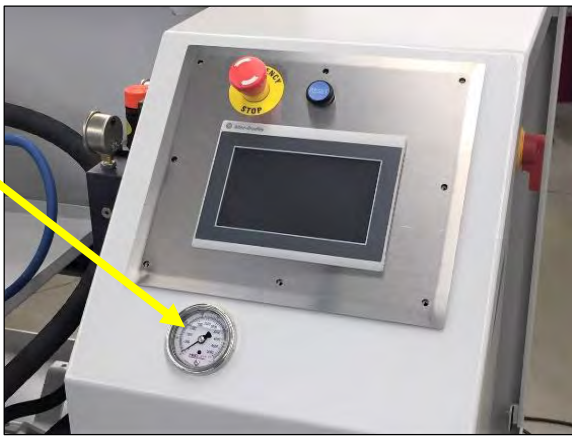


WARNING

Pushing the E-Stop does NOT disconnect all electrical circuits in the intensifier pump. High voltages are present in the electrical enclosure at all times when the main electrical disconnect is in the ON position.

3.4.3 System Oil Pressure Gauge

The system oil pressure gauge displays intensifier manifold system oil pressure. The gauge is connected to the compensator manifold on the main hydraulic pump. The gauge is graduated in psi and bar. The water pressure can be calculated by multiplying the system oil pressure by the intensification ratio of the intensifier(s) x20 for 60,000 psi [4136 bar] and x13 for 40,000 psi [2758 bar] systems. There is a pressure conversion chart at the end of this section.



3.4.4 Selecting Intensifiers on Redundant Systems

If your intensifier pump has two intensifiers connected in a redundant configuration, this procedure explains how to switch from one intensifier to the other. The intensifiers have the same pressure rating.

WARNING

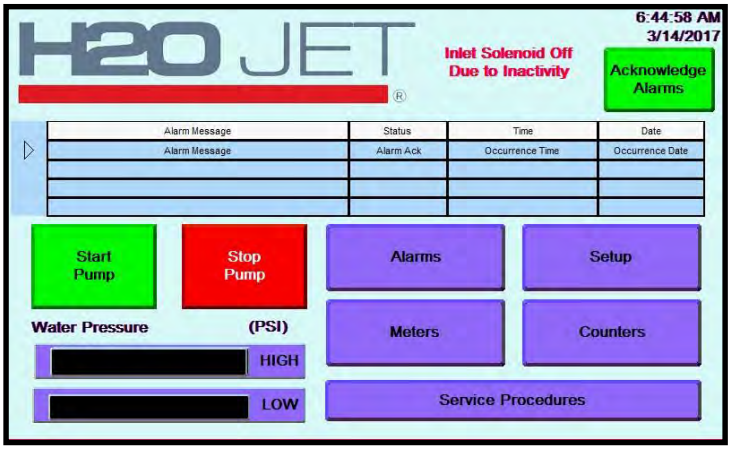
To minimize operator exposure to potential hazards, either turn the intensifier pump off or let it idle before opening the top cover.

CAUTION

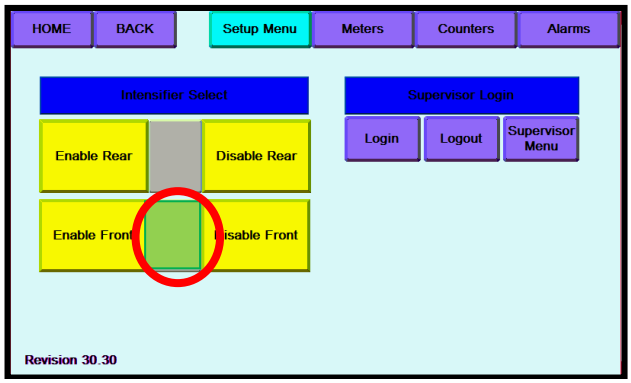
When an intensifier is disassembled for service, air is trapped inside. When selecting an intensifier for the first time after it has been rebuilt, it must be run in to avoid possible damage. See Section 3.2 "Initial Start Up and After Rebuilding", when returning a repaired intensifier to operation.

WARNING

The pump must not be operated with one intensifier removed. Both intensifiers must be in place for safe operation of the pump. Serious injury may occur.

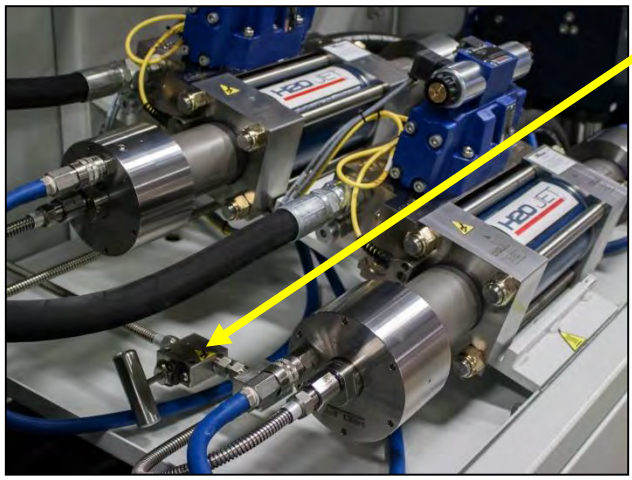


The opening screen for the O.I.T consists of: Start Pump, Stop Pump, Pressure select, and keys to jump to other pages. From this screen you will need to push the **Setup** button to access the correct menu.

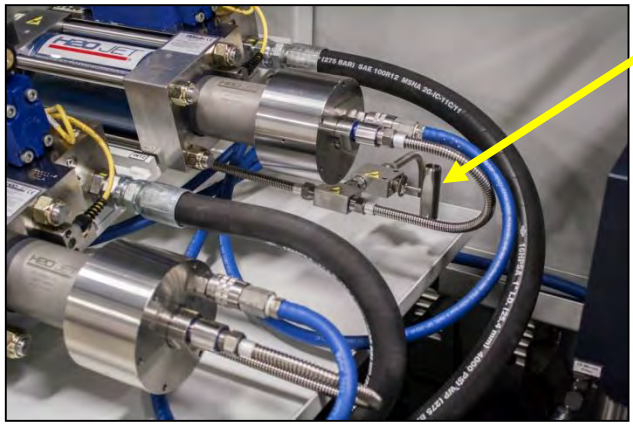


On the setup page you will need to select the intensifier you want to run.

For example: If you want to select the front intensifier, push the **ENABLE FRONT** button in the setup menu. The on-screen light will illuminate on whichever intensifier has been selected.



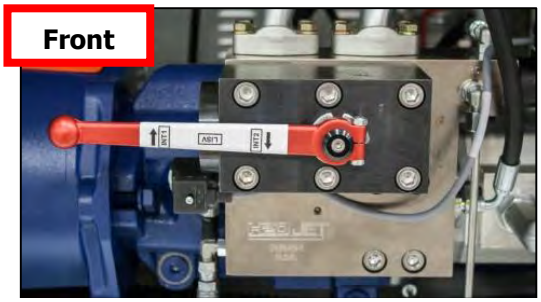
To run the front intensifier, open the front high pressure water valve (ISV1) and close the rear valve (ISV2).



To run the rear intensifier, open the rear high pressure water valve (ISV2) and close the front valve (ISV1).

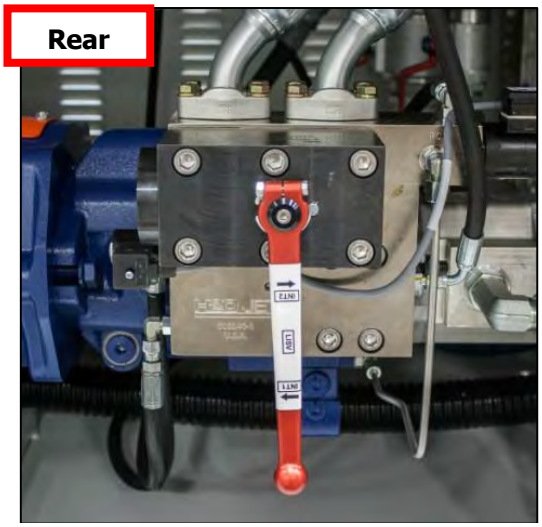
The intensifier selection can be made with the pump on, set at low pressure or turned off. Do **NOT** switch the valve under high pressure. The ball valve handle is labeled for ease of use, INT 1 refers to the front intensifier, while INT 2 refers to the rear intensifier.

Front



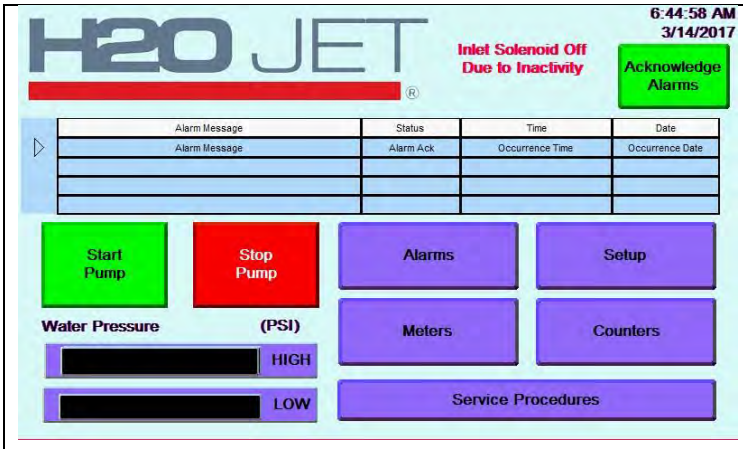
The directional switch valve is accessed through the front lower door. The handle points to the left for the front intensifier.

Rear



The handle points down for the rear intensifier.

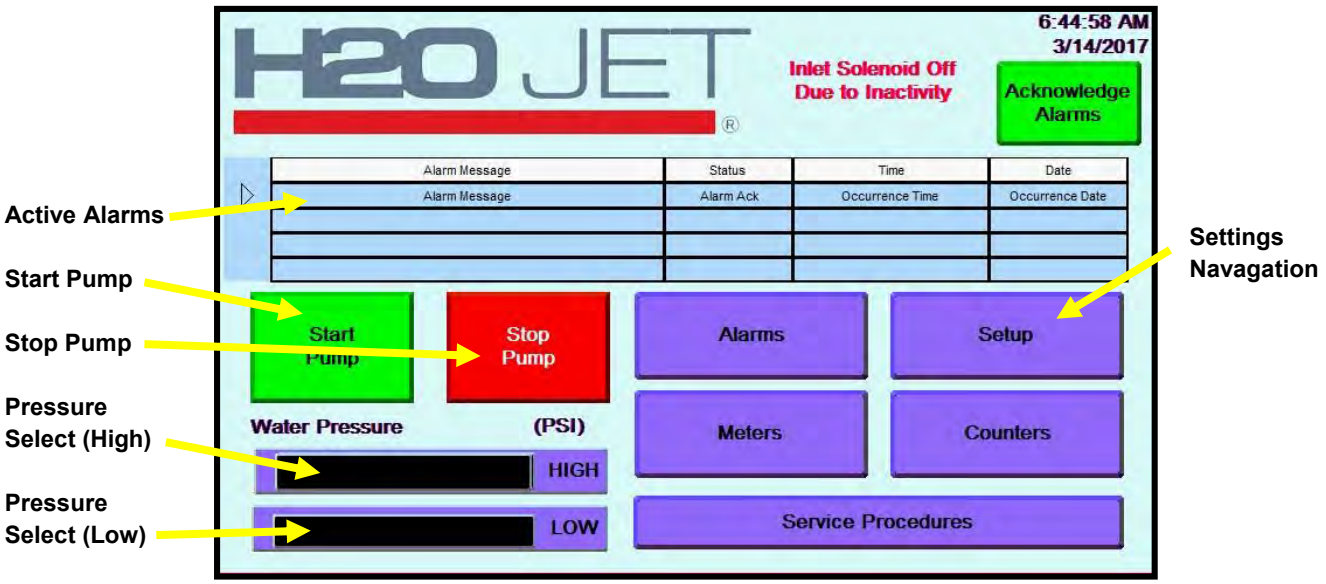
3.4.5 Hi / Low Pressure Switch Operation (Remote Control Option Units Only)

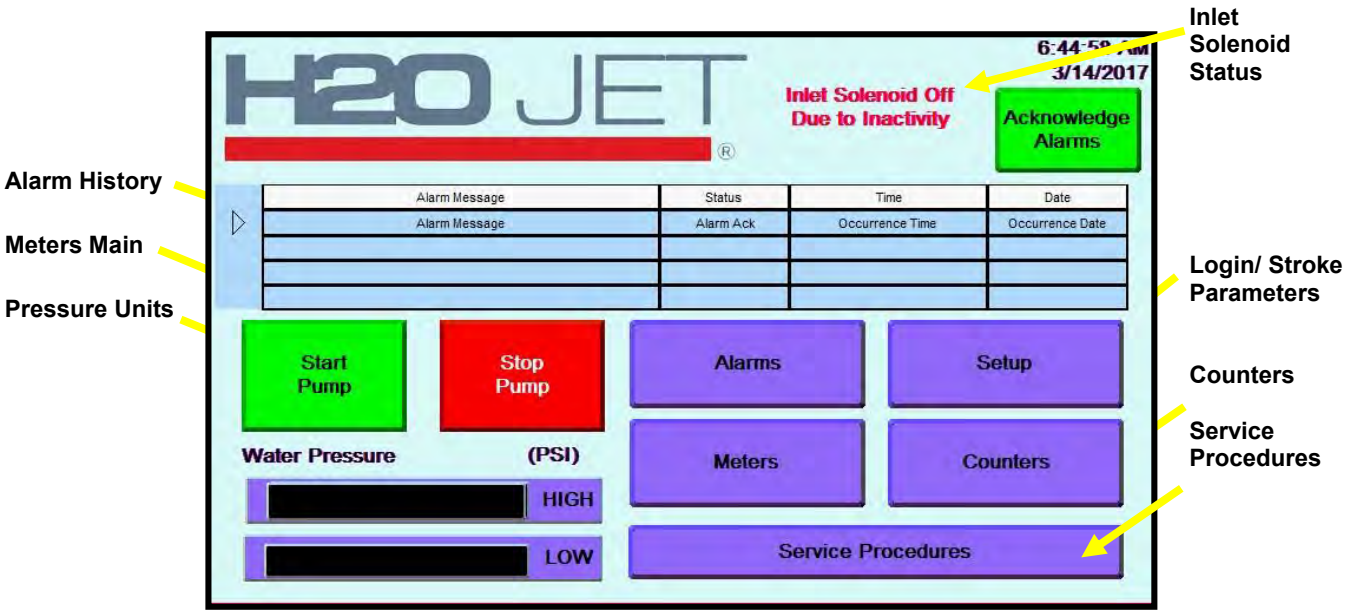


The Main Page includes the setting of the Hi / Low pressure on units with the optional Hi/Low remote control. Toggling is then done from the external Remote Control switch. The electrical schematic in the appendix shows how the external switch is connected to the electrical cabinet.

3.5 O.I.T. Detail

The O.I.T. display consists of an LCD touch screen control/display window.



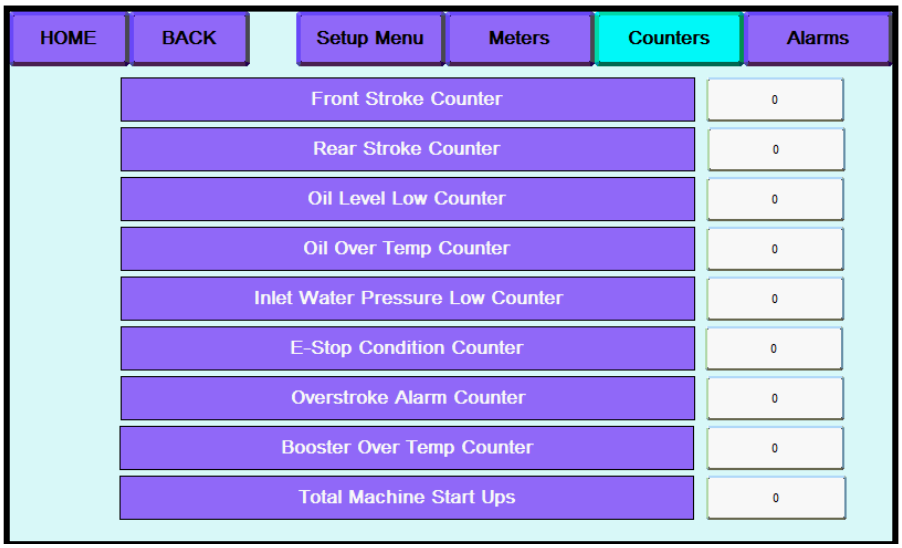


The functions of the control buttons are described in the following sections.

3.5.1 Counters Main

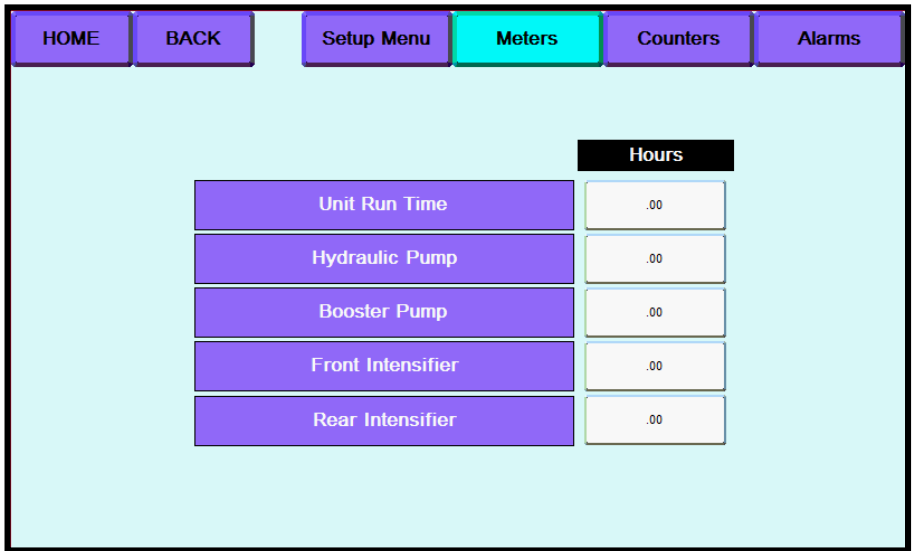
The “COUNTERS” page list:

- **STROKE COUNT** - The stroke count of the front and rear intensifiers can be logged when the “electronic shifting” package is supplied.
- **OIL LEVEL LOW OCCUR** – logs the number of times that the oil level has dropped below acceptable levels.
- **OIL OVER TEMP OCCUR** – logs the number times that the oil temperature exceeds acceptable levels.
- **INLET WATER PSI LOW** – logs the number of times the inlet water pressure falls below 30 psi [2.07 bar]
- **E-STOP COND OCCUR** – logs the number of times the emergency stop button is activated.
- **OVERSTOKE OCCUR** – logs the number of times the intensifier has shifted more times than allowed in a given interval.
- **BOOSTER OVER TEMP OCCUR** – logs the number of times the booster pump temperature exceeds acceptable levels.
- **TOTAL MACHINE START UPS** – logs the number of times the pump has started.



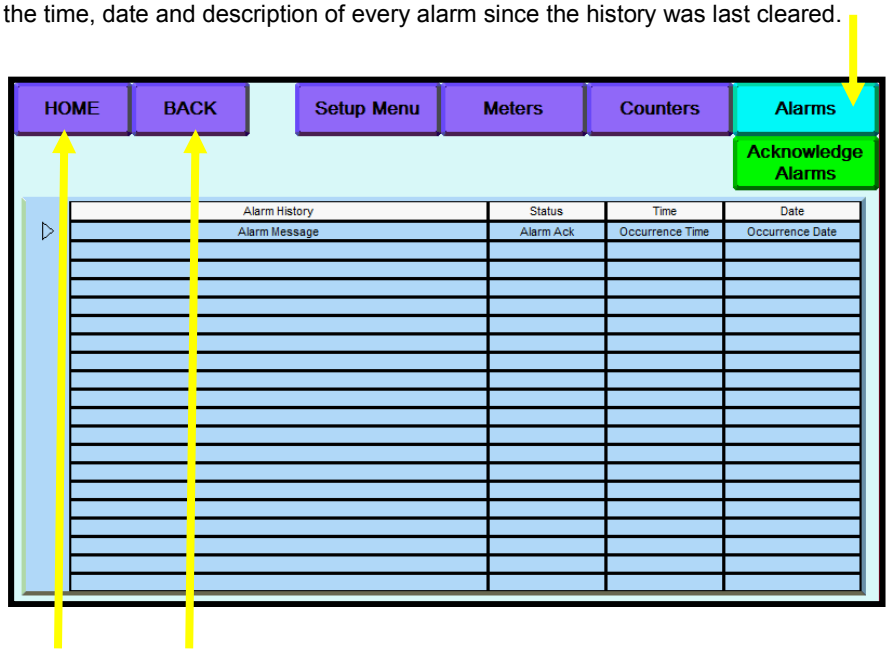
3.5.2 Meters Main

Maintains a record of the time the H2O Jet Pump unit, the hydraulic pump, booster pump, front and rear intensifiers have run.



3.5.3 Alarms

The “ALARMS” page lists all the faults that are currently active. Pressing the “ALARM HISTORY” button will display the time, date and description of every alarm since the history was last cleared.

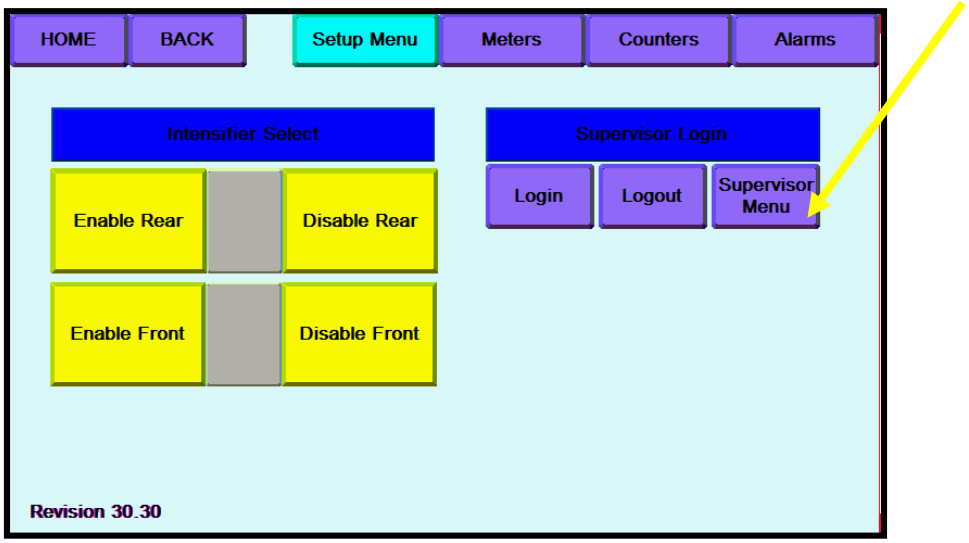


Home and Back

The Home Button takes you to the main screen. The back button sends you back to the previous page.

3.5.4 Supervisor Menu

The supervisor Menu is accessible through the “Setup Page” on the main screen. You must first Login to access the page. The Supervisor Menu is password protected, the factory set user id is **h2o** and password is **321**. Once logged in as a supervisor, this allows the supervisor to reset the meters and counters, and adjust under stroke fault timers. The meters and counters are very useful in tracking “mean time” between major repairs.



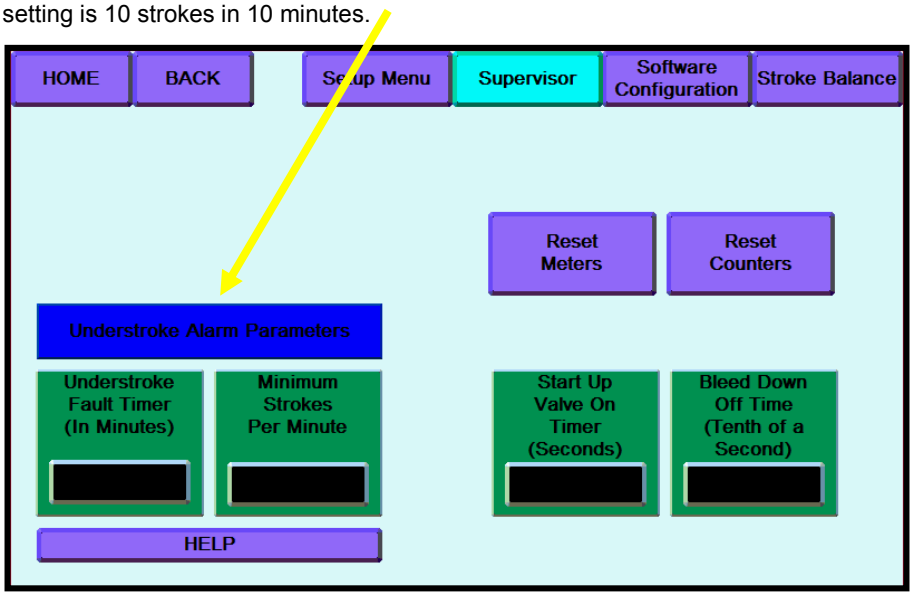
The Reset Meters and Reset Counters button will let you reset the meters and counters that are shown on the Meters page and Counters page.

The Start Up Valve On Timer controls the delay from when the pump is started to when pressure can be increased.

The Bleed Down Off Time controls the amount of time the bleed down valve stays open when switching from High to Low. If when switching from high to low, the pressure does not drop down to the low setting, input a larger number. The value is input in tenths of a second.

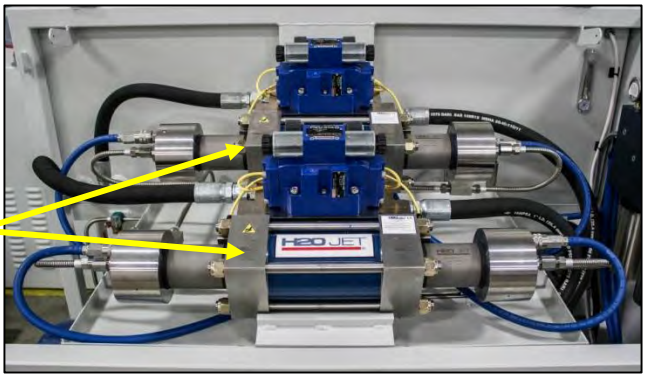
3.5.6 Understroke Parameters (Supervisor use only)

Sets the stroke parameters for the intensifier and provides information of failures/leakages within the system. Out of stroke tolerance is how long the machine has to accomplish the expected number of strokes. Minimum Stroke Fault Parameter is the number of strokes the machine must make within the “Bandwidth” amount of time. If the machine does not meet these numbers it will shut down in an alarm condition and display the reason. Leaving the machine running “deadhead” past the time limit will cause the Intensifier to shut down. The default minimum stroke limit setting is 10 strokes in 10 minutes.

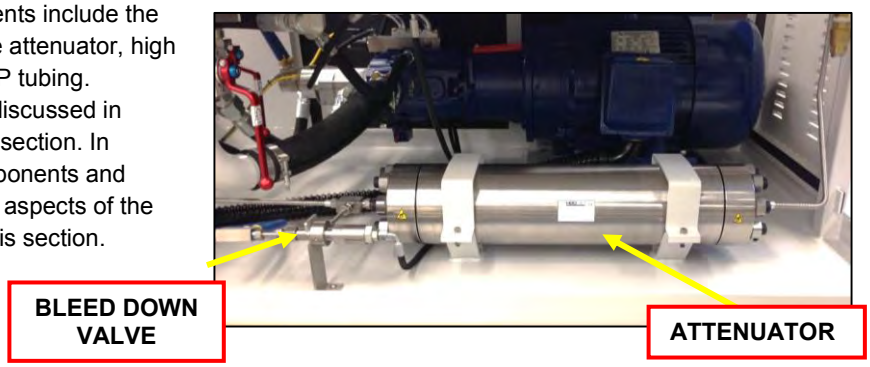


3.6 High Pressure Water System

The high pressure water system raises the relatively low pressure water inlet up to 60,000 psi [4,136 bar] supplying orifice diameters appropriate to the pump’s operating power.



The high-pressure water components include the hydraulic intensifier, high pressure attenuator, high pressure bleed down valve and HP tubing. Maintenance on the intensifier is discussed in detail in the “Service Procedures” section. In addition to the high pressure components and assemblies, the hydraulic cylinder aspects of the intensifier are also discussed in this section.



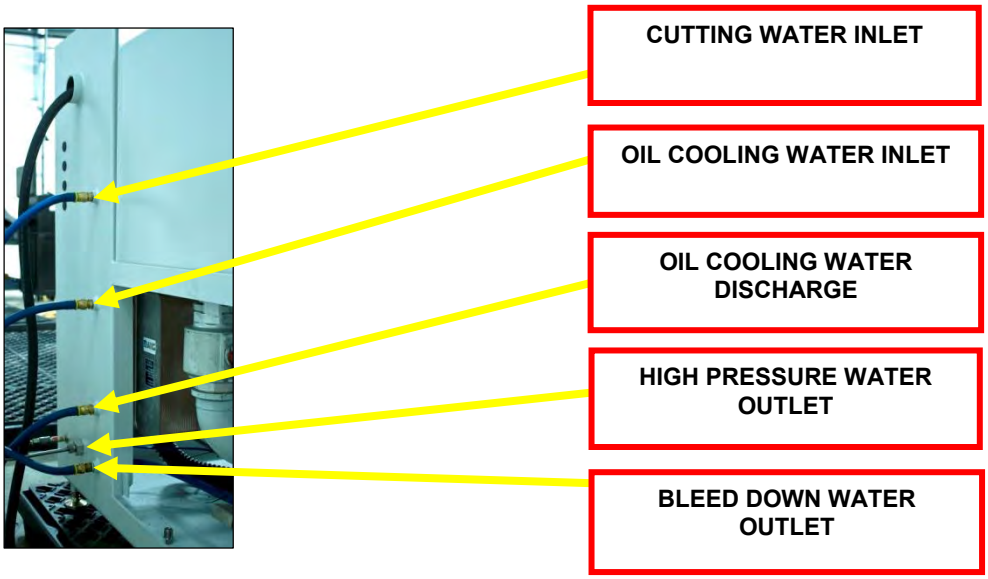
3.7 Low Pressure Water System Introduction

The H2O Jet Pump is equipped with two low pressure circuits:

- Cutting water supply for High Pressure intensifier assembly;
- Cooling water supply for the oil-to-water heat exchanger.

The low pressure water system supplies the pump with the following:

- Water of sufficient cleanliness and pressure to the inlets of the two High Pressure cylinders
- Cooling water with sufficient flow and low enough temperature to cool the oil-to-water heat exchanger.



3.7.1 Oil Cooling Water Supply

A minimum inlet pressure of 40 psi [2.75 bar] and a maximum inlet temperature of 70^{O} [21° C.] cannot be exceeded to maintain oil temperature under maximum operating conditions. A flow rate of 3-5 GPM [11-19 lpm] is required.

3.7.2 Cutting Water Supply

The cutting water supply includes the following:

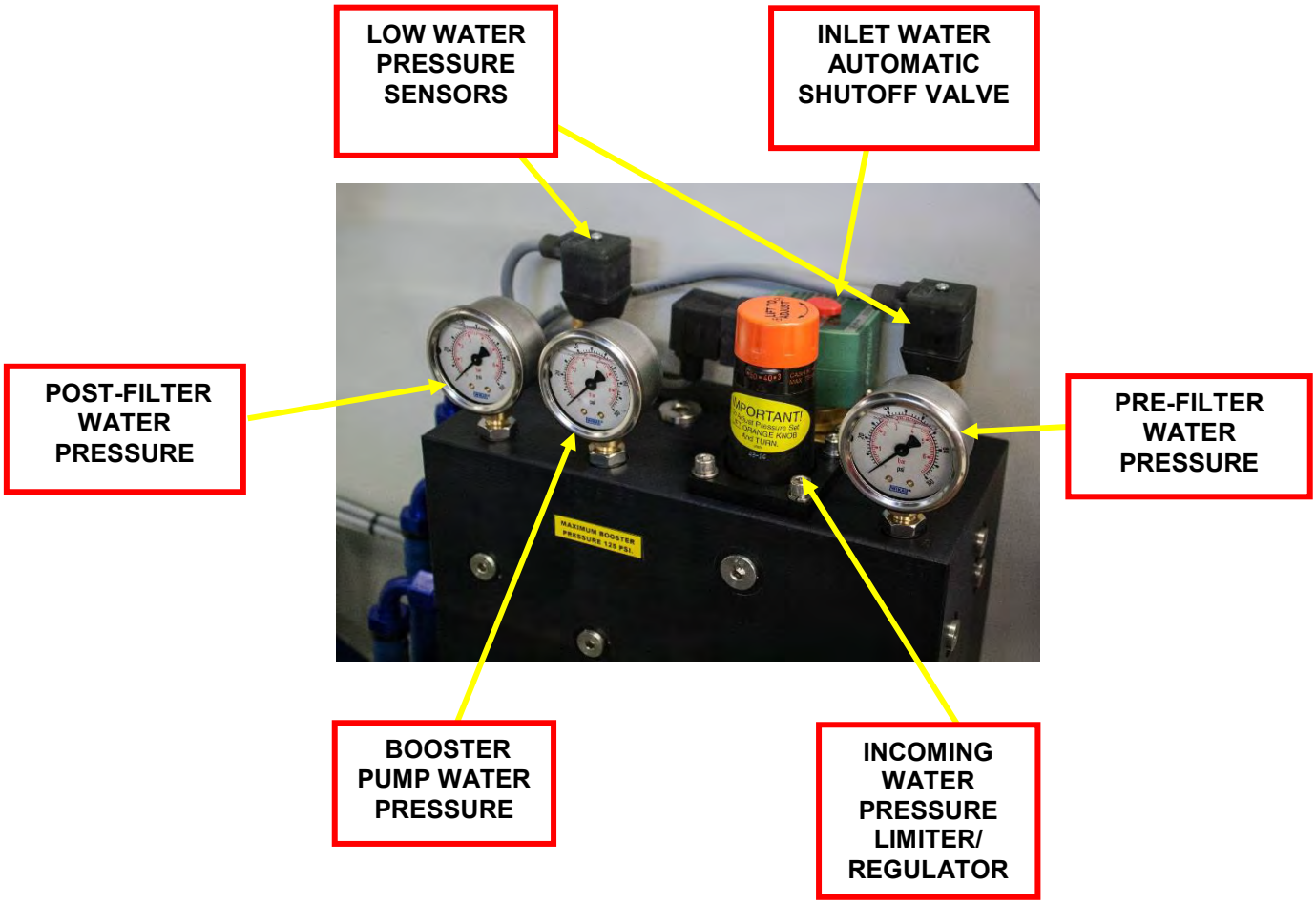
1 Inlet water shutoff valve.

2 Low pressure water filters to protect the booster pump and intensifiers from dirt and contaminants.

3 Inlet water pressure limiter / regulator.

4 Water pressure gauges.

3.7.3 Booster pump and sensors.



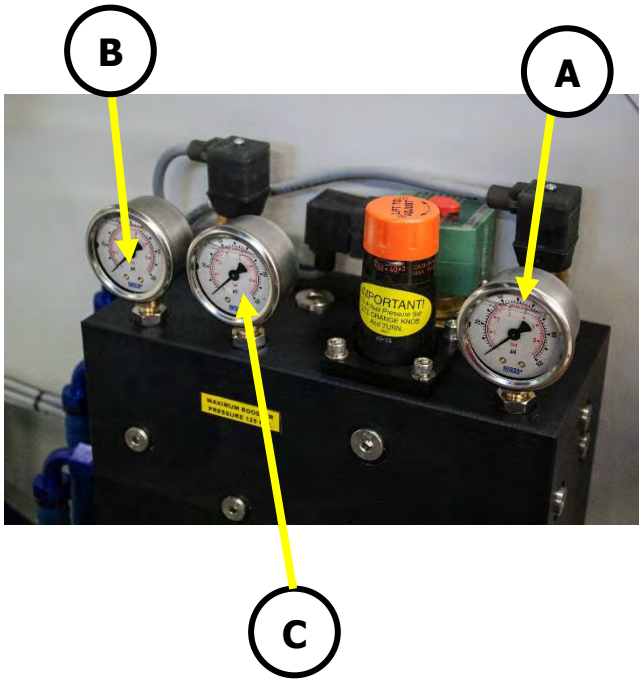
Water Filter Manifold Gauges

A. Inlet Water Pressure

B. Filter Outlet Pressure

C. Booster Pump Outlet Pressure

Note: While the intensifier assembly changes direction, the booster pressure will fluctuate slightly above and below the normal setting. Pressure fluctuation greater than 30 psi [2 bar] may indicate inadequate water supply to unit, or poor booster pump performance from a worn impeller.



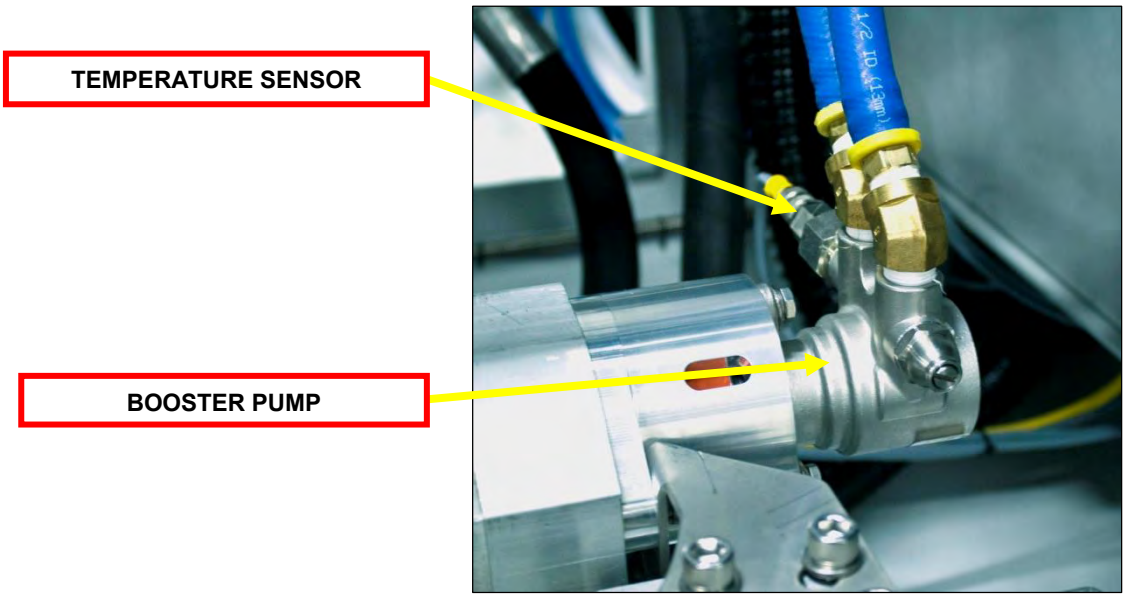
Operating Under Normal Conditions

During normal operation, the low pressure water system maintains the following conditions:

- Filter pressure drop (gauge reading **A** minus **B**) should not be more than 15 psi [1 bar];
- Booster pump discharge gauge (**C**) reading 90 - 125 psi (6.2 - 8.6 bar). Exceeding 125 PSI (8.6 bar) can result in damage to the filter block or bowls.

Operation

The cutting water for the booster pump enters through the Cutting Water Inlet. When the Emergency Stop is pushed the water inlet valve is opened and allows water to flow through the water filters and then to the booster pump. The booster pump will increase the inlet water pressure to 90-125 psi [6.2-8.6 bar] insuring proper supply to both of the intensifier assemblies (where applicable). If the inlet water pressure falls below 30 psi [2 bar], the low water pressure sensor will be activated and shut down the pump.

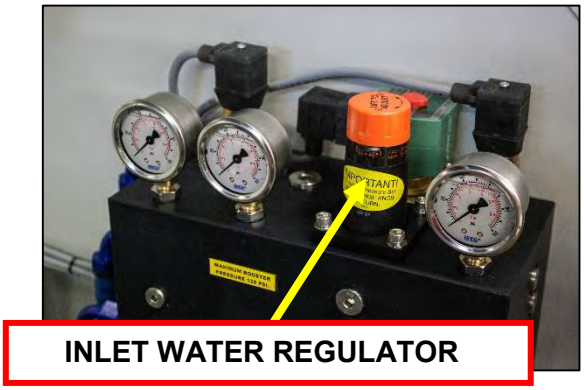


Note: The booster pump is factory set to deliver **90-125 psi [6.2-8.6 bar]** when the inlet pressure is at 40-45 psi [2.7-3.1 bar]. The pump may require adjustment if local inlet pressure varies, because discharge pressure depends on inlet pressure. Inlet pressure is affected by filter condition, as well as local water supply conditions.

3.7.4 Inlet Water and Booster Pump Pressure Adjustment

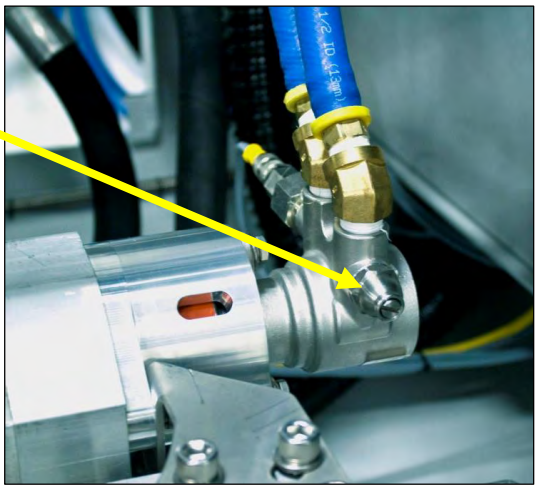
Step 1. Release the Emergency Stop and press the RESET button to open the inlet water solenoid. Set the inlet water pressure to 40-50 psi (2.7-3.1 bar) by turning the pressure regulator knob clockwise to increase or counter-clockwise to decrease the pressure.

If 40 psi (2.7 bar) cannot be obtained because of low inlet water pressure, you may run into issues with the pump shutting down during maximum water output. The low pressure water alarm switch is set to 30 psi (2.0 bar).



Step 2. Locate the adjustment screw inside the acorn nut of the booster pump.

Step 3. Turn the pump on, set to idle pressure (10,000 psi [690 bar]) and close the cutting heads. The booster pump pressure gauge should read 90-125 psi (6.2-8.6 bar). To adjust the pressure turn the booster pump adjustment screw in ¼ turn increments, clockwise to increase pressure and counter-clockwise to decrease the pressure.



Note: Do not exceed 125 psi (8.6 bar) as damage to the filter housing, bowls, and filter nuts can occur.

3.7.5 Low Pressure System Protections

Pump overheating due to lack of water, or long deadheaded conditions, is prevented by the temperature sensor on the booster pump, which turns the pump off if it senses a high temp condition.

To reduce booster pump overheating while deadheading, water is re-circulated through the backflow check valve to the water filter inlet.

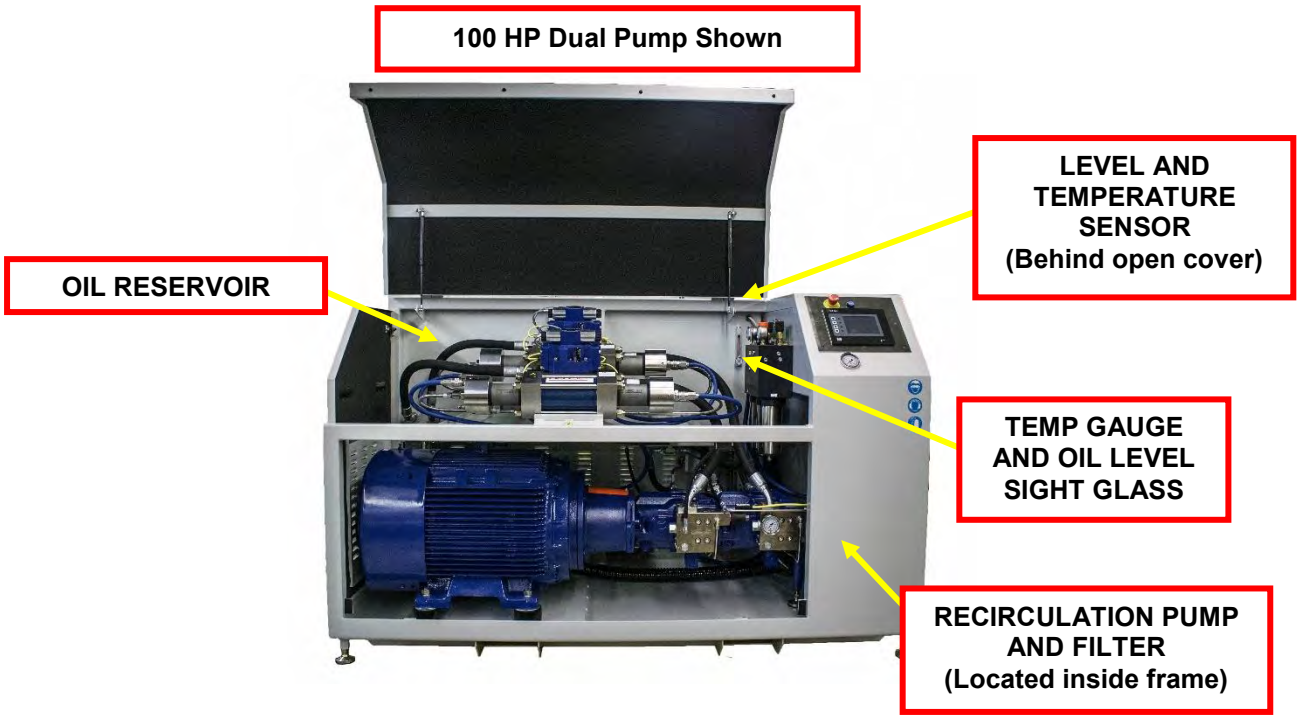
3.8 Heat Exchanger Operation and Oil Recirculation System

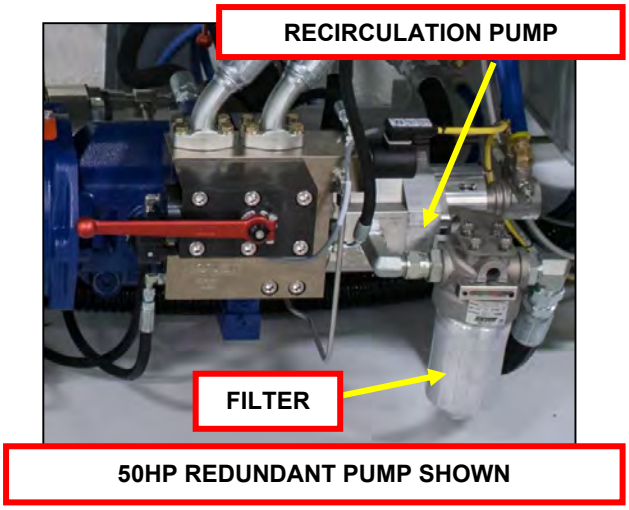
The heat exchanger system maintains the hydraulic oil operating temperature while optimizing the amount of cooling water flow. The system also provides the necessary oil conditioning and filtration to maintain oil cleanliness. The conditioning of the hydraulic oil includes cooling and cleaning. In combination with the hydraulic tank, the recirculation system also aids in removing air bubbles in the oil due to agitation and turbulent flow in the main pump circuit.

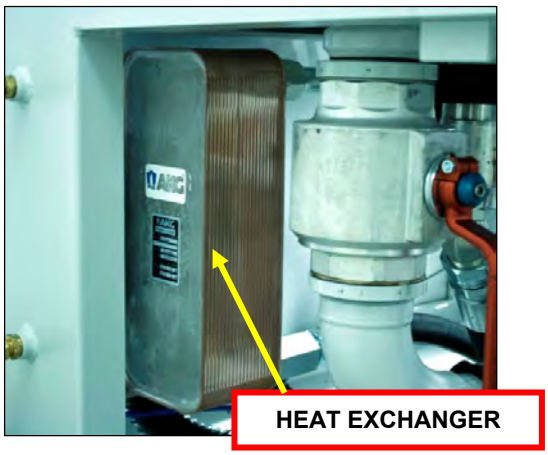
3.8.1 Components

The cooling and filtration system (recirculation system) is equipped with the following:

- Recirculation Pump (gear-type) – circulates the reservoir oil.
- Heat Exchanger – cooling water lowers the temperature of the oil in the oil reservoir.
- Oil Filter Assembly – removal of particulate contaminants from the oil.
- Reservoir – settle out water and other contaminants, removing air bubbles.







3.8.2 Operation

The recirculation pump draws oil from the hydraulic oil reservoir and pumps it through the oil filter. The oil is then pumped through the water/oil heat exchanger and back into the reservoir.

3.8.3 Maintenance Overview

During normal operating conditions, the oil will be maintained at the correct operating temperature. The reservoir has a temperature and level sensor to protect the system.

In order to get the best value from the hydraulic system (including the recirculation system), the filter element should be checked frequently and changed as needed. The hydraulic oil should be changed after 4,000 hours or 1 year of service (whichever comes first) or whenever a fluid sample indicates that it is contaminated and beyond usability. See Section 5.6. “Hydraulic Oil Return Filter Service” for complete instructions.

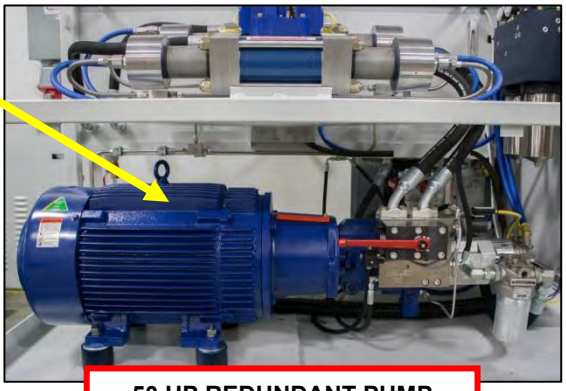
3.9 Electrical System

The electrical system contains all functions necessary for a turn-key operation. This includes the control and starter panel, intensifier reversal circuit, diagnostics, malfunction warning and protection.

The electrical enclosure and the display, buttons, lights and electrical harnesses into and out of this enclosure can be exposed to occasional water spray and dust per NEMA-12 standards.

Electrical Overview

There is only one electric motor on the H2O Jet Pump. The control voltage of 24VDC is furnished by the built-in power supply drawing its power from the motor's AC circuit.



50 HP REDUNDANT PUMP SHOWN

3.9.1 Motor Starter Circuit

Three motor starter circuits are offered as built-in assemblies for the **H2O Jet** 50hp and 100hp pumps.

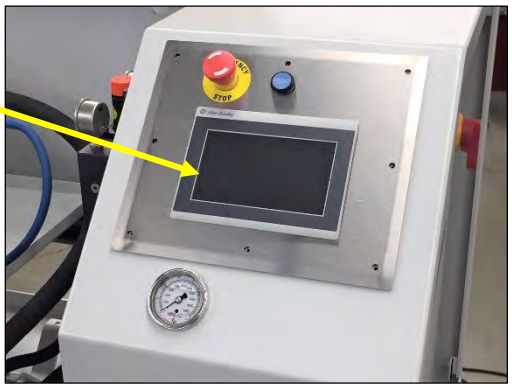
- Wye-delta starter, used commonly in Europe to reduce current surges during motor startup.
- Across-the-line starter, commonly used in the United States.
- Soft Start, an optional soft starter is available on Advantage Pumps.

Other features included in the motor starter circuits

- Manual disconnect with door handle interlock.
- Over-current protection.
- Hydraulic unloading during startup, allowing the motor to reach full speed.

3.9.2 Operator Interface Terminal

The operator controls the H2O Jet Pump primarily through the Operator Interface Terminal (O.I.T.). The digital interface (display) communicates with the PLC controller located inside the electrical enclosure.

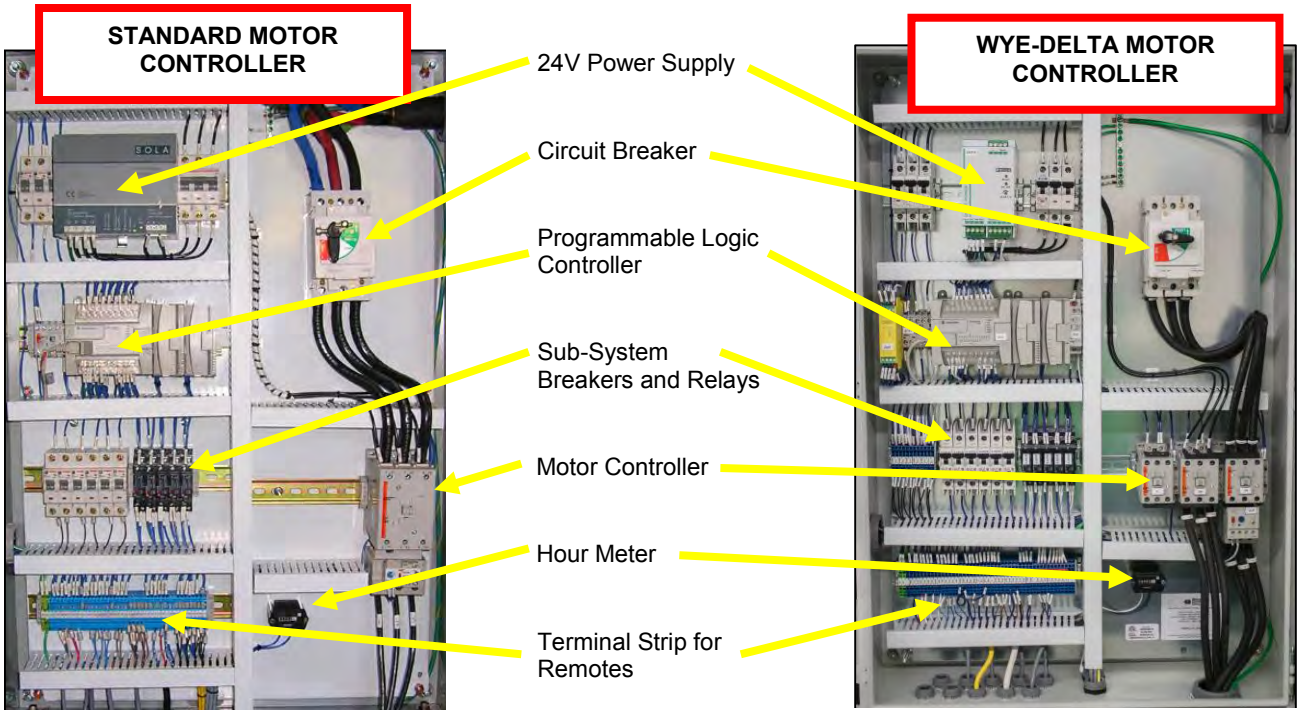


In order to prevent costly damage to the pump, automatic shutdown logic and diagnostic messages are displayed to the operator as to the cause of the shutdown. Some of the inputs that trigger automatic shutdown:

- Low hydraulic reservoir level.
- High hydraulic oil temperature.
- High booster pump temperature.
- High booster pump pressures.
- Low inlet water pressure.
- High-pressure intensifiers cycling out-of-tolerance (electronic shifting units only).

For more information on these conditions and recovery procedures, refer to Section 3 “Operating Instructions” and Section 4 “Troubleshooting Guide” of this manual.

Terminal blocks are provided in order to interface with the remote operator’s station.



3.9.3 Control Circuits and Logic

During normal operation, the control panel does not show any operating messages.

To activate the pump, turn on the Main Power. This will turn on the touchscreen display; however the pump cannot be started if the Emergency Stop button is still pushed down and the RESET button has not been pushed.

Twist clockwise and pull out the Emergency Stop button.

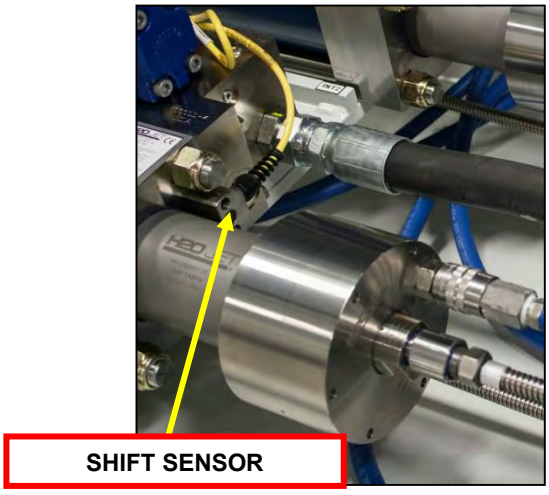
Push the blue Emergency Stop Reset button, **AFTER** you release the Emergency Stop**.** This will also open the Inlet Water Valve.

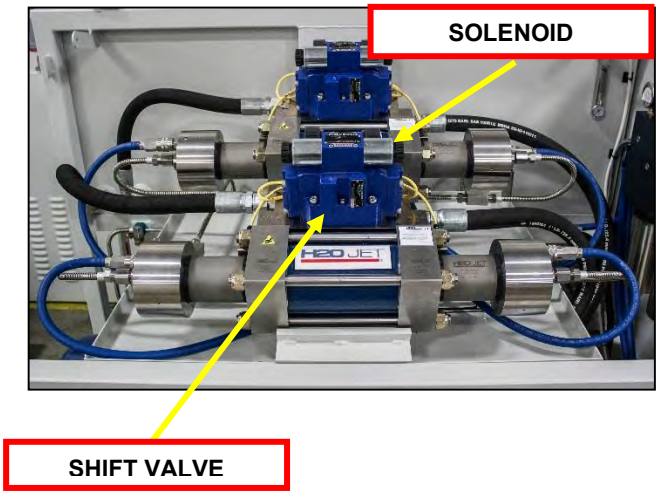
After pressing the “Start Pump” button on the control panel:

- The motor starter in the PLC is activated and the motor starts.
- The high-pressure bleed down valve will close as the hydraulic pump starts up.

Note: The high-pressure bleed down valve will not close without hydraulic pressure.

Electric shifting is controlled by shift sensors that send a signal to the PLC inside the control panel. The PLC sends a signal that switches the energized coil on the shift valve, sending hydraulic fluid to the opposite end of the intensifier, reversing its direction.





3.9.4 Maintenance Overview

Electrical components require minimum attention and service. The components that will require occasional service are the shift sensors mounted on the intensifier assembly. Section 5.11.2 “Shift Sensor Service” for complete maintenance instructions.

3.10 Oil Pressure Converstion Charts

Use these charts for setting water output pressure on Manual Pressure Control pumps. Charts are given for both 60,000 psi and 40,000 psi units and also metric scales for 4136 bar and 2667 bar measurement. The higher pressure units use a conversion factor of twenty times (20X) the oil pressure gauge reading. The lower pressure units use a conversion factor of thirteen times (13X) the oil pressure gauge reading.

Oil Pressure Conversion Chart
60K Unit (psi)
Conversion Factor = 20X

Water Pressure (psi)	Oil Pressure (psi)
60,000	3000
55,000	2750
50,000	2500
45,000	2250
40,000	2000
35,000	1750
30,000	1500
25,000	1250
20,000	1000
15,000	750
10,000	500
5,000	250

Oil Pressure Conversion Chart
40K Unit (psi)
Conversion Factor = 13X

Water Pressure (psi)	Oil Pressure (psi)
40,000	3077
35,000	2692
30,000	2308
25,000	1923
20,000	1538
15,000	1154
10,000	769
5,000	385

Oil Pressure Conversion Chart
4K Bar Unit
Conversion Factor = 20X

Water Pressure (bar)	Oil Pressure (bar)
4000	200
3750	187.5
3550	177.5
3250	162.5
3000	150
2750	137.5
2500	125
2250	112.5
2000	100
1750	87.5
1500	75
1250	62.5
1000	50
750	37.5
500	25
325	16.25

Oil Pressure Conversion Chart
2667 Bar Unit
Conversion Factor = 13X

Water Pressure (bar)	Oil Pressure (bar)
2667	205.2
2500	192.3
2250	173.1
2000	153.8
1750	134.6
1500	115.4
1250	96.2
1000	76.9
750	57.7
500	38.5
325	25.0

3.11 Revision History

Date	Rev. Id.	Description of Change	Written by	Checked by	Approved by
May 8, 2006	0	First Publication	P. Spencer Norby	JN	HA
Sept 27, 2006	A	Updated O.I.T screen shots to reflect new software version	M.Huntley	JN	HA
Nov 8, 2011	B	Updated O.I.T screen shots to reflect Red Lion HMI	M. Rasmussen	M.H.	H.A.
June 7, 2012	C	Updated O.I.T. screen shots to reflect new software version	L. Jorgensen	M.H.	H.A.
Oct. 15, 2013	D	Added procedure to adjust inlet water regulator on filter manifold.	M.Huntley	M.H.	H.A.
Mar. 25, 2015	E	Complete manual update.	L. Jorgensen	M.H.	H.A.
Mar. 14, 2017	F	Updated to Allen Bradley Touchscreen.	M.Huntley	L.J.	H.A.

4. TROUBLESHOOTING GUIDE

4. 1. Using the Troubleshooting Guide

The troubleshooting guide will help identify the probable cause of a system malfunction and establish the most effective corrective action.

Troubleshooting Tips

The following tips have proven helpful in isolating system malfunctions to remedy problems quickly and effectively:

1. Take a few minutes to listen to the machine and observe it in operation. Learn to recognize the normal noises and operating conditions of the system. This will enhance your ability to notice any unusual machine behavior.
2. Carefully and precisely define the symptom(s) of the problem. This is the most important step in identifying the probable cause.
3. Maintain a record of all service performed on the equipment. This record will provide valuable information to help you stock spare parts and schedule maintenance.

Using the Troubleshooting Guide

The probable causes of each malfunction and the corrective actions are listed. The corrective action is a condensed, step-by-step summary of the service required to remedy the problem. When you encounter a system malfunction:

1. Carefully and precisely define the malfunction.
2. On the Troubleshooting Guide, locate the symptom that most closely resembles your assessment of the problem.
3. Identify the most probable cause.
4. Follow the corrective action procedure.

If the symptoms in the guide do not correspond to your malfunction, or if the problem is not resolved or eliminated by the recommended corrective action, contact your service representative.

4. 2. Troubleshooting Table of Contents

4. 3. Troubleshooting Guide

CONDITION & POSSIBLE CAUSES	*CORRECTIVE ACTION*
1. Pump will not start	
E-STOP Button Depressed	Pull out E-STOP button, push RESET button. Push PUMP START button.
Power Disconnected	Check to see if the main power is available. Check to see if the main power disconnect is ON.
Control Power Interrupted	Check the power supply circuit protection for a tripped breaker. Check the power supply (24vdc) input and output.
Protection Activated	Check for “ALARM” message (LOW OIL LEVEL, HIGH OIL TEMPERATURE, or HIGH TEMPERATURE BOOSTER PUMP).
Motor Overload Relay Tripped	Find the cause of the overload and reset the overload relay.
2. Console display fails to illuminate	
Main Power Disconnected	Check the main power.
Door Unlatched (locked out)	Check to see that the door disconnect switch is properly engaged.
Control Power Not Available	Check the power supply circuit protection for a tripped breaker. Check the power supply (24vdc) input and output.
3. Pump quit running	
Unsafe Operation Detected	Check for a fault indication on the operator’s console and correct the fault. LOW OIL LEVEL, HIGH OIL TEMPERATURE, LEAK CONDITON, or HIGH TEMPERATURE BOOSTER PUMP.
Electrical Power Interruption	Check the power supply circuit protection for a tripped breaker. Check the power supply (24vdc) input and output.
Motor Overload Relay Tripped	Identify the cause for the overload and reset the overload relay.
4. No control power (24vdc)	
Circuit Breaker Tripped	Check the input circuit breaker of the power supply. Check the output circuit breaker (24vdc) for the power supply.
Power Supply Fault	Check the power supply input and output voltages.

CONDITION & POSSIBLE CAUSES	*CORRECTIVE ACTION*

5. Alarm message on the operator's console

Oil Temp	Check to see that the hydraulic oil tank temperature is above 140^{O}F (60^{O} C). Check the cooling water flow to the heat exchanger. Adjust the water modulating valve.
Oil Level	Check the hydraulic oil level on the reservoir sight glass. Check for and correct the hydraulic oil leak, and add oil to the reservoir.
Booster Pump	Check the booster pump temperature to see if it is above 128^{O}F (53^{O}C). Check the cutting water flow to and from the booster pump. Check the water bypass orifice. You may be spending excessive time in the deadheaded condition.

6. High pressure water, abnormal signal fluctuation

Orifice Large/Worn/Damaged	Check to see that the orifice size do not exceed the capacity of the pump. Check to see that the orifices are in good working order and that the orifice is not missing.
Check Piping Leaks	Check system components for leaks including the dump valve condition.
Check Valve Leakage	Inspect the high pressure outlet check valves. Inspect the low pressure inlet check valves.
Check Seal Leakage	Inspect the plunger, sealing head seals.
Hydraulic Control Malfunction	Check the hydraulic valves operation. Verify that the 4-way reversing valve is shifting properly. Verify that the shift sensor is properly installed.

7. Hot surfaces on high pressure cylinder and components

H. P. Discharge Check Leaking	Inspect the check valve seat, poppet, spring and guide condition.
Low Pressure Inlet	Inspect the check valve inlet poppet and seat.
Plunger	Check the plunger seal for leaks and check the plunger for wear. Replace if necessary.
Damaged High Pressure Cylinder	Check the cylinder inside diameter for damage. Replace if any damage is found.

CONDITION & POSSIBLE CAUSES	*CORRECTIVE ACTION*

8. Oil and water leaks from weep holes, high pressure

Oil Leak at H. P. Intensifier	Check the hydraulic cylinder O-ring for leakage. Check the shift sensor area for oil leakage. Remove, inspect, replace or clean hydraulic seal.
Water Leak at the H. P. Plunger Seal	Replace the seal assembly. Check the plunger and follower if the leak is greater than 1 drop in 10 strokes. Check for scratches, circumferential or longitudinal grooves, or material build up on inside diameter of the High pressure cylinder. Replace immediately if any damage is found.
Water Leaks at the Check Valve Seal	Check the seal assembly. Check for scratches on the inside diameter of the High Pressure cylinder. Replace immediately if any damage is found.

9. Hot hydraulic oil

Restricted or No Cooling Flow	Check cooling water flow to and from the heat exchanger. Check the water pressure differential across the heat exchanger, 40 psi (2.75 bar) minimum is required for the flow through the exchanger. Check the operation of the water modulating valve.
Water inlet valve not open	Check and adjust the water inlet.
Heat Exchanger Clogged	Flush the heat exchanger, improve quality of cooling water.

10. Oil pressure is satisfactory, but water flow is insufficient

Worn high-pressure water seals, accompanied by water leakage	Replace the high-pressure water seals. Avoid operating the intensifier at a stroke rate higher than specified
Worn check valves	Rework or replace the check valves as required
Excessive water requirement	Reduce the number of nozzles in use or reduce the orifice size. Refer to the water flow rate chart.
Defective auto bleed down valve	Rework or replace the valve.

CONDITION & POSSIBLE CAUSES	*CORRECTIVE ACTION*

11. Oil pressure is satisfactory, but water pressure is low

Low Hydraulic Pressure Setting	If in LO pressure mode, turn the remote pressure switch to HI mode.
Restricted or No Cutting Water Supply	Check the cutting water supply flow and pressure.
Water Filter Clogged	Check the pressure differential at the filter gauges, and replace the elements if the difference exceeds 15 psi (1 bar) while the pump is operating.
Trapped Air	Bleed the air from the cutting water plumbing.
Leak in the high-pressure water lines	Inspect fittings for leakage and torque to specified torque values. Bleed down the high-pressure water system before servicing its components.
Worn hydraulic oil piston seal	Replace seals. H2O Jet recommends replacing all hydraulic oil seals at the same time.
Excessive demand for H.P. water	Reduce demand to rated output.
Worn check valves	Rework check valves.
Leaky high-pressure water seals	Replace seals.
Faulty high-pressure bleed-down	Rework or replace.

12. High pressure check valve leaks

If there are no visible high pressure water leaks, but there are higher temperatures on the high pressure cylinder or check valve, this is an indication of a high pressure or low pressure check valve leak. Use corrective action listed at right.	• Inspect the condition of the HP Check Valve and Seat. • Inspect the condition of the Inlet Check Valve and Seat. • Inspect the Check Valve Sealing Head for scratches or mechanical damage. Lap surfaces or replace if necessary.

13. Normal temperature, but the check valve is malfunctioning

Check the inlet high pressure valve	1. Follow the steps outlined in the “High Pressure Check Valves Leak” procedure. 2. A bad inlet check valve will be indicated by a piston moving after the shift sensor cables are reconnected.
Check the discharge high pressure check valve after completing the inlet check	1. Re-install all the high pressure plumbing and shift sensor cables. 2. Start the pump and then close the intensifier valve block assemblies. 3. Stop the pump and watch the high pressure gauge. 4. If the pressure drops, one of the four discharge check valves is leaking. 5. Determine which valve is leaking by inspection; look for erosion or uneven wear on the poppet or seat.

CONDITION & POSSIBLE CAUSES	*CORRECTIVE ACTION*

14. Pump/motor insert fails prematurely

Loose motor or hydraulic oil pump coupling halves	1. Check the position and torque of both motor and oil pump coupling halves. Make sure no obstruction is causing misalignment. 2. Replace the coupling insert. 3. Adjust the coupling halves if required. 4. Torque the set screws on the coupling halves.
Loose hydraulic oil pump mounting screws or hydraulic oil pump shaft misalignment	1. Torque the hydraulic oil pump mounting screws to the specified torque, making sure all mounting surfaces are free of debris and are not deformed. 2. Replace the coupling insert. 3. Adjust the coupling halves and torque the set screws.

15. Excessive pump noise, followed by a loss of oil pressure

Insufficient inlet hydraulic oil flow to the pump	1. Make sure the hydraulic oil reservoir gate valve is fully opened. 2. Make sure the hydraulic oil reservoir is full.
Malfunctioning hydraulic oil pump	1. Drain the hydraulic oil from the system. Replace the hydraulic oil and clean the reservoir whenever this service is performed. 2. Thoroughly clean the hydraulic oil system components. 3. Replace the hydraulic oil pump. 4. Replace the oil filter.
Water in oil	Drain oil from reservoir and inspect.

16. Hydraulic oil changes color and becomes foamy

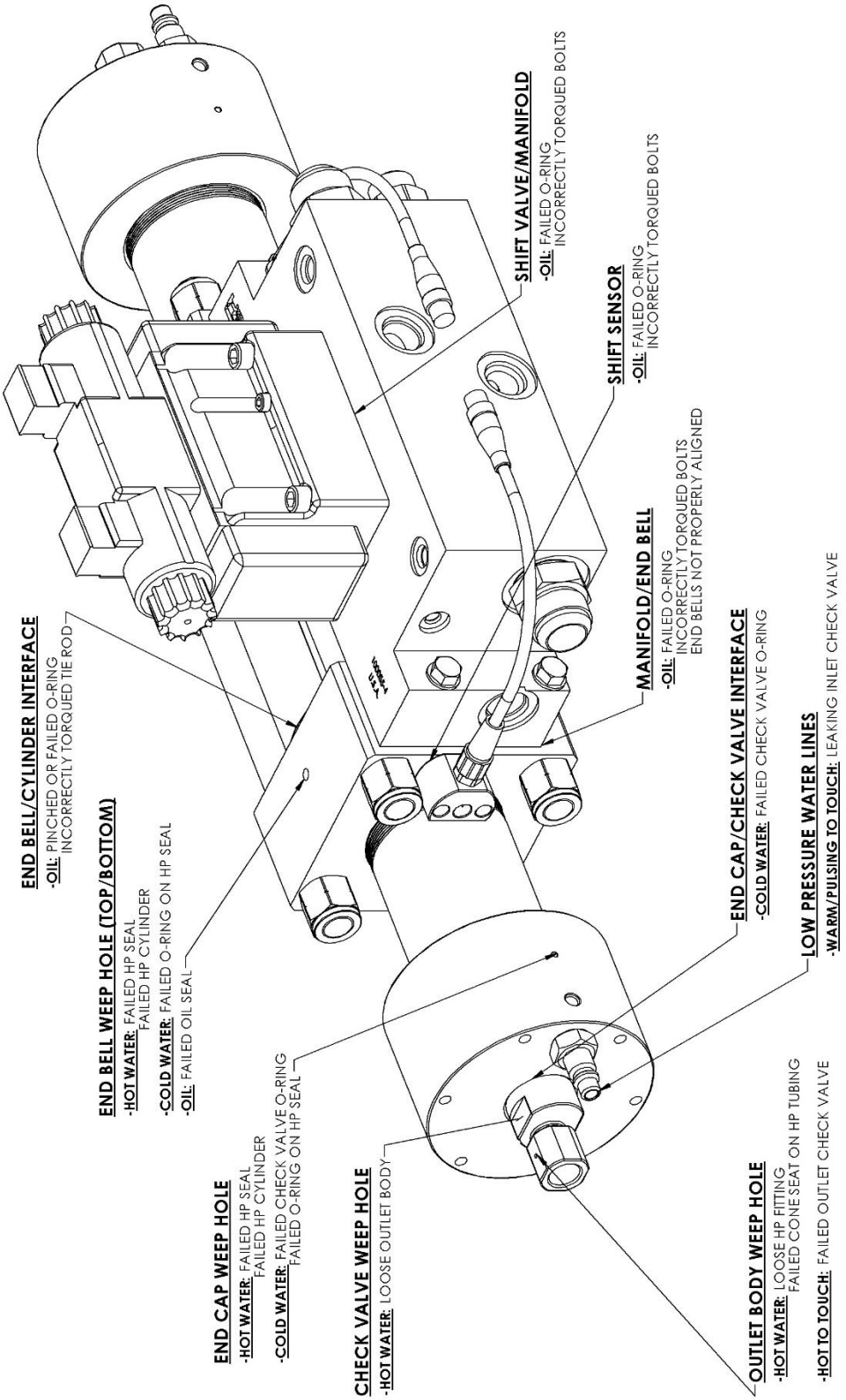
Leaky heat exchanger	1. Remove the heat exchanger. 2. Pressure test the heat exchanger; it must not leak when subjected to 150psi [10.34 bar] air pressure at ambient temperature. 3. If the heat exchanger is defective, replace it. Replace all hydraulic oil and seals. Clean the reservoir and replace the hydraulic filter. 4. If not defective, reinstall on the intensifier pump and check for a source of water vapor condensation.
Excessive water vapor condensation	1. Replace the hydraulic oil and thoroughly clean all lines. 2. Follow the recommended procedure for removing water vapor condensates.
Air leak in the suction line	Check for leaky fitting; tighten hose as required. Replace hose if necessary.
Faulty main system relief valve	Check the valve for excessive heat build-up. Repair or replace as required.

17. Oil contains metallic particles

CONDITION & POSSIBLE CAUSES	*CORRECTIVE ACTION*
The following are signs of excessive wear of the hydraulic oil cylinder; uneven stroking, sluggish shifting, lower stroking rate, unusually high hydraulic oil pump noise during shifting, a sudden drop in the intensifier's ability to meet the demand for high-pressure water, and severe pressure fluctuation in the output water.	
Excessive wear of the hydraulic oil cylinder	1. Immediately stop the intensifier pumps if one or more of the conditions listed above is present. 2. Disassemble the intensifier; inspect the components, and rebuild, replacing all worn parts. Inspect hoses. 3. Drain, thoroughly clean, and refill the hydraulic oil reservoir. (See the "Contaminated Hydraulic Oil System" service procedure 5.5.3.) 4. Replace the screen filter in the reservoir tank. 5. Replace the oil filter. 6. Reinstall the intensifier and return the equipment to service.
The following are signs of a faulty hydraulic oil pump; higher-than-usual audible pump noise, the pump is unable to maintain the rated hydraulic oil pressure, or loss of water pressure at no increase in water flow.	
Excessive wear of the hydraulic oil pump	1. Immediately stop the intensifier pumps if one or more of the symptoms listed above is present. 2. Replace the hydraulic oil pump after draining and thoroughly cleaning the hydraulic oil system. Refill the hydraulic oil reservoir. (See the "Contaminated Hydraulic Oil System" service procedure.) 3. Return the intensifier pump to service after replacing the hydraulic oil filter. Close the reservoir gate valve; remove the gravity feed oil supply line. Inspect for metal shavings; note the size and type.
Wrong type of hydraulic oil used	Replace with approved oil.

CONDITION & POSSIBLE CAUSES	*CORRECTIVE ACTION*
18. Water is leaking from high pressure tubing	
Excessive torsional movement or alternating load (relative movement of fitting components)	Re-torque the fitting to recommended torque values; repair or replace as required.
High pressure collar not placed properly	Allow 2 to 3 threads to be exposed between collar and tip.
Improper coning and/or threading of tubing	1. Refer to the procedure for coning and threading high-pressure tubing in Small High-Pressure Components manual. 2. Re-cone and rethread the leaky fitting if re-torquing does not eliminate the leakage.
Eroded fitting	Replace the fitting.
19. Orifice assembly life span is too short	
Clogged or ruptured delivery system component filter	Remove and inspect protective filters; replace if clogged or ruptured.
20. Oil is leaking around pump shaft	
Defective hydraulic oil pump seal	Replace the seal; check for leaks after replacement.
21. Intensifier cycles, but oil pressure is low or non-existent	
No hydraulic oil in the system	1. Immediately turn the intensifier pump off. 2. Examine all suction and delivery lines for leaking. Check the oil level in the reservoir, and open the suction line gate valve. Clean up any oil spillage.
Broken motor coupling	1. Remove the motor coupling cover plate and examine the coupling. 2. Replace the coupling insert or coupling halves as required.
Loss of pressure	Check the manual appendix section for the hydraulic pump information on loss of pressure.
Malfunctioning hydraulic oil pump compensator	Remove and replace the compensator valve.
Defective hydraulic oil pump	Remove and replace the hydraulic oil pump.

TROUBLESHOOTING GUIDE



4.5. Revision History

Date	Rev. Id.	Description of Change	Written by	Checked by	Approved by
May 8, 2006	0	First Publication	P. Spencer Norby	JN	HA
Mar. 31, 2015	A	Complete Manual Update	L. Jorgensen	M.H.	

5. Service Procedures

5.1 Service Procedures

- The service procedures are arranged in step-by-step instructions. Service instructions are not limited to replacing parts during scheduled or unscheduled maintenance. They also include preventative maintenance procedures to ensure trouble-free operation of the machinery.
- The various operating systems of the machine as well as its assemblies and subassemblies are covered in the manual. The illustrations shown can be used for reference and identification.

5.1.1 Service Tips

- Make a routine daily inspection of the entire machine before operating it. Visually check all parts of the machine for any abnormal condition. If any malfunction is noted, refer to the troubleshooting guide and the applicable service procedure to correct the problem.
- Read and thoroughly understand each service procedure before performing any maintenance. If you have questions or are unsure of proper procedure, contact the **H2O Jet** Pump Service Department.
- Read all the notes and the precautions in the service procedures.
- As may be applicable, turn off the electrical power and relieve the system pressure before performing any service function.
- Whenever a service is to be performed while the power to the equipment is turned on, or while the system is pressurized, take extra precautions to avoid potential injury.
- Routinely check for loose bolts or wire connections.
- Routinely check high-pressure water lines and fittings for leaks. High-pressure water leakage is wasted energy.
- Inspect all around the machine for parts, tools, and rags before operating the equipment.
- Make sure all the operating parts of the machine are clean.
- As applicable, make sure that the inlet water and cooling water valves are open and the high-pressure water bleed down valve is closed before putting the machine back into service.
- Maintain records of the service performed on the machinery. Such records will provide valuable information for reordering spare parts.
- Handle critical parts with care and avoid scratching or denting the high-pressure water system components.

5.1.2 Mechanical System Safety Tips

- Before starting the system, be sure you know how to stop it.
- Repair all leaks in pipes, tubing, fittings, or connections immediately.
- Never attempt to perform any maintenance functions or clean around the equipment while the system is in operation.
- Use the proper tools for the specific job. Using the wrong tools can result in injury or costly damage to the equipment.

- Be sure that all tools, parts and rags are cleared from any moving parts after servicing the equipment.
- Never climb on or around the equipment on makeshift devices. Use only approved catwalks, ladders or platforms.
- Be alert at all times when working around the equipment.
- During equipment maintenance, take the system out of service. The controls shall be properly locked and marked with a warning sign.

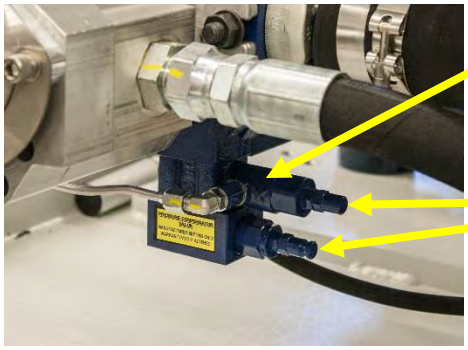
5.1.3 Electrical System Safety Tips

- Always assume that the power is on in all electrical systems. Make it a practice to check and lock out 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 is on, regardless of whether the E-STOP button is in or out.
- Electronic troubleshooting and servicing of electrical devices shall be performed only by properly trained personnel.
- Personnel shall take extra precautions when servicing the power system in a damp environment.
- Use proper tools. Make sure that tools are well insulated for the job.
- Disconnect circuit breakers and lock them in the OFF position before servicing the electrical system. If this is not possible, have someone stand ready in case of an emergency.
- Use only proper test apparatus; check it regularly for proper operation.
- Capacitors shall be given sufficient time to discharge or discharging shall be done manually and with care.
- Never alter or bypass protective interlocks or devices unless specifically instructed to do so and all precautions are followed.
- Any replacement wires shall conform to the manufacturer's specifications, including proper color coding, wire numbers, and size.
- Control panel doors or junction box covers must be closed after servicing.
- Do not use jumper wires across fuses or fuse holders.
- Use caution when connecting a test probe to test points.

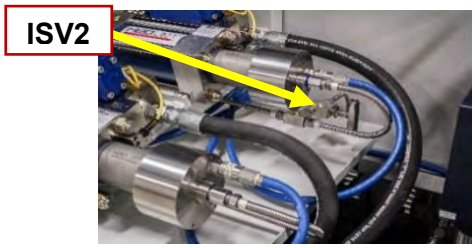
5.1.4 Hydraulic Oil and Water Valve Identification

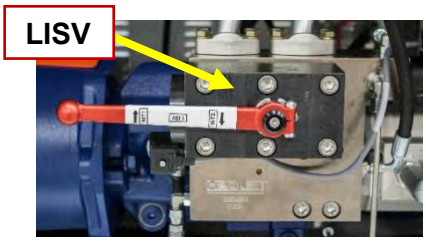
WARNING

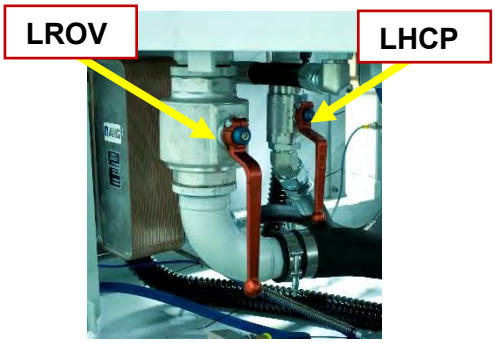
The pressure compensator valve on the main hydraulic pump is factory set for safety reasons and is not to be user adjusted. Tampering with this setting will void the warranty of the H2O Jet pump. The pressure compensator valve is located on the bottom of the main hydraulic pump. Pressure within the system could exceed ratings by as much as 66%.



Abbreviation Table	
INT1	Intensifier 1 (Front)
INT2	Intensifier 2 (Rear)
ISV1	Intensifier Switch Valve (Front) – HP Water
ISV2	Intensifier Switch Valve (Rear) – HP Water
LISV	Low-Pressure Intensifier Switch Valve – Hydraulic (Redundant Models Only)
LROV	Low-Pressure Reservoir On/Off Valve
LHCP	Low-Pressure Hydraulic Circulation Pump (Valve)







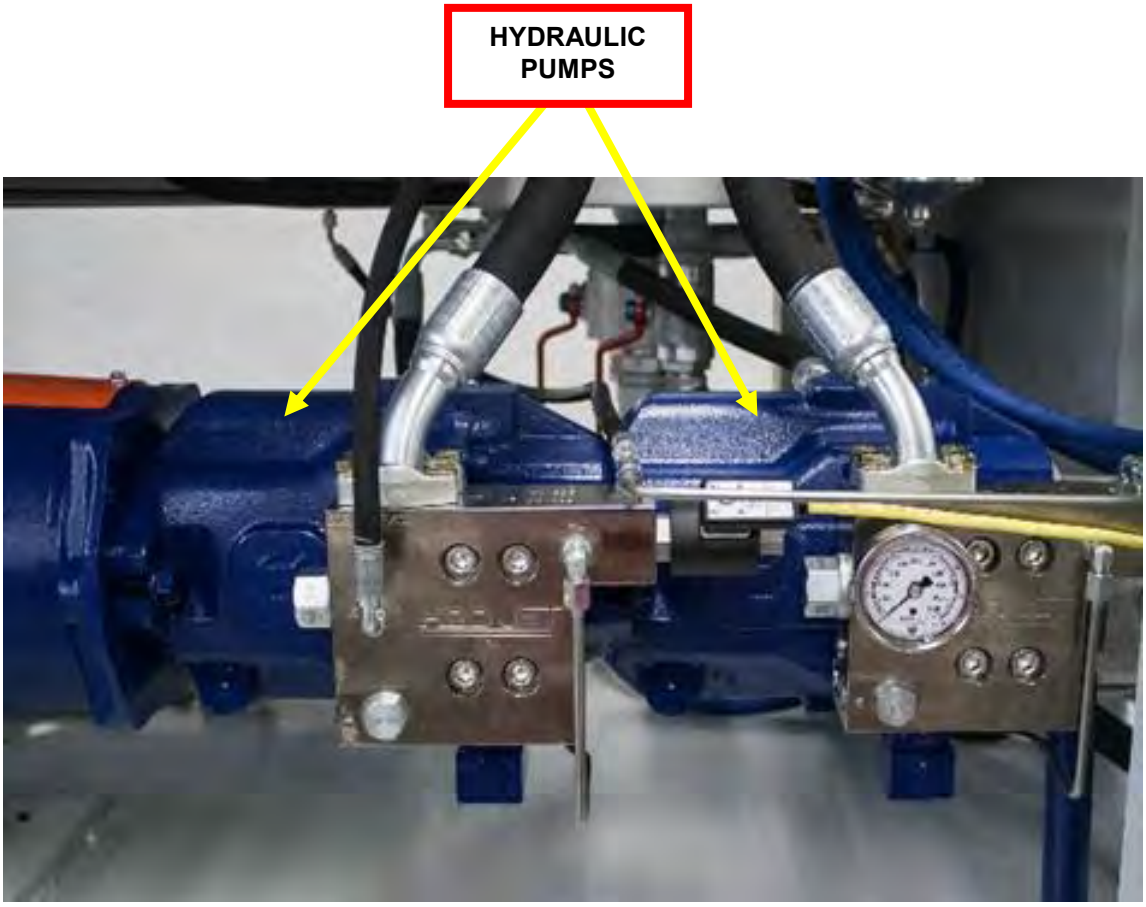
5.2 Main Hydraulic Oil Pump Service

A four cubic inch axial piston, variable displacement, pressure compensated oil pump is used to generate hydraulic oil pressure to operate the intensifier. The pump is connected directly to a 50 or 100 hp electrical motor by two coupling halves and a soft coupling insert. The pump requires no routine maintenance.

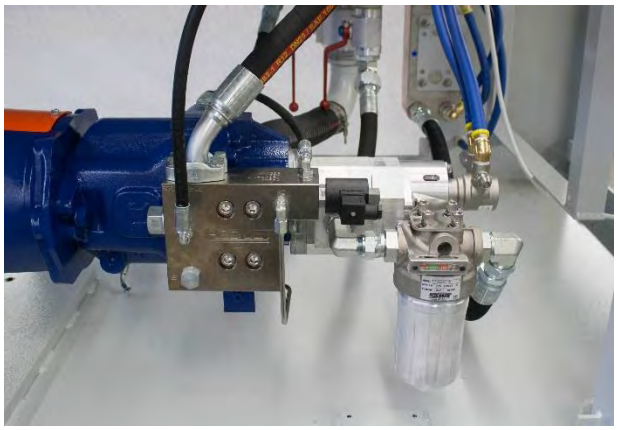
Problems associated with the pump are; leaks, noise, metallic debris in the hydraulic oil, and erratic or low oil pressure. To address these problems, this service procedure has been broken down into the following:

5.2.1 Pump Service Manual [See Appendix]
5.2.2 Replacing the Coupling Insert
5.2.3 Replacing the Hydraulic Oil Pump

If the pump is running normally and no unusual sounds are audible, but the hydraulic oil pressure will not reach the rated value, the oil pump compensator valve may be malfunctioning. If the oil pump reacts very slowly or overreacts to changes in demand, the compensator may need adjustment. Contact H2O Jet for assistance with adjusting the compensator valve, **DO NOT** attempt to adjust the valve on your own.

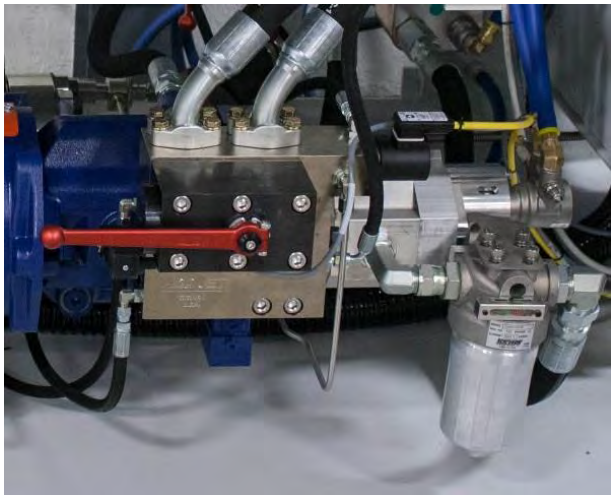


(100 HP Dual Casappa Pump Shown)



50 HP Single

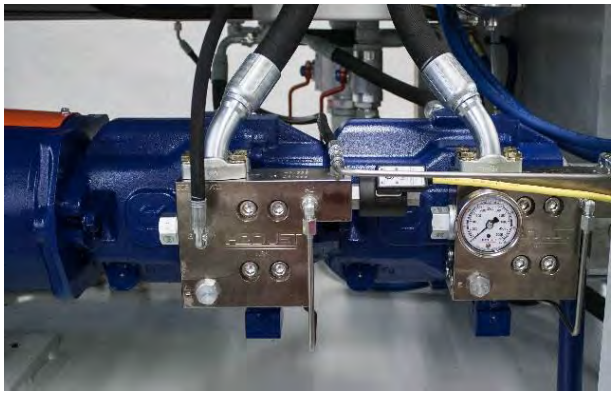
Having only one intensifier there is no switch valve for the proportional valve/manifold assembly.



50 HP Redundant

Note position of the Lower Intensifier Switch Valve (LISV) on the side of the Main Hydraulic Pump

Handle down is for the front intensifier.
Handle left is for the rear intensifier.



100 HP Dual

Having dual intensifiers, there is no switch valve for the proportional valve/manifold assembly

5.2.2 Replacing the Coupling Insert

Replace the coupling whenever it begins to; deteriorate, becomes too loose, and/or becomes noisy. The coupling insert is replaced by unbolting the pump from the motor, sliding the pump back approximately 3 inches [76 mm], and replacing the insert.

WARNING

Place the main electrical disconnect in the OFF position and bleed down all high-pressure lines. Place an "Out of Service" tag on the main electrical disconnect and lock it out. Failure to do so may result in damage to equipment or injury to personnel.

1. Shut down the system.
2. Open the front and side access doors and identify the major components.
3. Support the oil pump to allow it to be pulled from the motor at least 3 inches [76mm]. Although blocking and/or jack can be used to support the pump (it may weigh in excess of 140 lbs [64 kg] for the 100 hp pump and 75 lbs [34 kg] for the 50 hp pump) , a forklift can also be used by trained, experienced personnel.
4. Remove the four bolts mounting the adapter to the electric motor and slide the housing away from the electric motor to facilitate access.
5. Remove the old coupling insert and check for any looseness in the couplings. Check that the coupling halves are clean and place the new coupling insert into one of the coupling halves.
6. Inspect the couplings to make sure they are not too tight or pressing against the housing walls. Couplings must be able to spin without contacting the housing.
7. Slide the pump and adapter back up to the electric motor and install the four bolts. Torque to bolt specifications using a figure-eight pattern.
8. Close all access doors.
9. Check all around the pump for tools, parts, and rags. When all is clear, start the pump and operate for five minutes.
10. When all work is satisfactory, the pump is ready for routine operation.

5.2.3 Replacing the Main Hydraulic Pump

Replace the hydraulic oil pump if one of following conditions exists:

- An unusual noise is present
- Low oil pressure exists
- Metallic flakes are found in the hydraulic oil

As with any oil pump service, expect oil spillage. When the factory floor drains must be oil-free, install a barrier to prevent oil passage. Oil spillage can be limited to a few drops by using drip pans, plugging each line and port with a plastic cap or rubber plug, and allowing a generous "drip time."

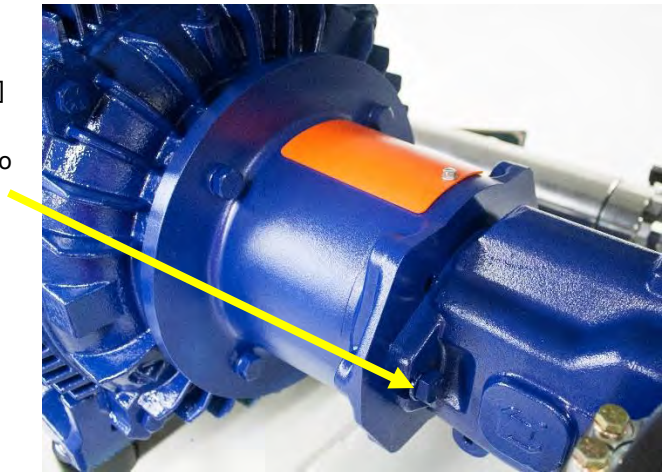
CAUTION

If the oil pump is being replaces because of catastrophic failure of the oil pump that resulted in a contaminated hydraulic oil system, see "Contaminated Hydraulic Oil System" at the end of this service procedure.

WARNING

Place the main electrical disconnect in the OFF position and bleed down all high-pressure lines. Place an "Out of Service" tag on the main electrical disconnect and lock it out. Failure to do so may result in damage to equipment or injury to personnel.

1. Shut down the system.
2. Open the front and side access doors and identify the major components.
3. Place drip pans under the oil pump.
4. Close the reservoir shutoff valves [LROV and LHCP]
5. Remove the Recirculation pump as per its instructions in section 5.3.
6. Remove the plug from the bottom of the hydraulic oil pump and drain completely.
7. Loosen the oil pump suction line at the lowest point to drain the oil from the line and pump.
8. Remove the system pressure line. Plug and secure the lines out of the way.
9. Remove the case drain line. Plug and secure the line out of the way.
10. Remove the pressure control valve [compensator] line. Plug and secure the line out of the way.
11. Remove the two [2] bolts that attach the adapter to the pump; remove the adapter.

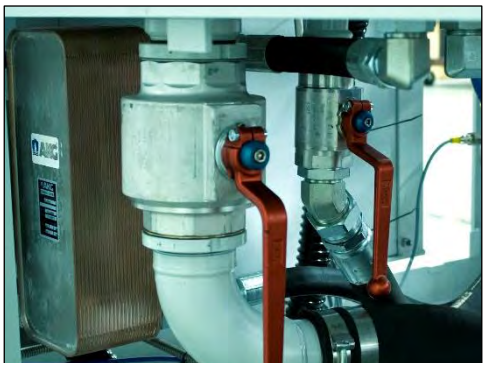


12. Support the oil pump to allow it to be pulled away from the motor at least 3 inches [76 mm]. Although blocking and/or jacks can be used to support the pump. It may weigh in excess of 140 lbs [64 kg] for the 100 hp pump and 75 lbs [34 kg] for the 50 hp pump. A forklift can also be used by trained, experienced personnel.
13. Carefully maneuver the pump away from the adapter. The Coupler will separate inside the adapter. Set the pump on blocks as it will roll otherwise.

NOTE: The pump assembly can weigh more than 140 lbs [64kg]. Use caution when removing the assembly from the pump frame.

14. Measure the coupling location on the pump shaft. It is important to get it in the same location
15. Loosen the set screw and remove the coupling half. If you can't easily remove the coupling, use a gear puller. Retain the shaft key.
16. Slide the coupling onto the splines new pump shaft.
17. Transfer all the fittings to the new pump if a new pump is being installed.
18. Maneuver the pump into the frame and up to the motor. Make sure the coupling insert has remained in place.
19. Install the two bolts that attach the hydraulic pump to the adapter and tighten.
20. Inspect the couplings to make sure they are not too tight and are not pressing against the housing walls. Couplings must be able to spin without touching the housing.
21. Connect the pump case drain, system pressure, and suction lines. When making the connections, be sure the lines are not twisted and all fittings are correctly oriented to minimize stress on the lines. Lubricate the O-rings with Parker Super O Lube or clean hydraulic oil.
22. Reinstall the recirculation pump as per the instruction in section 5.3.
23. Make sure all tools, parts and rags are removed from the pump.
24. Open the reservoir shutoff valves to supply oil to the pump.
25. Oil pump seals are easily damaged by operating the pump while air is trapped in the pump cavities. To purge air from the pump, successively press the start and stop buttons on the console to jog the pump. The pump should pick up pressure after 4 or 5 jogs. If it does not, check that the reservoir shutoff is open, and the reservoir contains oil.
26. Operate the pump at idle 500 psi [34 bar] for 3 to 5 minutes while checking for leaks. Increase the pressure slowly to maximum rated value while checking for leaks.
27. After operating the pump for 7 to 10 minutes and all work is satisfactory, shut down the pump.
28. Check all around the pump for tools, parts, and rags, and remove the "Out of Service" tag from the main electrical disconnect.
29. The pump can be returned to routine operation

5.3 Recirculation Pump Replacement



1. Open the back access panel. Shut off both valves on the bottom of the reservoir tank. The large one (LROV) feeds the main hydraulic pump. The small valve (LHCP) feeds the recirculation pump.
2. Open the front access panel and remove the water booster pump and its adapter according to the directions given in section 5.16.2.
3. Remove and cap the hoses from the recirculation pump. Have caps ready as the reservoir will drain back through the line from the heat exchanger.
4. The recirculation pump is held in place by two bolts. Support the pump as the bolts are loosened.
5. The shaft connection is a simple keyed shaft. Be careful to retain the shaft key as the unit is pulled away from the main hydraulic pump.
6. Lightly coat the shaft and key of the new recirculation pump with white grease.
7. Carefully slide the new pump into place, making sure to align the keyed shaft as it enters the main hydraulic pump housing.
8. Bolt the recirculation pump to the main hydraulic pump.
9. Remove caps and reinstall all hydraulic hoses and tighten clamps.
10. Reinstall water booster pump as directed in section 5.16.2
11. Open both valves on the bottom of the oil reservoir.
12. Check all hydraulic fittings for leak.
13. Recheck fittings on water booster pump.
14. Purge trapped air from the hydraulic system before operating the pump continuously. Jog the pump by successively pressing the START AND STOP buttons and then wait a few moments after each jog until an audible change indicates that the pump is filled with oil. If the hydraulic pump fails to pick up pressure after four or five jogs, make sure the oil reservoir is full and the ball valve is open.
15. Inspect area for tools, rags and spills before closing cabinet.

5.4 Electronic Pressure Control

The electronic pressure control system is complex and fully integrated. The diagnostic procedure for the system would be very lengthy to print and follow. If your H2O Jet Pump develops a pressure control problem you cannot diagnose after checking electrical connections please call H2O for technical assistance and one of our technicians will walk you through the diagnosis procedure for your pump.

5.5 Hydraulic Oil Service

The hydraulic oil must be checked after a predetermined number of operating hours, at the end of a specific time period, whenever the oil has become contaminated, or the oil pump is replaced. Refer to “Periodic Maintenance Schedule”.

5.5.1 Service Steps

1. Once a month, open the drain valve on the bottom of the tank. Allow the oil to drain into a clear beaker until pure oil is evident, and then recap the drain valve. Place the beaker on a level surface and allow the oil to settle for at least 10 minutes.
2. After 10 minutes, clean hydraulic oil will appear to be floating on a small quantity of water. The water is condensation from the air drawn into the reservoir as the oil cools. If the water within the beaker exceeds 200 ml per month, drain the water from the reservoir according to the above procedure every 2 to 3 weeks or as is required to maintain a condensate level less than 200 ml.
3. Under normal operating conditions, the oil should be replaced every 4000 hours.

Muddy-looking oil can indicate that an excessive amount of water is present in the oil. Make sure the oil filler cap is in place and is keeping out all water. Check the heat exchanger for leaks. Resolve the problem and change the oil according to the steps listed below before returning the pump to routine operation.

If the oil has a burnt color or smell, or if there is debris in the sample, additional service work is required. See the “Hydraulic Oil Pump” service procedure for more information.

5.5.2 Changing the Hydraulic Oil

The following is the accepted procedure for changing the hydraulic oil.

WARNING

Place the main electrical disconnect in the OFF position and bleed down all high-pressure lines. Place an “Out of Service” tag on the main electrical disconnect and lock it out. Failure to do so may result in damage to equipment or injury to personnel.

If the oil is being changed after a pump or hydraulic piston failure where the oil has become contaminated with metallic debris, follow the “Contaminated Hydraulic Oil System” service procedure. 5.5.3.

1. Shut down the system
2. Remove the back panel and locate the reservoir drain valve located on the bottom of the reservoir.

3. Connect a length of hose to the valve to allow the oil to be drained into a container. The reservoir can contain as much as 80 gallons of liquid.
4. When the oil has stopped draining, flush the reservoir by pouring 1 to 2 gal [3.8 to 7.61 liters] of fresh oil into the reservoir through the oil filler opening. Watch the oil for dirt and cloudiness as it drains from the reservoir. Repeat this procedure until the oil drains clean.
5. Change the hydraulic oil filter. See the “Hydraulic Oil Filter” service procedure for instructions.

CAUTION

Failure to completely clean the hydraulic oil system after metal flakes have been pumped through it may lead to failure of a new pump, hydraulic oil cylinder, shift valve, pilot valve, shift cables, pressure control valves, and other components.

6. Remove and replace the in-tank Strainers, PN 606115-20 and 606115-40.
7. Close the drain valve and refill the reservoir with fresh hydraulic oil. The following are the only acceptable oils:
    a. Chevron Rando HD 46
    b. Conoco Megaflow AW 46
    c. Mobil DTE-25 Medium
    d. Shell Telus S2 M 46
    e. Agip Arnica 46
8. Fill the reservoir to the proper level. The reservoir can hold up to 80 gallons [303 L]. (Note: Oil from a new drum does not meet cleanliness requirements of the hydraulic system. It is important to use an oil transfer pump that will force oil through a filter into the reservoir.)
9. Oil pump seals are easily damaged by operating the pump while air is trapped in the pump cavities. To purge air from the pump, successively press the start and stop buttons on the console to jog the pump. The pump should pick up pressure after 4 or 5 jogs. If it does not, check that the reservoir shutoff is open, and the reservoir contains oil.
10. Operate the pump for 3 to 5 minutes at the maximum rated pressure and check for leaks.

CAUTION

Operating the pump under full pressure before all air is purged from the system may damage the pump seals.

11. When all work is satisfactory, make a final inspection around the pump for tools, parts, and rags, and then replace the back panel.
12. Remove the “Out of Service” tag from the main electrical disconnect.

    The pump can be returned to routine operation.

5.5.3 Contaminated Hydraulic Oil

When the hydraulic oil pump is being replaced because of catastrophic failure (metal flakes are evident throughout the hydraulic oil system), several additional steps must be taken.

CAUTION

Failure to completely clean the hydraulic oil system after metal flakes have been pumped through it may lead to failure of a new pump, hydraulic oil cylinder, shift valve, pilot valve, pressure control valves, and other components.

WARNING

Place the main electrical disconnect in the OFF position and bleed down all high-pressure lines. Place an "Out of Service" tag on the main electrical disconnect and lock it out. Failure to do so may result in damage to equipment or injury to personnel.

Service Steps:

1. Shut down the system.
2. Remove the covers from the reservoir and completely clean the interior.
3. Remove **ALL** hydraulic oil hoses:
    - Bypass
    - Suction
    - System pressure
    - Pressure control valve
    - Slow start
    - Dual pressure
    - Manifold
4. Pour fresh oil through all loose lines (hoses) to clean and flush out the old oil.
5. Flush the hydraulic oil pump by pouring fresh oil in the top of the pump and hand rotating the couplers to move the fresh oil into the pump.
6. Remove the heat exchanger. Test the heat exchanger for leaks as described in the "Heat Exchanger Service" procedure. If the heat exchanger is faulty, replace it.
7. Remove the oil filter and discard. Remove the 2 in-tank strainers. Thoroughly clean the strainers and reinstall. Install a new filter.
8. Remove the shift valve, pilot valve, and manifold. Completely clean and flush with fresh oil.
9. Remove the pressure control valve, relief valve, and lines. Flush with fresh oil.
10. Remove the intensifier and disassemble the hydraulic oil cylinder. Inspect for seal failure. Replace parts as needed. Completely clean the intensifier and the hydraulic oil cylinder.
11. Reassemble the hydraulic system. Fill the system with clean oil.

12. Operating the pump while air is trapped in the pump cavities can easily damage the oil pump. To purge air from the pump, successively press the start and stop buttons on the console to jog the pump. The pump should pick up pressure after 4 or 5 jogs. If it does not, check that the reservoir shutoff is open, and the reservoir contains oil.
13. Operate the pump at idle 500 psi [34 bar] for 3 to 5 minutes while checking for leaks. Increase the pressure slowly to maximum rated value while checking for leaks.

NOTE: After servicing the hydraulic system, the oil level may be lowered. Check the reservoir oil level and add oil as needed.

14. After operating the pump for 7 to 10 minutes and all work is satisfactory, shut down the pump.
15. Check all around the pump for tools, parts, and rags, and remove the “Out of Service” tag from the main electrical disconnect.

The pump can be returned to routine operation. After operating the pump with fresh oil for 10 to 20 hours, drain the reservoir and refill with fresh hydraulic oil.

5.6 Hydraulic Oil Filter Service

Replace the hydraulic oil filter for any of the following reasons:

- After a specific number of operating hours; or
- A specific time period has elapsed; or
- The hydraulic oil is changed; or
- The Service Indicator on the side of the Filter Head points to the red region.
- The filter is external type spin on unit filtering the recirculation line. It is located near the Hydraulic Pump.
- Under normal operating conditions the oil filter should be replaced every 2000 hours.

WARNING

Place the main electrical disconnect in the OFF position and bleed down all high-pressure lines. Place an “Out of Service” tag on the main electrical disconnect and lock it out. Failure to do so may result in damage to equipment or injury to personnel.

1. Shut down the system.

2. Locate the oil filter assembly.

   (Note the visual service indicator- if the float is in the red region during operation, this indicates a clogged filter.)

3. Close the LHCP Valve.
4. Place a drip pan under filter.
5. Using 15/16” wrench, unscrew filter housing. Remove filter cartridge and place in drip pan.
6. Lubricate the new filter O-ring with Parker Super O-Lube (P/N 400001-1) or fresh hydraulic oil and place into filter housing.
7. Spin on filter housing. Using the 15/16” wrench tighten filter housing to 35 ft-lbs (47Nm).
8. Open the LHCP Valve.
9. Use the normal start up procedure to reach the full operating pressure. Operate the pump for 3 to 5 minutes at the maximum rated pressure and check for leaks
10. When all the work is satisfactory, make a final inspection for tools, parts, and rags. The cover can now be closed.
11. Remove the “Out of Service” tag from the main electrical disconnect.

The pump is ready for routine operation.

5.7 Piping Torque Specifications

Refer to the Torque Specifications Table below when specific torque requirements for high pressure water components and connections are not listed in a specific service procedure. Mounting bolts and machine screws shall not be torqued beyond the manufacturer's recommended limits.

PIPING TORQUE SPECIFICATIONS TABLE		
COMPONENT	**U.S. [ft-lbs]**	**SI [Nm]**
High–Pressure Fittings		
High-Pressure Gland Nut [1/4"]	15-25	20-34
High-Pressure Gland Nut [3/8"]	35-45	47-60
High-Pressure Gland Nut [9/16"]	60-75	80-100

The torque values for high-pressure water assemblies and fittings are listed in U.S. Customary System foot-pounds [ft-lbs] and International System [SI] Newton-meters [Nm].

WARNING

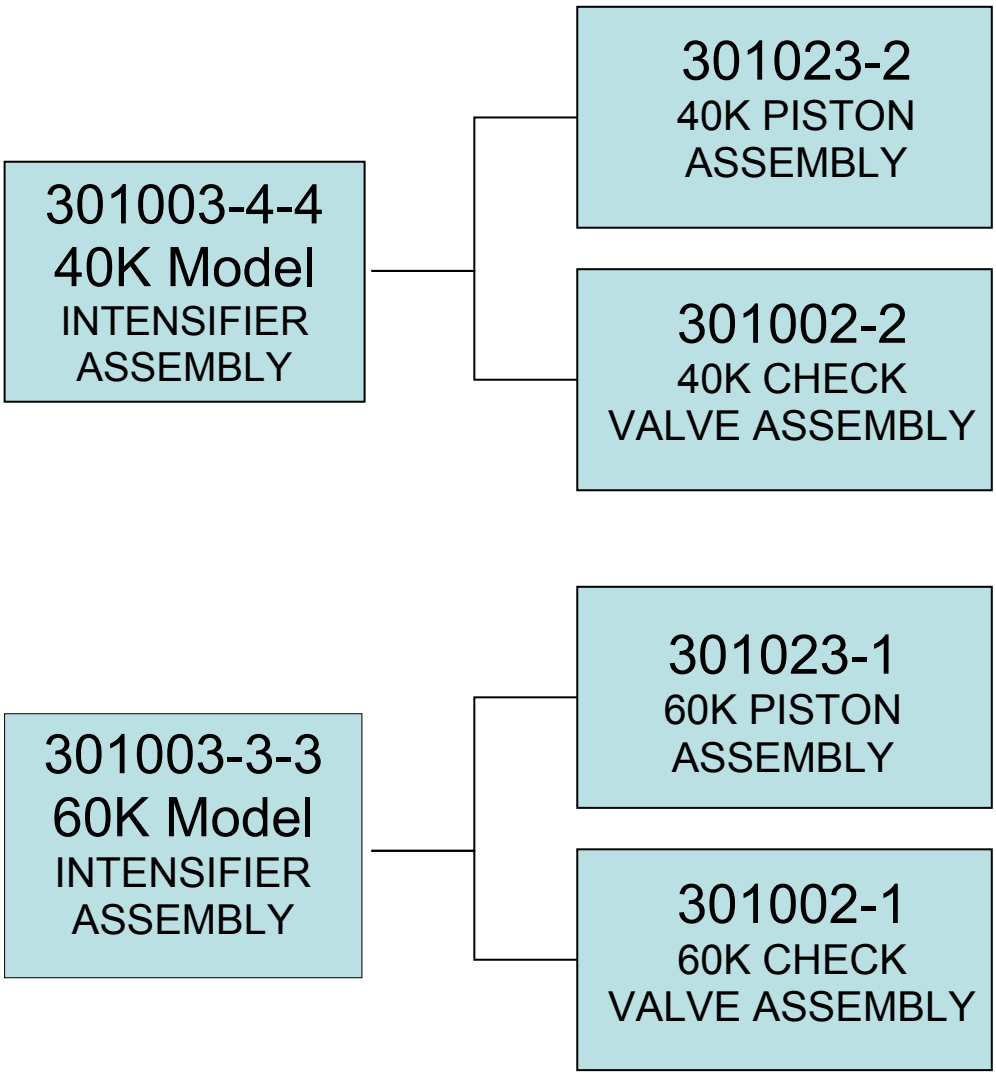
Threads for all high-pressure connections must be lubricated with Blue Lubricant P/N 400001-1 or severe damage may occur.

5.8 Intensifier Service

Detailed instructions are provided on disassembly and reassembly of the hydraulic intensifier, including high pressure seal maintenance. A discussion of detailed inspection and repair for individual high pressure subassemblies is also provided. The high pressure Attenuator is discussed but no disassembly procedures are included since Attenuators are not serviceable by the customer.

5.8.1 Drawings Tree for 40K and 60K Intensifier Assemblies

If you have reason to order drawings of the Intensifier and the piston and check valve subassemblies please follow the Drawing Tree below. Note that these are for the Intensifier itself and do not include the Shift Valve and Pilot Valve assemblies.



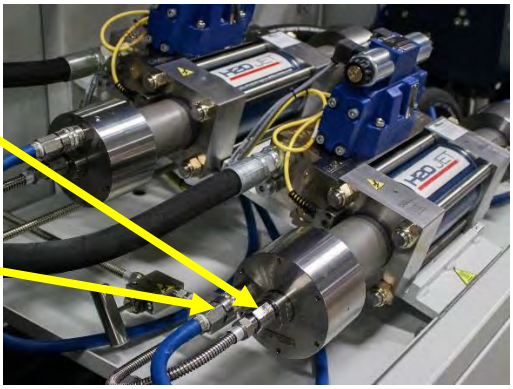
5.8.2 High Pressure and Low Pressure Piping

Disconnect from/Reconnect to Intensifier Pump:

WARNING

Before performing maintenance on the waterjet pump, observe motor starter lockout/tagout procedures.

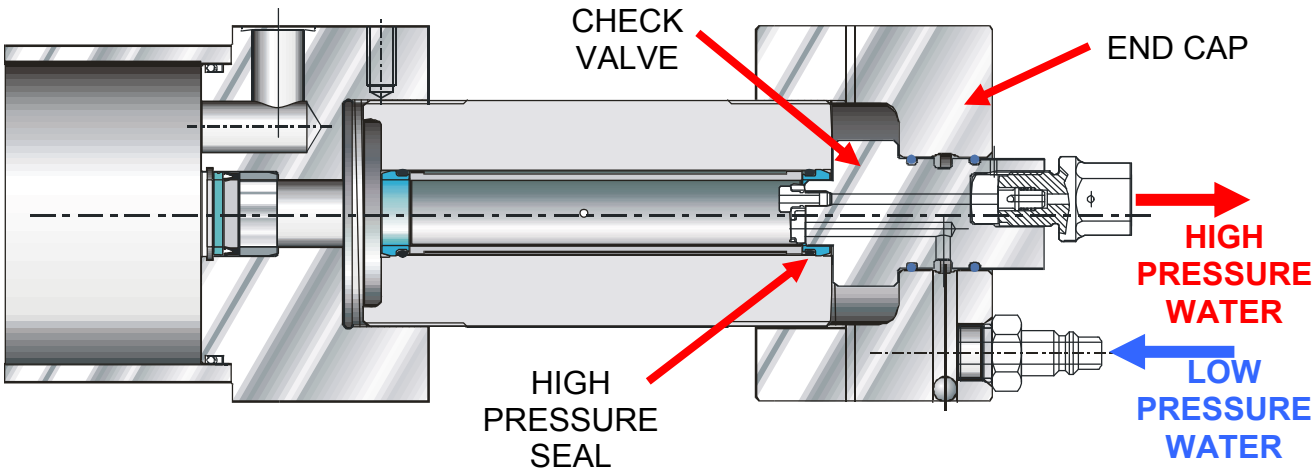
1. With an open end wrench, loosen and remove the high pressure piping attached to discharge high pressure check valve. Move tubing to clear work area.
2. Remove the low pressure water quick disconnect.



3. The End Cap can be removed with the discharge high pressure check valve attached. For service of the discharge high pressure check valve on the intensifier assembly, refer to section 5.9.1 “Discharge High Pressure Check Valve”.

WARNING

The H2O Jet Redundant Pump must not be operated with one Intensifier removed.



4. With the high pressure piping and the low pressure cutting water plumbing disconnected, the following operations can be performed:
    a. The End Cap can be removed from the High Pressure Cylinder
    b. High Pressure Cylinder can be removed from the End Bell

5. After the pump has been re-assembled, the high pressure water piping and low pressure quick disconnect can be re-attached.

6. Install the high pressure water piping. Tighten high pressure connections using a 13/16” wrench. Also use a backup wrench when tightening the high pressure connection. Re-attach the low pressure quick disconnect hose and turn on cutting water supply and check for low pressure leaks.

CAUTION

Check that all shift sensors are properly installed prior to starting the motor.

7. Start the H2O Jet Waterjet Pump. Operate at low pressure [without a cutting orifice] to flush the high pressure passages, and then operate the pump at high pressure with orifice installed to check for leaks.

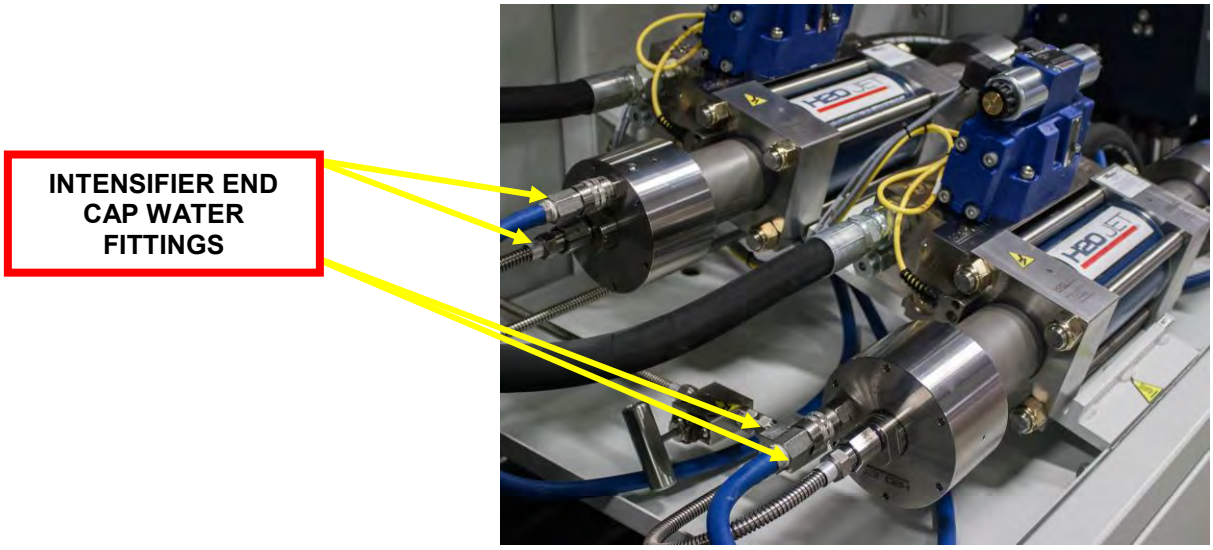
5.8.3 High Pressure End Cap: Removal & Installation

WARNING

Place the main electrical disconnect in the OFF position and bleed down all high-pressure lines. Place an "Out of Service" tag on the main electrical disconnect and lock it out. Failure to do so may result in damage to equipment or injury to personnel.

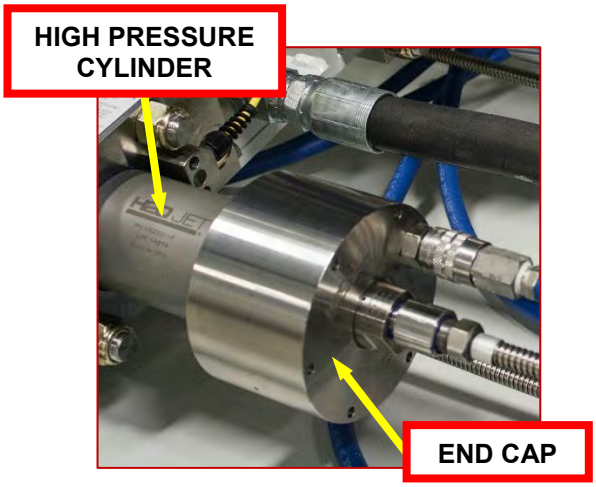
1. Shut down the system.

2. Remove low pressure and high pressure piping from the end cap. Low pressure lines are quick disconnects and blue rubber hose



3. With a pin spanner wrench, turn the End Cap counter-clockwise, breaking the End Cap loose [tapping the spanner wrench with a plastic mallet may be required]. Continue to unscrew the End Cap until it is removed. It is best if you also remove the check valve assembly at the same time.

   If the Cylinder and End Cap unscrew from the end bell together, hold the HP cylinder stationary with the Cylinder Wrench and tap the spanner wrench to loosen the End Cap.



4. After you have completed any maintenance to the End Cap or the Check Valve Assembly, you can reassemble them to the High Pressure Cylinder.

   Apply anti-seize goop on the flat end of the High Pressure Cylinder [see picture below right] and then on the shoulders of the check valve.

   Place the check valve into the High Pressure Cylinder and then thread the End Cap on. Turn the End Cap clockwise until it bottoms out and then tighten it with a spanner wrench using only your hands. Any torque greater than this could cause problems the next time you want to service the End Bell.

5. Tighten the end cap using one of the two methods below:

   Using Spanner Wrench: Place the spanner wrench in the end cap holes. Lightly tap the spanner wrench with a dead blow hammer. Do not over tighten. Any torque greater that this could cause problems next time you want to service the End Bell.

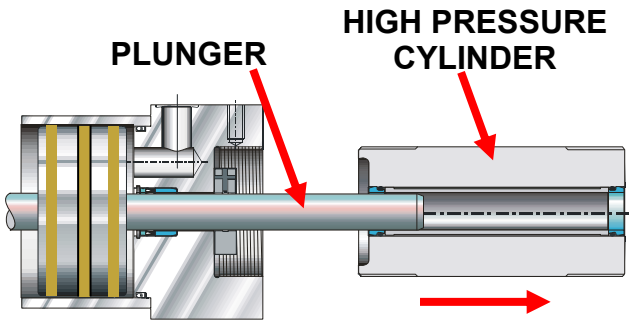
   Using H2O Jet Torque Tool: Place the torque tool on end cap, and torque to 85 ft-lbs [115NM].

5.8.4 High Pressure Cylinder: Removal & Installation

The High Pressure Cylinder can be unthreaded from the cylinder head either with or without its End Cap and check valve assembly still attached, although it is recommended that the End Cap and check valve assembly be removed first. We also recommend the following procedure because of the combined weights of the parts.

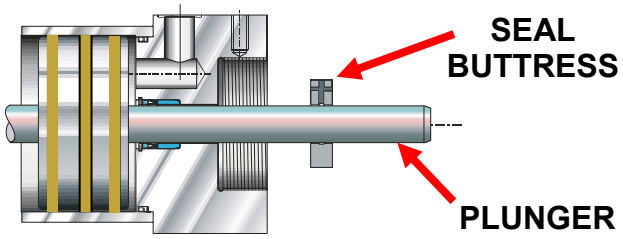
1. Remove End Cap from the High Pressure Cylinder by following procedures outlined in Section 5.8.3.

2. Unthread the High Pressure Cylinder from the End Bell using a HP cylinder wrench. Support the weight of the cylinder until it completely clears the plunger. The High Pressure Cylinder is heavy and can damage the plunger or cause injury if it is not supported correctly.

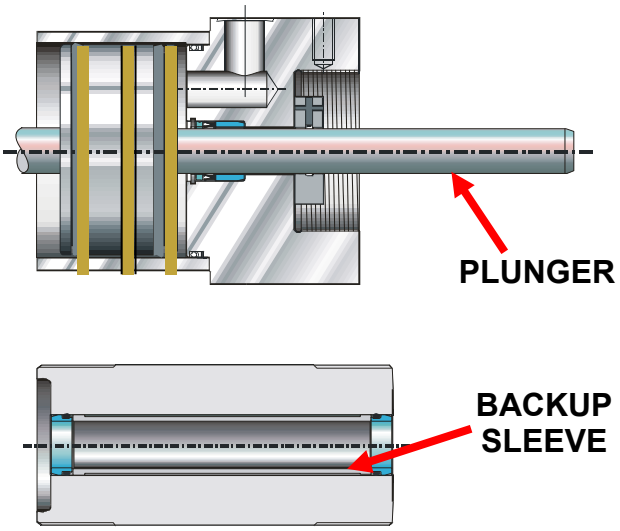


3. With the High Pressure Cylinder removed, the high pressure seals can be serviced and the High Pressure Cylinder Backup Sleeve can be inspected and polished.

4. Remove the Seal Buttress from End Bell. Wipe and clean surfaces, weep holes, and grooves in Seal Buttress flange and check the flange for cracks.



5. Prior to installing new plunger high pressure seals, the following tasks should be accomplished, as necessary:
   - Inspect plunger's exposed surface for scratches, surface discoloration, or unusual contact markings. Remove and replace plunger.
   - Inspect and polish High Pressure Cylinder Backup Sleeve as described later in this section.



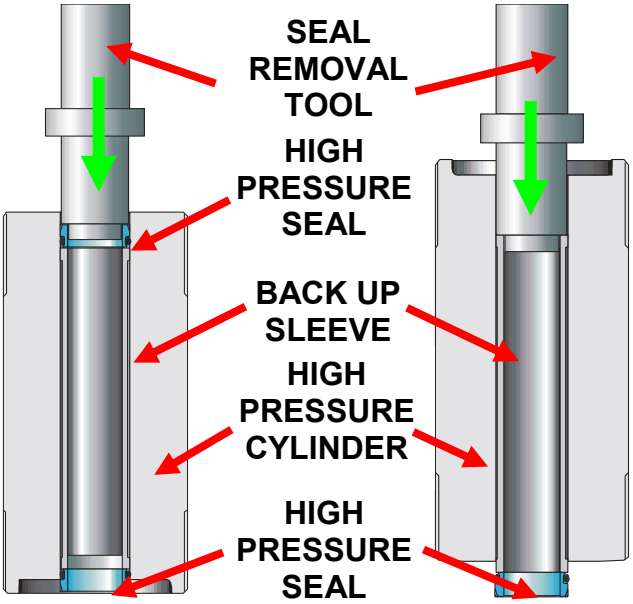
6. Inspect the High Pressure Cylinder threads and apply Anti-Seize Goop to the threads and shoulder guides. Be careful not to slam the High Pressure Cylinder up against the End Bell because this could damage the threads. Screw the High Pressure Cylinder into the hydraulic cylinder head. Note that shoulder guides are close fitting smooth diameters located at either end of cylinder threads. Be sure to support the weight of the High Pressure Cylinder. As the high pressure plunger goes into the cylinder, the cylinder will become difficult to rotate. Use the special cylinder wrench to assist, as necessary.
7. Tighten the High Pressure Cylinder hand tight. Do not tighten any tighter than hand tight.
8. Follow the procedure in section 5.8.3 for installation of the End Caps.

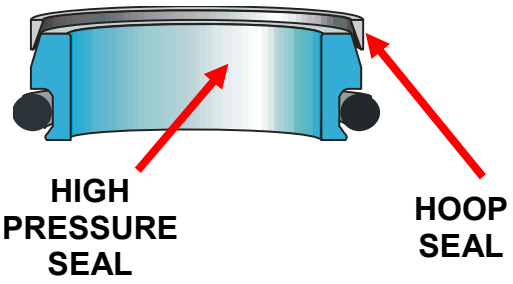
5.8.5 High Pressure Cylinder Seals: Removal & Installation

1. Remove the high pressure and low pressure water lines using the procedure described in **Section 5.8.2.**
2. Remove the End Cap using the procedure described in **Section 5.8.3.**
3. Remove the High Pressure Cylinder using the procedure described in **Section 5.8.4.**

4. Remove one of the High Pressure Seal and Hoop Seal from the High Pressure Cylinder using the special aluminum seal removal tool and a plastic faced mallet. Be extremely careful not to scratch the bore of the High Pressure Cylinder during this process.

Note: Failure to follow this procedure will result in dramatically reduced cylinder life and will void the warranty. Do not use any other method or tool to remove the seals.



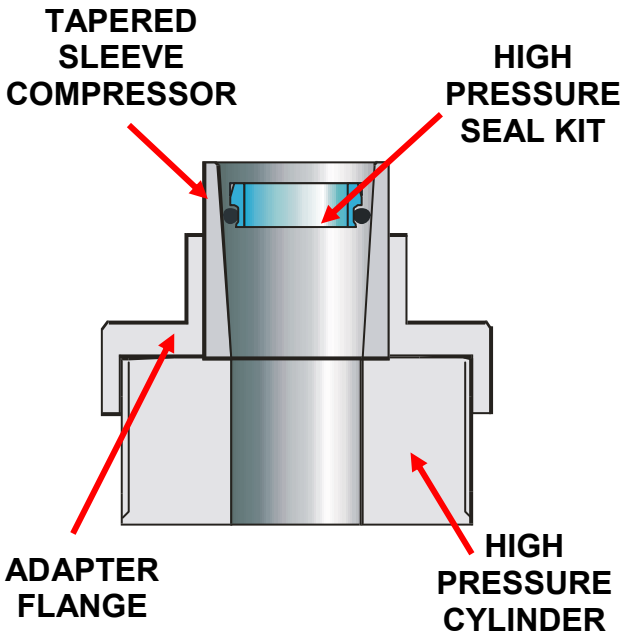


5. Turn the High Pressure Cylinder over and repeat the process to remove the second seal.
6. Once the High Pressure Seals are removed, the Backup Sleeve can be examined for wear.
7. Clean the sealing areas of the High Pressure Cylinder inside diameter and inspect the cylinder for rings, scratches, pits, and residue build-up forming a ring. Running a fingernail across the ring will cause it to appear as a surface flaw. It is usually necessary to clean the area before performing an inspection.

Note: The High Pressure Cylinder ends often show a “step” between the backup sleeves and high pressure seals where the two overlap by a small amount. This is normal and does not indicate a flaw in the cylinder.

8. Installation of the high pressure seals is a little more complicated and requires the use of the Adapter Flange and Tapered Insert Sleeve Compressor.
9. Remove high pressure seals, o-rings, and hoop seals from their packaging. Place the red o-ring onto the blue high pressure seal in the o-ring grove. The o-ring is pre-lubed, there is no need to add food grade lube here. Place the hoop seal on the blue high pressure seal. It is critical that the hoop seal is facing the correct direction.
10. The High Pressure Seals will be installed first into the dynamic end (flat end) of the High Pressure Cylinder using the High Pressure Seal Install Kit.

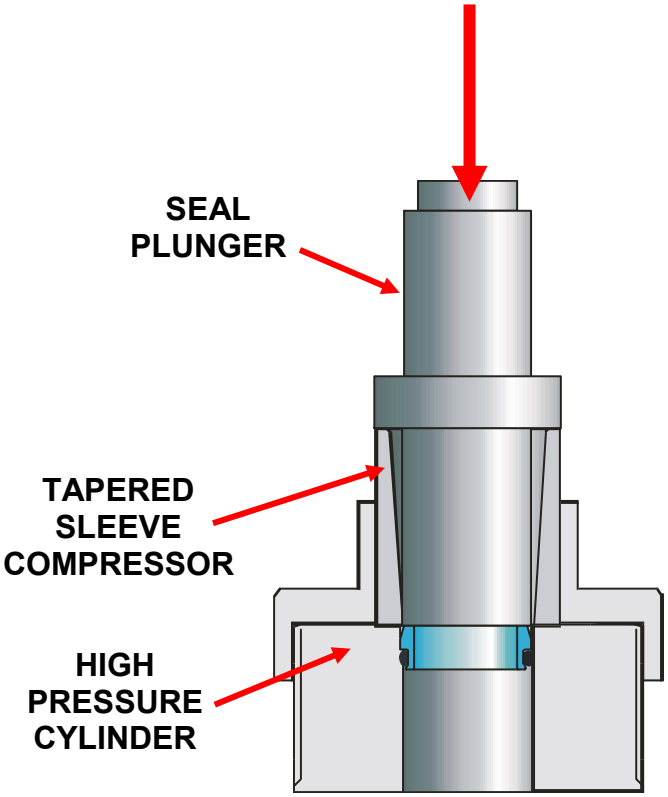
10. Screw the Adapter Flange onto the flat end of the High Pressure Cylinder and place the Taper Sleeve Compressor into it with the largest inside diameter facing outwards.



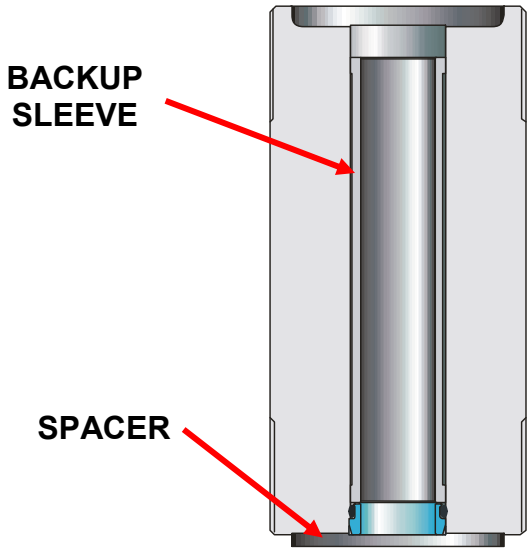
11. Lubricate the High Pressure Seal Kit assembly with Food Grade Grease and insert the kit inside Tapered Sleeve Compressor with the O-Ring facing in.

12. Using the Seal Plunger tool, push the Seal Kit Assembly into the High Pressure Cylinder. A rubber mallet may be required to position the Seal Kit Assembly flush with the end of the High Pressure Cylinder.

Note: Failure to follow this procedure will result in dramatically reduced cylinder life and will void the warranty. Do not use any other method or tool to install the seals.



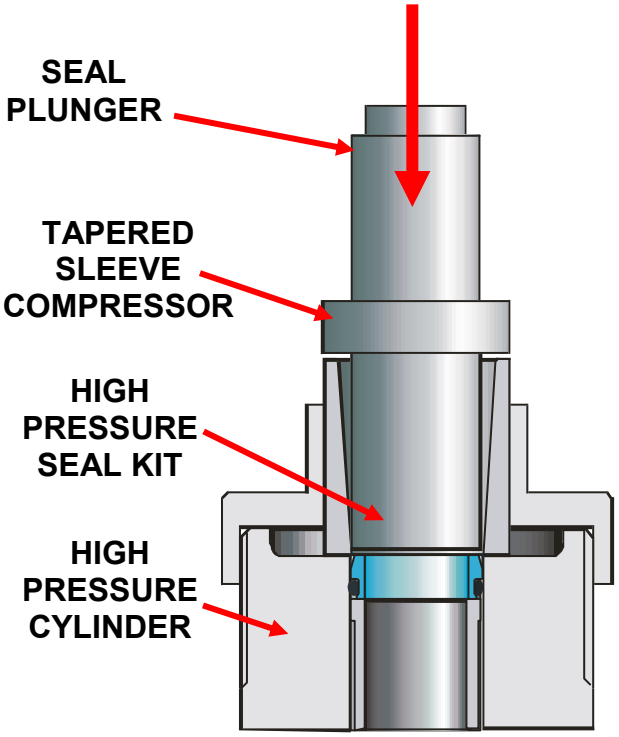
13. Unscrew the Adapter Flange from the flat end of the High Pressure Cylinder and turn the cylinder over and place the flat side on the large aluminum spacer.



14. Coat the Backup Sleeve with Food Grade Grease and then slide it into the High Pressure Cylinder.

15. Place the Flange Adapter on the other end of the High Pressure Cylinder and insert the Tapered Sleeve Compressor with the large inside diameter facing out.

16. Apply Food Grade Grease to the High Pressure Seal kit and to the inside of the tapered sleeve and use the Seal Plunger to push the seal kit in flush.



17. The High Pressure Cylinder assembly can now be placed back onto the intensifier assembly using the procedure described earlier in this section.

18. Install the Check Valve assembly as described in Section 5.8.3

19. Install the End Cap, high and low pressure piping as described in Section 5.8.2

5.8.6 End Bell

The intensifier assembly fixture is **required** for this procedure. The fixture is used during the reassembly process to square the End Bells with each other and to minimize the possibility of O-ring damage as the cylinder is being drawn onto the End Bells. When the End Bells are assembled out of alignment, oil manifold leakage and breakage may occur.

With the High Pressure Cylinder removed, the Hydraulic End Bell can be easily removed and the Hydraulic Cylinder components can be serviced.

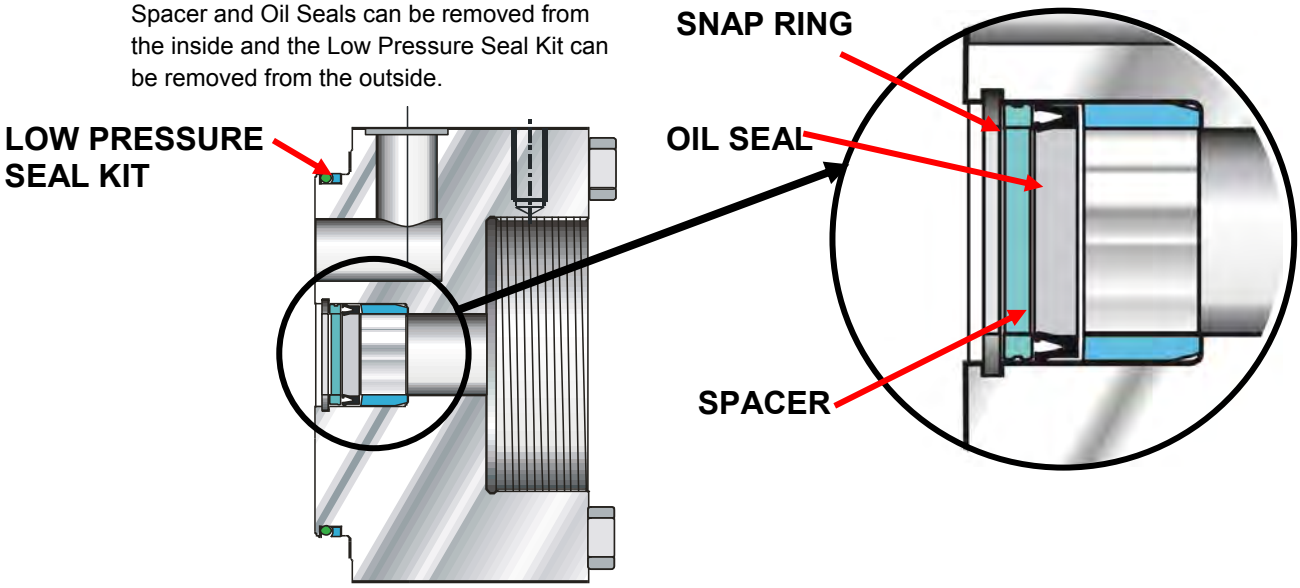
- Plunger
- Hydraulic Cylinder End Bell
- Hydraulic Piston and Cylinder

The plunger surfaces can become streaked with longitudinal scratches or flaws, the surface can become discolored or dull in appearance, or the outboard end can become smeared with stainless steel due to contact with the bore liner. If any of these conditions become severe, the plunger high pressure seal and possibly, the hydraulic seals will leak excessively. Repair of the plunger surface flaws usually cannot be accomplished on site. H2O Jet offers a plunger reconditioning service.

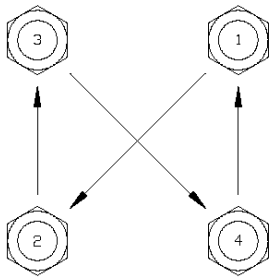
Note that the directional shifting valve assembly comes as either top mount or side mount. Aside from the placement, all other aspects regarding servicing are the same for either configuration.

1. Remove the End Cap and the High Pressure Cylinder using the procedures in Sections 5.8.2 through 5.8.4.
2. Remove the shift sensor or sensor cable assembly at the cylinder end to be serviced. Remove the remaining shift sensor to drain the hydraulic oil into the tank if you are going to service both ends of the hydraulic cylinder.
3. Loosen and remove the tie rods and nuts (4] holding the End Bell to the hydraulic cylinder. The End Bell and Seals can now be replaced.

4. With the End Bell removed the Snap Ring, Spacer and Oil Seals can be removed from the inside and the Low Pressure Seal Kit can be removed from the outside.



5. Re-assemble the End Bell and hydraulic cylinder by reversing the above steps. Apply food grade grease to seals to aid in installation and seal seating.
6. Mount the intensifier on the intensifier assembly fixture.
7. Tighten the four cap screws mounting the end bells to the assembly fixture finger tight. Tighten one eighth to one-quarter turn. Do not tighten any more as the bolts must hold the end bells tight against the fixture to prevent any misalignment, but not interfere with the tightening of the tie rod nuts.
8. Torque all tie rod nuts to 20 ft-lbs [27 Nm], then 40 ft-lbs [54 Nm], then 60 ft-lbs [81 Nm], then 80 ft-lbs [108 Nm], then 100 ft-lbs [135 Nm], then 120 ft-lbs [163 Nm] using a figure-eight pattern.



TORQUE SEQUENCE OF TIE ROD NUTS IN FIGURE 8 PATTERN

CAUTION

Remember to install and properly torque the shift sensors. Failure to do so will result in considerable spraying of hydraulic oil.

5.9 Check Valve Service

The check valves are contained in a two-piece unit in the end cap. The components of the check valve are shown below.

When the check valves require service, one or more of the following conditions are usually present.

- High-pressure water temperature at the outlet fitting exceeds 120^{O}F [49^{O}C] indicating excessive back-flow through the outlet check valve.
- Hydraulic piston slams to the end of travel indicating excessive back-flow through the inlet check valve.
- Repetitive spiking of the high-pressure water pressure indicating that one or both of the valves may be leaking excessively.

Note: If the check valves are the only part of the intensifier being serviced, the intensifier does not have to be removed from the cabinet. However, the area must be free of airborne dust and particles.

5.9.1 Discharge High Pressure Check Valve

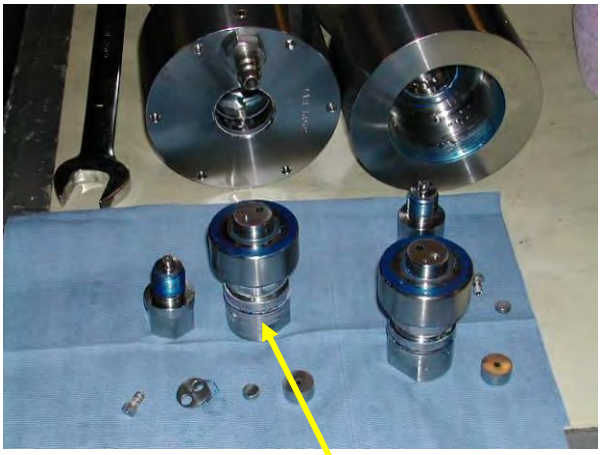
The high pressure check valve can only be serviced after the End Cap is removed from the intensifier High Pressure Cylinder.

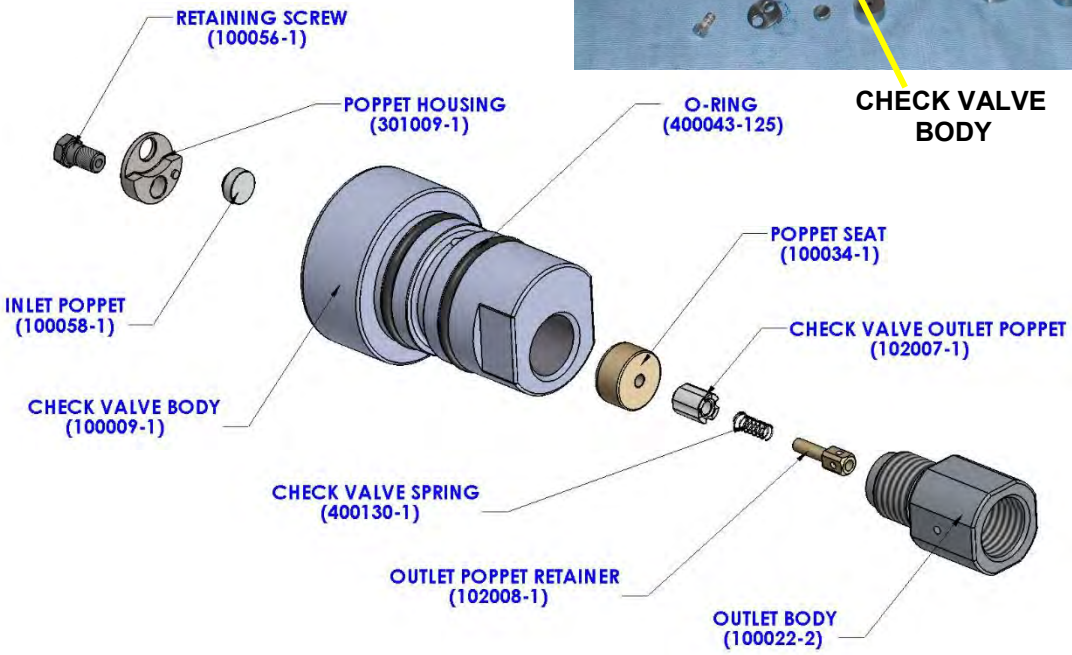
1. Shut down the system.

WARNING

Place the main electrical disconnect in the OFF position and bleed down all high-pressure lines. Place an "Out of Service" tag on the main electrical disconnect and lock it out.

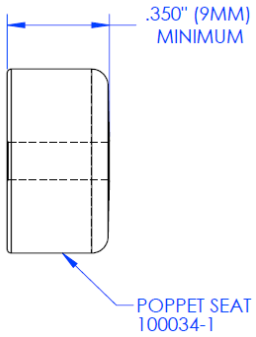
2. Remove the Outlet Body and Check Valve Body from the End Cap and disassemble as described in Section 2.2. through 2.4.
3. Remove the Check Valve Body from the End Cap.





CHECK VALVE ASSEMBLY,60K
(301002-3)

4. With the Outlet Body removed from the Check Valve Body, the Outlet Poppet and spring will normally stay in the valve body. The Outlet Poppet is easily removed and the Poppet Seat can be removed with a magnet. Upon inspection, the seat should be checked for damage or cracking and replaced if necessary. The seat is not symmetric, and the rounded side should face the Check Valve Body. When reinstalling the Poppet Seat, apply a thin film of Anti-Seize Goop to the rounded face only. **DO NOT** apply goop to the flat face of the Poppet Seat.
5. Inspect the Outlet Poppet and Poppet Spring for wear. Replace the Poppet Spring and Outlet Poppet if either is worn.
6. Outlet Poppet Lapping- A minimum allowable thickness of 0.350" [8.890 mm] must be maintained on the insert after lapping. Follow the procedures in Section 5.9.2, steps 5 through 7.



7. **DO NOT** apply Goop to the sealing face of the Outlet Body when re-installing the Outlet Poppet and Poppet Spring into the Outlet Body.
8. Apply Anti Seize Goop to the Outlet Body threads and install the Outlet Body into the Check Valve Body. **DO NOT** apply Goop to the sealing face of the Outlet Body.
9. Using a torque wrench combination, torque the Outlet Body to 50 ft-lbs [67 Nm].
10. Install the Check Valve Body and the End Cap to the High Pressure Cylinder as described in section 2.3.
11. Reconnect the high pressure and low pressure piping, collar and the quick disconnect as described in Section 2.2.
12. Start the **H2O Jet** pump. Operate at low pressure (without a cutting orifice) to flush the high pressure passages, and then operate the pump at high pressure with orifice installed to check for leaks. Verify that the high pressure fittings do not leak, and that the high pressure water signal is normal [indicative of the normal check valve operation].

5.9.2 Inlet Check Valve

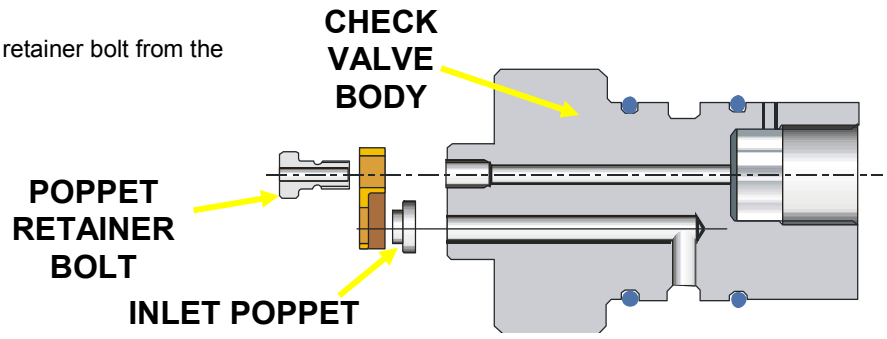
1. Shut down the system.

WARNING

Place the main electrical disconnect in the OFF position and bleed down all high-pressure lines. Place an "Out of Service" tag on the main electrical disconnect and lock it out.

2. Remove the Outlet Body and Check Valve Body from the End Cap and disassemble as described in Section 2.2 through 2.4.

3. Unscrew the poppet retainer bolt from the Check Valve Body.



4. With the inlet check valve disassembled, inspect and refinish the Check Valve Body seal surface and Inlet Poppet face as described below, if necessary.

5. Use Hydraulic Oil to adhere 400 grit abrasive paper to a granite lapping block. Make sure that there are no air bubbles between the sheet and the granite block. Place a few drops of water on the abrasive paper. Lap the Check Valve Body in a figure-8 pattern until all surface imperfections have been removed. See **Figure 1.**

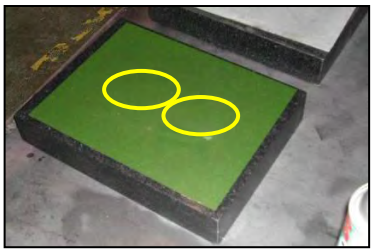


Figure 1

6. Remove the 400 grit paper and apply 600 grit to the granite block. Lap the body in a figure 8 pattern until the face is evenly polished.

7. To finish the lapping process, place the 400 grit paper back on the granite block. Draw the check valve body in a straight line along the abrasive strip once, then rotate the body 90 degrees and repeat the score. This will give a cross-hatch appearance and show any uneven areas due to improper lapping. This will also help avoid the poppet from sticking. If any uneven or rounded areas are present, repeat step 4 through 6. **See Figure 2.**

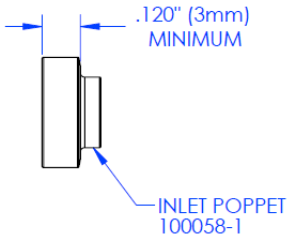
8. A minimum thickness no less than 0.120” [3.048 mm] must be maintained on the check valve inlet poppet after lapping.

FIGURE 2

9. Carefully clean the lapped seat and threads of the Check Valve and re-inspect the part. .

10. Apply a very small drop of Loctite 242 on the Retaining Screw threads. Be careful to not apply too much Loctite, as this could cause the inlet poppet to stick.

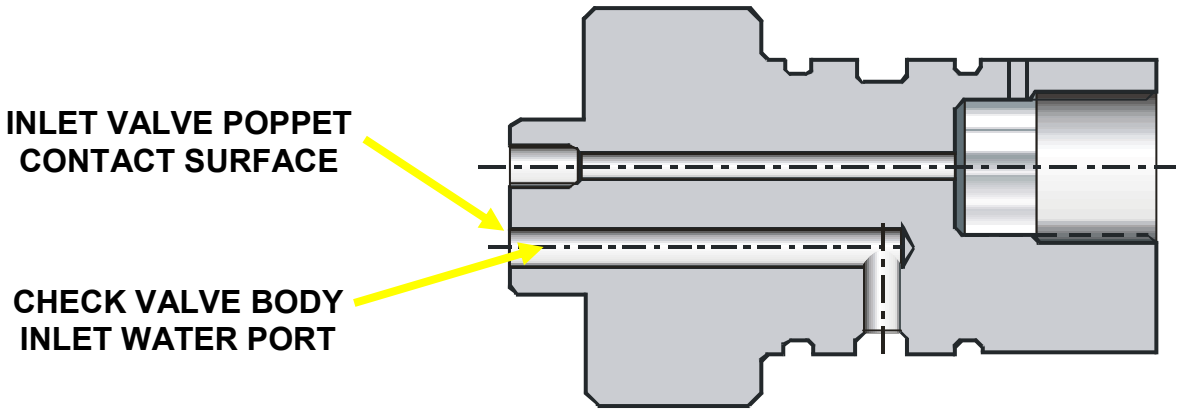
11. Assemble the Inlet Poppet under the Poppet Housing and torque to 5-ft-lbs [7Nm]. Ensure the Inlet Poppet moves freely.



5.9.3 Check Valve Body

The Check Valve Body should be inspected for scratches and wear on the Inlet Check Valve Poppet contact surface.

In addition, the Check Valve Body inlet water port should be examined for cracking.



A. Inspect the Inlet Poppet sealing surface of the sealing head for pits, scratches, or jetting erosion.

B. Refinishing the Check Valve Body inlet poppet face is mandatory when rebuilding the Check Valve Body as described in Section 3.2.

C. If the Sealing Surfaces of the Check Valve Body cannot be restored by lapping, the parts can be machined flat prior to lapping. Ensure only the sealing surface is machined and the perpendicularity between the machined face and the component axis is maintained. Ensure the minimum dimensions are maintained as per **Figure 3**.

D. Finish lapping the face as described in Section 3.2.

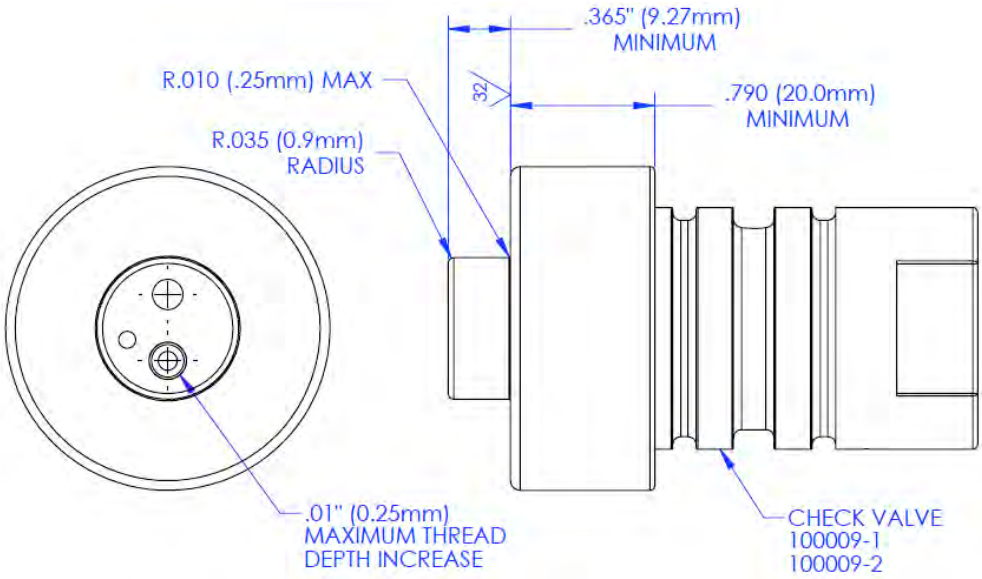


Figure 3

5.10 Piston Service

The inside diameter surface of the hydraulic cylinder should be inspected for any wear grooves and the surface finished whenever the hydraulic End Bells are removed. Excessive grooving on the hydraulic cylinder bore is indicative of piston seal wear.

When the piston assembly requires service, one of the following conditions is usually present.

- Worn piston seals allowing excessive oil flow around the piston.
- A jammed piston or detached plunger.

Disassembly of the Hydraulic Oil Cylinder, End Bells, and High Pressure Cylinders to access the piston involves the removal of the intensifier from the cabinet and a complete teardown of the intensifier on a workbench. An experienced technician using the proper tools and procedures can usually complete the procedure in 2 to 3 hours.

1. Shut down the system

WARNING

Before performing maintenance on the waterjet pump observe motor starter lock out/tag out procedures.

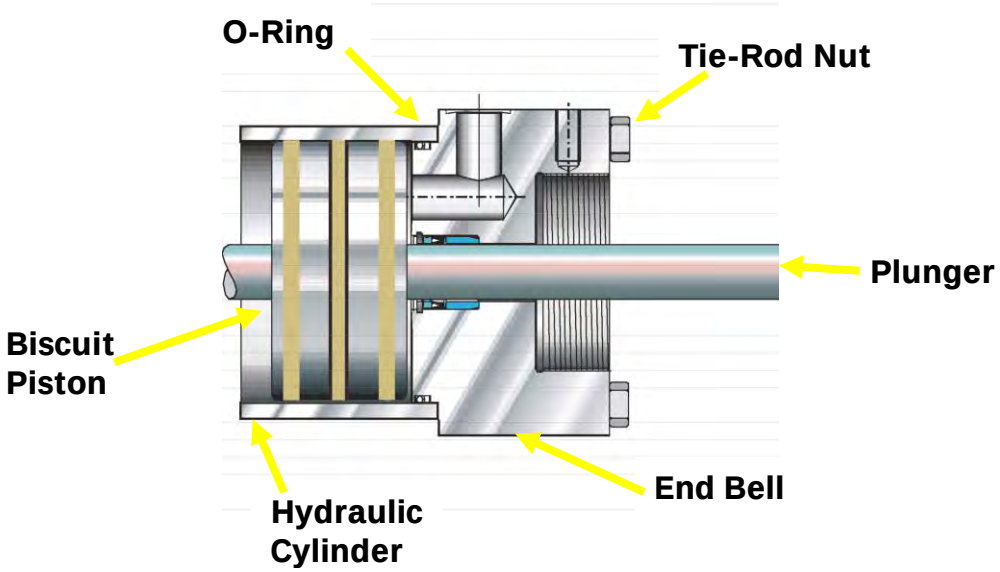
6. Remove the High Pressure and Low Pressure piping as described in Section 2.2.

7. Remove the intensifier from the cabinet.

8. Remove the End Cap and the High Pressure Cylinder using the procedures in Sections 2.3. and 2.4.

9. Remove the shift sensors at the cylinder ends to drain the hydraulic oil out of the cylinder.

10. Loosen and remove the tie rods and nuts retaining the End Bells to the hydraulic cylinder. The End Bells and O-rings can now be removed.

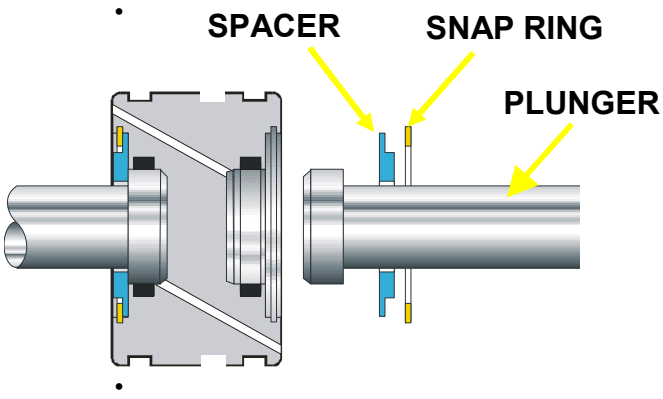


11. To remove the hydraulic piston from the hydraulic cylinder, remove both End Bells. If the hydraulic piston must be driven from the cylinder bore due to the seal squeeze and friction, use a plastic headed hammer to avoid striking the assembly with a metal object.

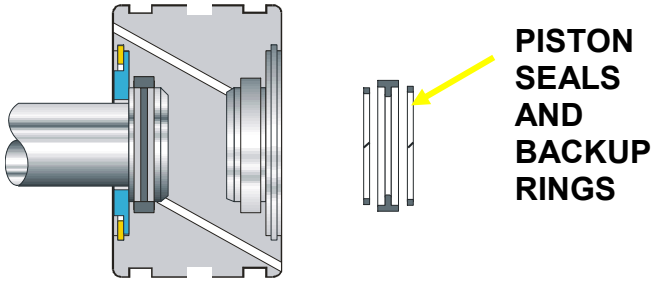
12. Follow the next steps to disassemble the piston and plunger.

13. Remove the snap ring and spacer. The spacer can be loosened by blowing air into one of the four openings in the retainer.

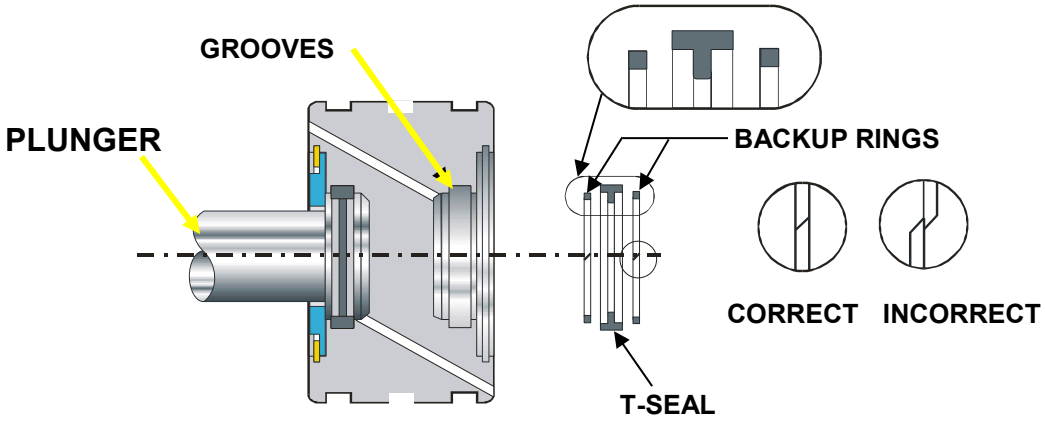
14. Remove the plunger by hand. Repeat the above step for the other plunger. Set plungers aside



11. Remove the O-ring and backup rings from both sides of the piston using a non-metallic tool to prevent scratching or scoring of the piston. Remove the piston seals.

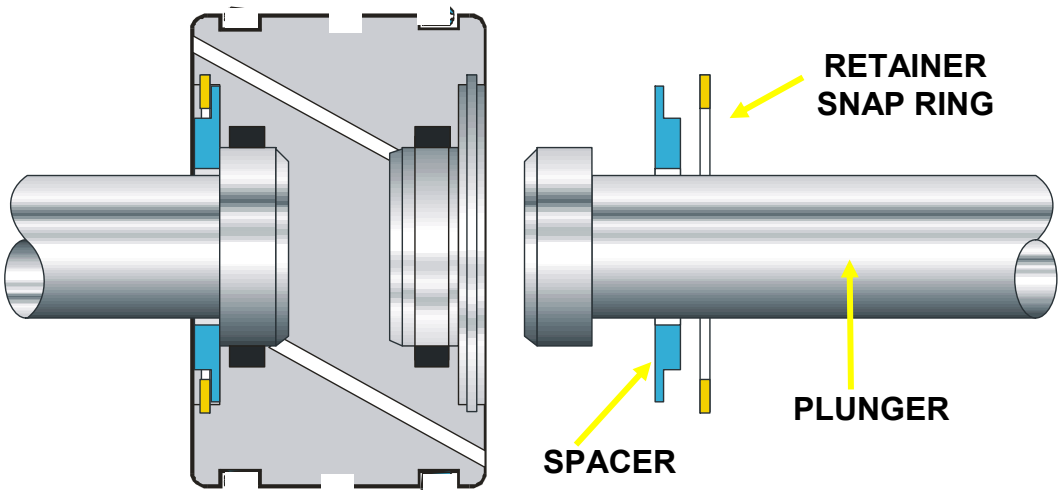


13. Clean all parts of the piston assembly, Ensure that oil, dirt, and burrs are removed from all surfaces. **Piston assemblies: 301023-1 (60K Unit) 301023-2 (40K Unit).** Lubricate the T-Seals and backup rings with Parkers O-Lube. Place two backup rings and one T-Seal in each piston groove as shown below. The T-Seal must be in the middle of the two backup rings.



14. Install the plungers into the counter bores of the piston biscuit with a turning motion. Ensure that the T-Seals [40K and 60K] and O-rings do not get nicked or rolled.

15. Install the spacers and snap rings into the grooves. Slide the retainer assemblies over the plungers with the large end facing inward as shown below.



16. Remove the piston seals.

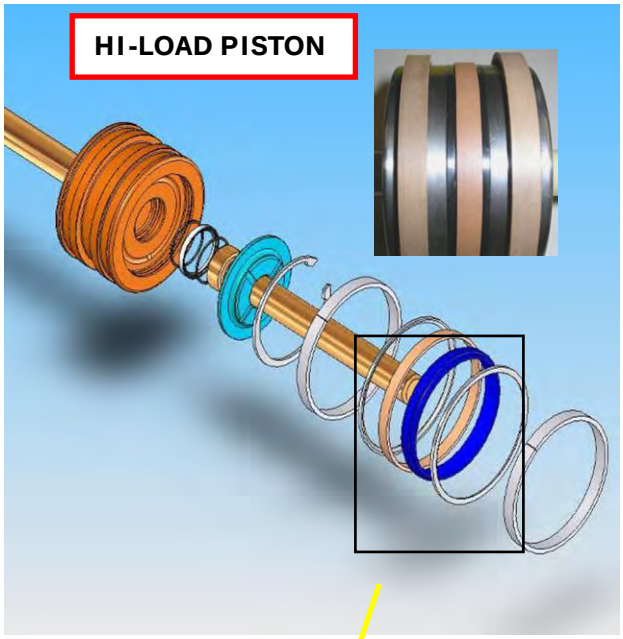
CAUTION

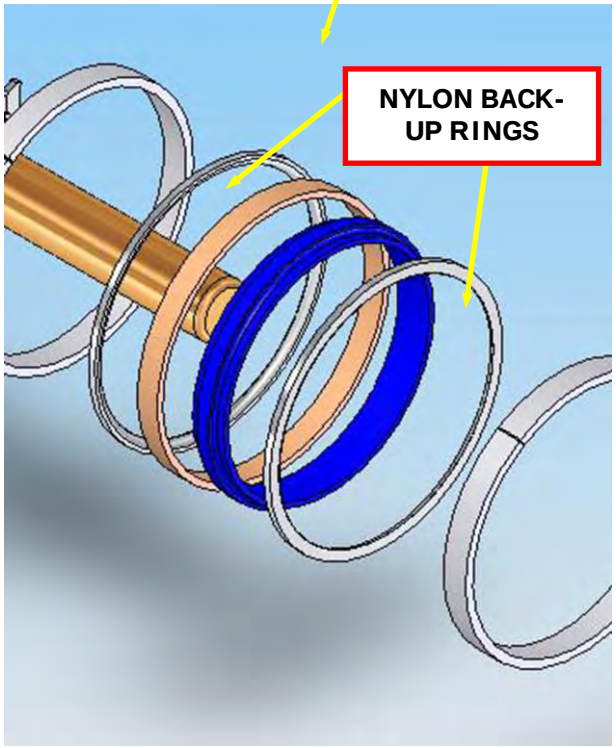
Do not scratch the bottom surface of the piston seal groove. Scratches to the seal groove sides and/or the bottom can result in hydraulic leaks.

17. With the seals removed, inspect the seal groove bottom for marks or scratches and residue buildup. Clean and/or repair the groove surfaces as required.

The Hi-Load Piston Seals

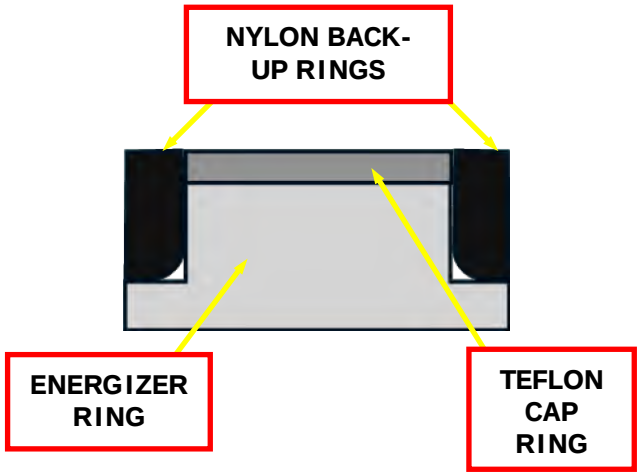
All H2O Jet Pumps now come with the Hi-Load Piston. This means it uses different material and an extra sleeve on the center of the hydraulic piston to give it longer life. Replace the center ring first as per the instructions below. The two outer Teflon Bearing Rings are simpler. These bands simply rest in their slots, however rotate the bands so the end joints do not line up.





The center band on the Hi-Load Piston consists of four parts. There are two Nylon Back-up Rings, an inner Energizer Ring and an outer wear ring. Be careful when replacing the rings that the piston is not scratched.

a. Carefully slide the inner energizer ring over the piston until it rests in the center slot.
b. Use a mandrel and finger sleeve to stretch the Teflon Cap over the piston. Detailed instructions are included with the new seal kit. The Teflon Cap Ring must sit centered on top of the Energizer. Heating the Teflon Cap Ring in 150°-200° [65°-90°C] water for 2-3 minutes will soften the Cap Ring enough to facilitate installation.
c. The Teflon Cap must be resized using a ring compressor for at least three minutes so it will fit in the hydraulic cylinder.
d. Install the Nylon Back-up Rings on each side of the Teflon Cap. Note that the curved inside edge faces the Teflon Cap.
e. Inspect Cylinder for scratches, burrs and gouges to ensure cylinder is fit to be used.
f. Lubricate cylinder and piston assembly with hydraulic oil.
g. Use a ring compressor to contain Wear Bearings and T-Seal assembly.
h. Some pressure may be required to push the piston assembly into the cylinder bore.

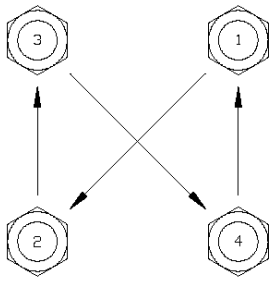


18. Remove the seal compression tool, and continue to drive the piston assembly into the hydraulic cylinder until it is approximately centered in the cylinder.

19. Continue the intensifier re-assembly by installing the End Bells, and tie rods. Whenever the tie rods are removed, the intensifier assembly fixture must be used to ensure that the end bells are aligned during the assembly process.

20. Mount the intensifier on the intensifier assembly fixture. Tighten the four cap screws mounting the end bells to the assembly fixture finger tight. Tighten one eighth to one-quarter turn. Do not tighten any more as the bolts must hold the end bells tight against the fixture to prevent any misalignment, but not interfere with the tightening of the tie rod nuts.

21. Torque all tie rod nuts to 20 ft-lbs [27 Nm], then 40 ft-lbs [54 Nm], then 60 ft-lbs [81 Nm], then 80 ft-lbs [108 Nm], then 100 ft-lbs [135 Nm], then 120 ft-lbs [163 Nm] using a figure-eight pattern.



TORQUE SEQUENCE OF TIE ROD NUTS IN FIGURE 8 PATTERN

22. Re-install the High Pressure Cylinder(s) and End Cap(s) by following, in reverse order, the procedure as described in Sections 5.8.3 through 5.8.5.

CAUTION

Remember to install and tighten shift sensors. Failure to do so will result in a considerable spraying of hydraulic oil.

5.11 Electric Directional Shift

5.11.1 Electric Shift Operation

1. The piston within the Hydraulic Oil Cylinder nears the end of the stroke
1. The piston makes contact with a Shift Pin
2. The Shift Pin movement is transferred to the actuator assembly with its magnetic tip.
3. The magnet activates the shift sensor
4. The shift sensor sends the message to the PLC (Programmable Logic Controller).
5. The PLC activates the correct Solenoid on the end of the Pilot Valve Assembly [one solenoid for each direction].
6. The solenoid pushes a shaft into the Pilot Valve housing that pushes the Pilot Valve Spool to the correct side
7. The Pilot Valve directs a small flow of oil to the end of the Directional Shift Valve moving its spool.
8. The Directional Shift Valve Spool directs the main hydraulic oil flow to the compressed side of the hydraulic cylinder.
9. The large-diameter hydraulic biscuit piston pushes the small-diameter High-Pressure Plunger (they are a single assembly).
10. The High-Pressure Plunger compresses the water up to the cutting-water pressure and sends it out the Check Valve.
11. When the piston assembly reaches the end of its stroke it contacts the Shift Pin on the other shift sensor assembly and the cycle repeats.

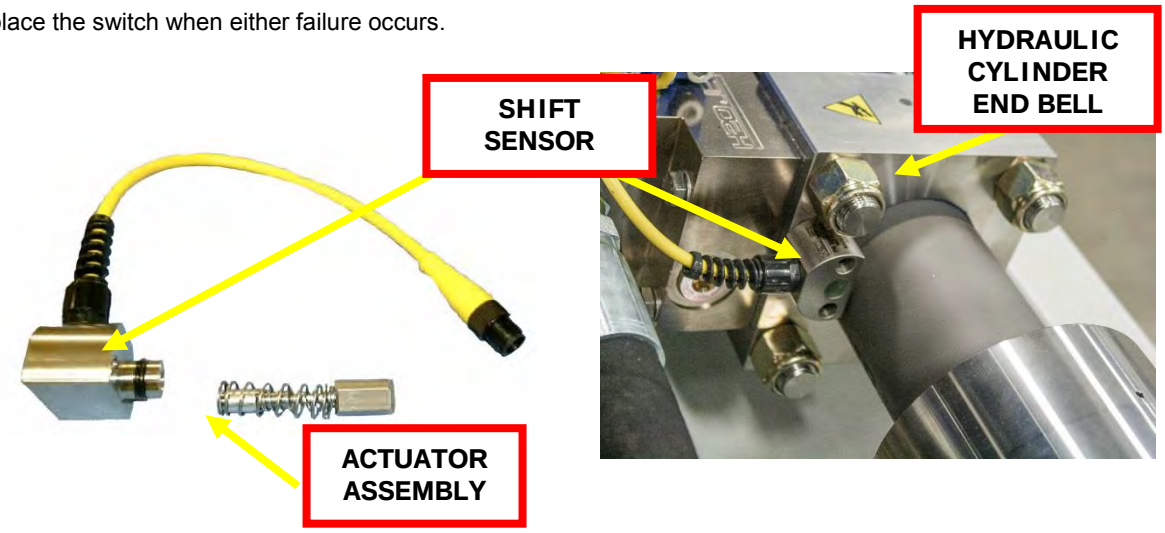
If the intensifier pump quits cycling, the shift sensor may need to be replaced. Check the LED lights on the switches

Symptoms of a failed shift sensor:

a. The LED lights do not change state [indicates the switch is not sensing the internal piston]

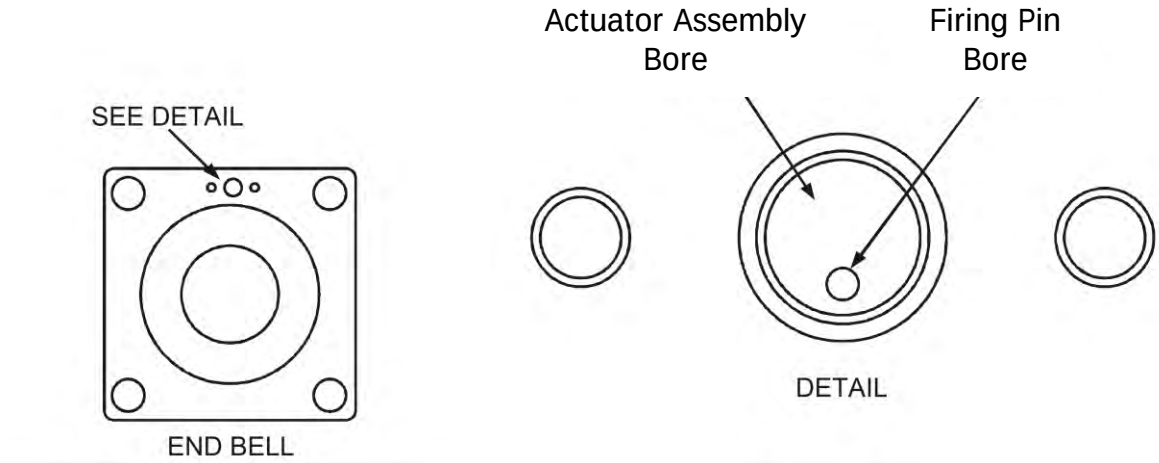
b. The LED lights are continuously flashing.

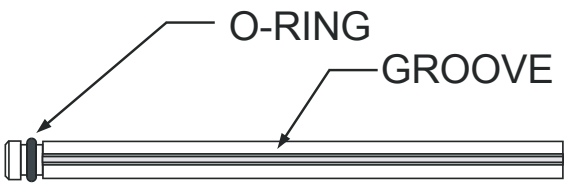
Replace the switch when either failure occurs.



5.11.2 Shift Sensor Service

1. Turn off the **H2O Jet** pump, disconnect and LOCKOUT electric power.
2. Disconnect the shift sensor cable.
3. Remove the sensor screws
4. Carefully remove the shift sensors (This may require some force, the o-ring creates considerable resistance)
5. The shift sensor is an induction sensor. The PLC senses the flux in the current passing through the induction coil. Testing the shift sensor requires special equipment. If it does not seem to be functioning simply replace it.
6. Remove the Actuator Assembly
7. Inspect the Actuator Assembly for ease of movement, springs intact, magnet intact.





8. To remove the Firing Pin, lubricate the O-ring in the Firing Pin tool and insert it into the intensifier actuating plunger bore, O-ring end first. Slowly pull out the tool; this creates a suction, which extracts the pin.

9. The Firing Pin should be approximately 1.150” [29.2 mm] long, have a shaft OD of approximately 0.082”[2.08 mm], and have no measurable bend.

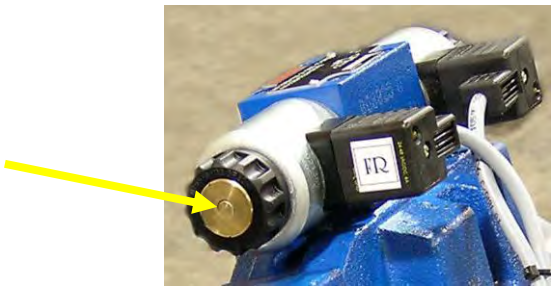
Firing Pin

10. Inspect the Firing Pin bore in the End Bell. It must be polished and have no gouges, burrs, or other surface disruptions. It must not be elongated or egg shaped.
11. Replace the Firing Pin in the End Bell.
    a. Use the Firing Pin tool and a small Allen wrench
    b. Place the Firing Pin in the groove of the tool with the head toward the o-ring.
    c. Insert the too into the actuating plunger bore using the small Allen wrench to apply pressure against the pin.
    d. Rotate the tool until the pin lines up with the Firing Pin Bore. The pressure applied will force the Firing Pin into the bore. Visually check the pin to make sure it is correctly installed.
12. Insert the Actuator Pin Assembly, large end first, so the magnet faces the switch.
13. Install new sensor and screw back into place.
14. Reconnect the sensor cable
15. Torque the sensor bolts to 6 ft-lbs [8 Nm]
16. The directional shifting will probably have to be instructed which way to go at start-up. See the Operations section of this manual, Section 3.7.1

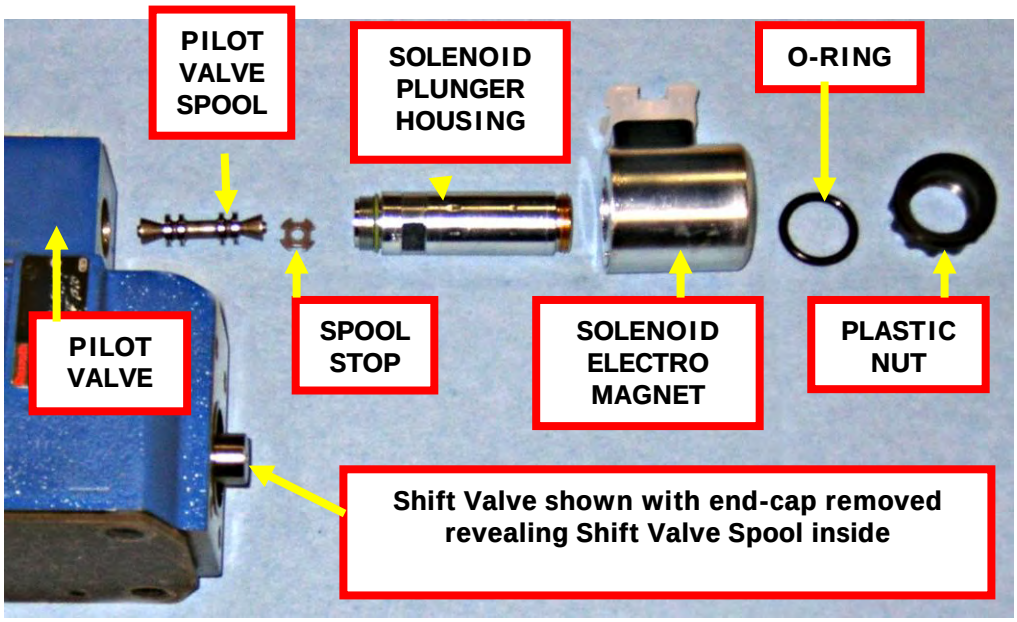
5.11.3 Solenoid / Pilot Valve Service

There are a variety of diagnostics and procedures for the Solenoid / Pilot Valve Assembly.

1. The Pilot Valve Spool and Solenoid Plunger can checked for freedom of movement without tearing down the Pilot Valve. The end of the Solenoid has a small center ring. When the machine is turned off the center section can be depressed with a small wooden dowel. It will initially go in about a quarter inch [6 mm] and then the movement of the Valve Spool can be felt. If not, try this from the other side. The Pilot Valve Spool itself will only move one-eighth inch [3 mm]. If no movement is felt the entire assembly will probably have to be replaced.



2. While the intensifier is off. 24 volts can be applied across the front and rear contacts (not the side one) on the solenoid connection to check for solenoid movement.
3. The black plastic nut on each solenoid can be unscrewed and the electro-magnet portion of the solenoid removed.
4. Inside there is a silver shaft that houses the solenoid plunger and a spring to absorb shock from the Pilot Valve Spool's movement. This shaft has a set of notches on it to receive a wrench for removal.
5. When the assemblies are removed from each side the pilot valve spool can be manually pushed from side to side to check the movement.
6. The Pilot Valve Spool should then be removed at this point to check for burrs and other signs of wear and leakage. If there is any wear or leakage across the valve, the entire assembly must be replaced.

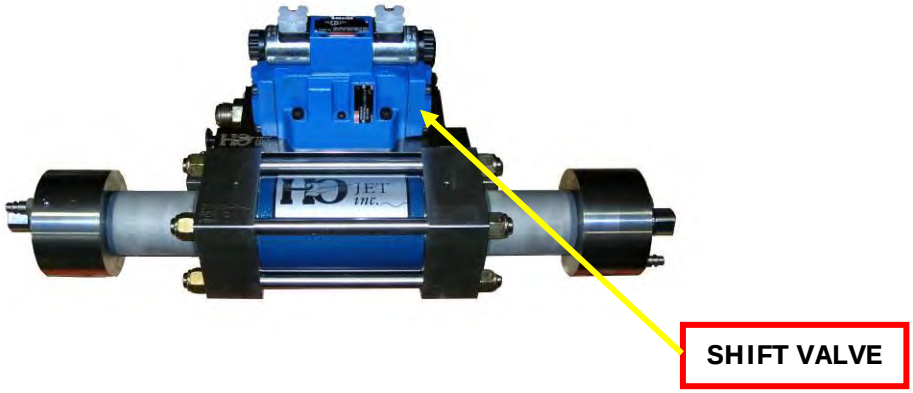


If it becomes necessary to replace the Pilot Valve Assembly it is a simple procedure.

1. Shut down and lock out the electrical panel for the Intensifier.
2. Unplug the connections at the Solenoid where the shift lights are located.
3. Unscrew the Allen-head screws on top of the Pilot Valve Assembly.
4. Make sure there is a slight film of oil on the o-rings and face of the new pilot.
5. Notice that the Electric Shift Pilot Valve uses flat o-rings. If you also operate an H2O Jet Pump that is Mechanical Shift it will have regular o-rings.
6. Clean any debris that may be on the joining surface of the Shift Valve top and check for scratches or other marks.
7. Mount the new Pilot Valve Assembly in place so the wire connections on the Solenoids face the back of the cabinet.
8. The Allen-head screws only have to be hand tight at about 15 ft. lbs [20 Nm].
9. Reconnect the cables to the Solenoids. Notice they are labeled for front left [FL], front right [FR] and so on.
10. The directional shifting may have to be instructed which way to begin at start-up. Instructions for this are in the Operations section of the manual, section 3.7.1.

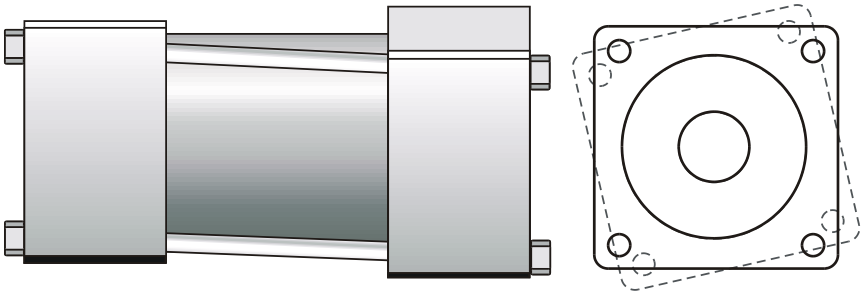
5.13 Shift Valve and Manifold Service

Oil flowing into and out of the intensifier hydraulic oil cylinder flows through the shift valve. The valve spool opens and closes passageways to direct pressure oil into one end of the cylinder, and bleeds the oil from the opposite end, causing the cylinder to stroke. The spool movement is controlled hydraulically by a pilot valve mounted directly on the shift valve. The shift valve and manifold require no routine maintenance.



Problems associated with a faulty shift valve are usually limited to an uneven, slow, or non-cycling intensifier. Uneven stroking can also be caused by check valve problems. While over speeding is usually associated with filtering water supply or high pressure water systems.

A cracked manifold and leaky O-rings are usually the result of misaligned end bells (i.e., one end bell is rotated in relation to the other).



END BELL MIS-ALIGNMENT

Whenever the tie rods are removed, the intensifier assembly fixture must be used to ensure that the end bells are aligned during the assembly process.

Service Steps:

1. Shut down the system.

WARNING

Place the main electrical disconnect in the OFF position and bleed down all high-pressure lines. Place an "Out of Service" tag on the main electrical disconnect and lock it out. Failure to do so may result in damage to equipment or injury to personnel.

When the pump is operating, the shift valve may contain 3,000 psi [207 bar] oil pressure. Therefore, NEVER start or operate the pump when any of the shift valve parts are loose or removed.

2. Remove the four cap screws that secure the end cover to the shift valve. Remove the other end cover.
3. Using your fingers, check the shift valve spool for freedom of movement. The spool must move with light pressure through the full stroke. If the spool is jammed, the valve must be replaced.

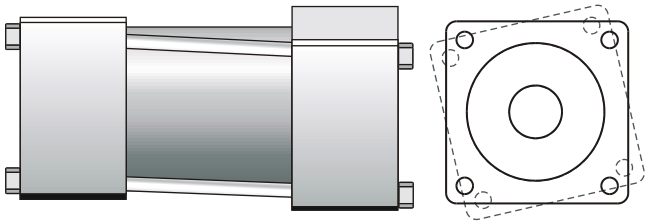
   If you are replacing the spool valve, skip to Step 6.
4. Remove the spool and check that all grooves in the spool are clean and all polished surfaces are undamaged. Check the inside of the shift valve body for any damage or foreign material. If everything is satisfactory, insert the spool into the shift valve.
5. If the shift valve and manifold are satisfactory, replace the end cap. You need not follow this procedure any further.

WARNING

The shift valve is a specially modified unit designed for use in this application. Using a substitute shift valve may create a potential safety hazard, may lower the performance of your pump, and will void your warranty.

6. If the shift valve or port O-rings must be replaced, remove the shift cable and pilot valve and set them aside. See the "Shift Cable and Pilot Valve Service" for the correct procedure.
7. Loosen the fasteners in one-eighth turn increments until all torque has been removed. Remove the shift valve and discard it if faulty.
8. Check the manifold and O-rings. If they are not in need of service, proceed to Step 23. If the manifold or O-rings need service continue with step 9.
9. Disconnect the oil supply and return lines from the manifold; cap the lines with the plugs supplied with the pump.
10. Disconnect the water supply lines at the quick-disconnects.
11. Remove the pressure relief valve and set aside. Use a Spanner wrench [400025-1] to make removal easier.
12. Disconnect the small diameter, hydraulic high-pressure line connected to the manifold. Move the high-pressure lines out of the way.
13. Loosen the cap screws mounting the manifold to the intensifier in one-eighth turn increments.
14. Remove the cap screws mounting the manifold to the frame and remove the manifold.

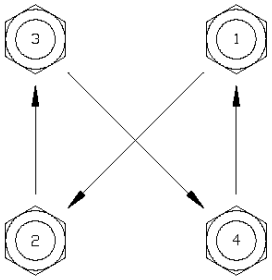
15. If the manifold is cracked, check that the end bells are in alignment with each other using a steel straight edge. If any misalignment is noted, mount the intensifier on the intensifier assembly fixture and loosen the tie rod nuts.



END BELL MIS-ALIGNMENT

16. Tighten the four cap screws mounting the end bells to the assembly fixture finger tight. Tighten one eighth to one-quarter turn. Do not tighten any more as the bolts must hold the end bells tight against the fixture to prevent any misalignment, but not interfere with the tightening of the tie rod nuts.

17. Torque all tie rod nuts to 20 ft-lbs [27 Nm], then 40 ft-lbs [54 Nm], then 60 ft-lbs [81 Nm], then 80 ft-lbs [108 Nm], then 100 ft-lbs [135 Nm], then 120 ft-lbs [163 Nm] using a figure-eight pattern. Remove the intensifier from the intensifier assembly fixture and place it back on the pump.



TORQUE SEQUENCE OF TIE ROD NUTS IN FIGURE 8 PATTERN

18. Clean and inspect all parts to be reused.

19. Lubricate the new O-rings with Parker Super O-Lube and place in the port cavity's end bell. If any oil is lost in the process, refill with fresh oil.

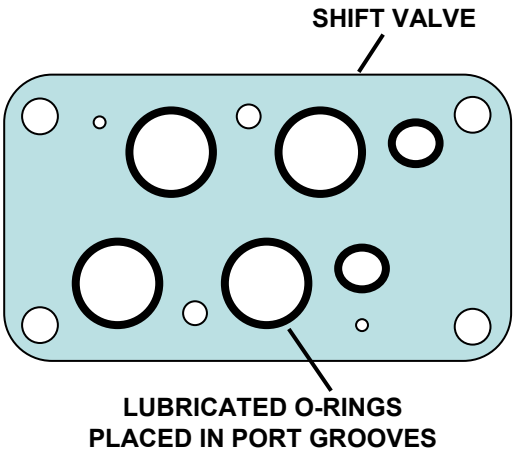
20. Align the manifold ports with the intensifier ports and thread in the fasteners.

21. Torque all cap screws to 25 ft-lbs [34 Nm] in one-eighth to one-quarter turn increments using a figure-eight pattern.

22. Thread in the cap screws mounting the manifold to the pump frame and torque to 110 ft-lbs [149 Nm].

23. Connect the oil supply and return lines to the manifold.

24. Lubricate the O-rings with Parker Super O Lube and place the O-rings in the port grooves of the shift valve to be installed.



25. Place the shift valve onto the manifold and thread in the fasteners. Torque the fasteners in one-eighth turn increments in a two-step process.

-Vickers Valve:

a. Torque all caps screws [1-6] to 10 ft-lbs [14 Nm]

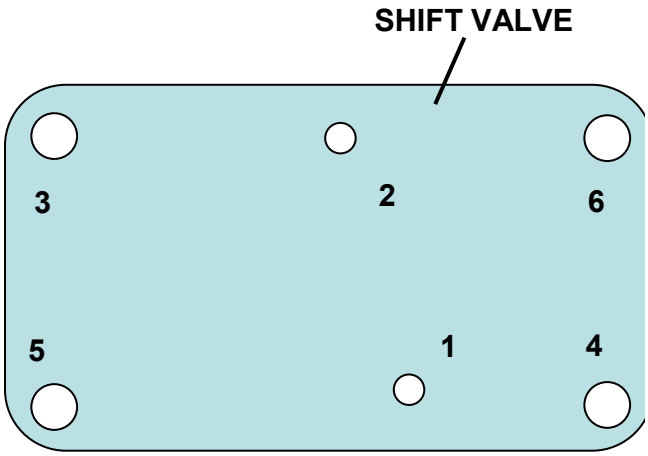
b. Torque the outer cap screws [3-6] to 25 ft-lbs [34 Nm] incrementally in criss-cross pattern.

-Rexroth Valve:

a. Torque screws 1 and 2 to 11.5 ft-lbs [15.5 Nm].

b. Torque the outer screws [3-6] incrementally to 55 ft-lbs [75Nm] in a criss-cross pattern.

c.. Check screws 1 and 2 are at 11.5 ft-lbs [15.5 Nm].



TORQUING SEQUENCE

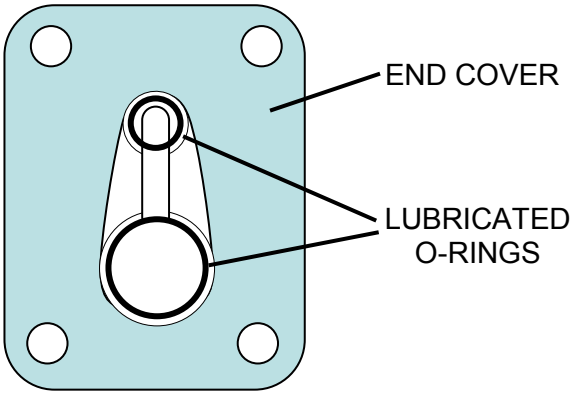
CAUTION

Failing to properly follow the torquing sequence when installing the shift valve may warp the body sufficiently to prevent spool movement . Such warpage is usually not reversible.

26. Using your fingers, make sure the spool moves freely.

27. Lubricate the end cover O-rings with Parker Super O-Lube and mount the end cover to the shift valve housing. Torque the cap screws to 10 ft-lbs [14Nm].

28. Install the pilot valve and the Solenoid cables.



29. Attach the water supply lines at the quick-disconnect fittings. Attach the high-pressure tubing at both ends, and then torque the gland nuts.

30. Check the intensifier for incomplete work, tools, parts and rags. Start the pump and operate at idle oil pressure.

31. Slowly increase the pressure to the rated output while checking for leaks.

32. Stop the pump and inspect for any leakage and correct as required.

33. When all the work is satisfactory, remove the “Out of Service” tag form the main electrical disconnect.

34. The pump is ready for routine operation.

5.14. High Pressure Attenuator

There is no servicing of the high pressure Attenuator that can be done at the customer site. The seals in the high pressure Attenuator are tested by H2O Jet to pressures in excess of the operating pressure making disassembly difficult. Specialized equipment is required for testing the torque and alignment of the ends. Should there be a high pressure water leak at the Attenuator, the Attenuator should simply be replaced. The defective attenuator should be returned to H2O Jet for replacement or servicing. The Attenuator weighs 400 lbs. [181 kg]. Great caution for hands and fingers must be used when removing the Attenuator from the cabinet.

1. Shut down system and lock out the electrical disconnect
2. Ensure the Bleed Down Valve has activated and there is no High-Pressure Water in the system.

WARNING

Place the main electrical disconnect in the OFF position and bleed down all high-pressure lines. Place an "Out of Service" tag on the main electrical disconnect and lock it out. Failure to do so may result in damage to equipment or injury to personnel.

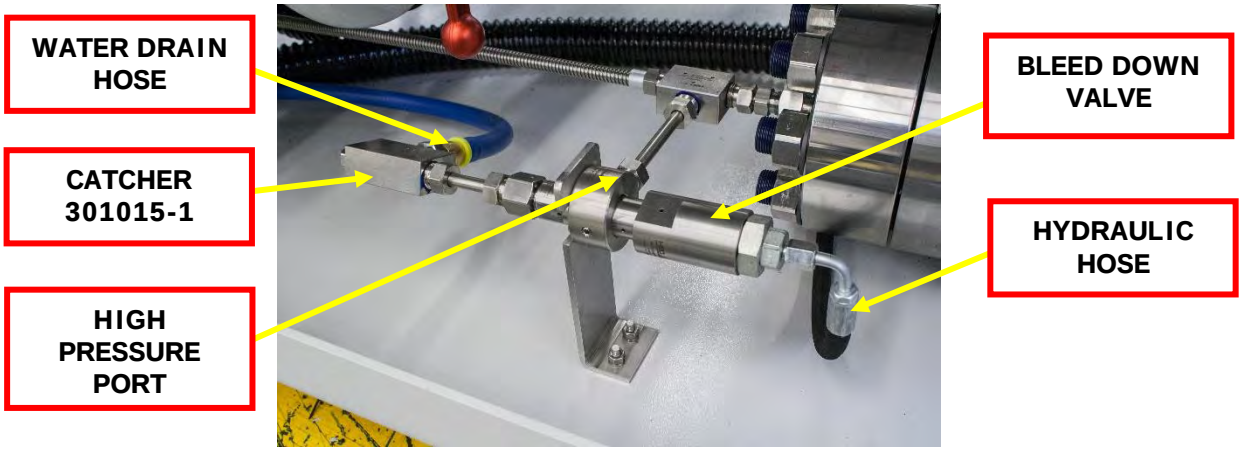
3. Prepare a ramp or other lifting device for removing the Attenuator from the cabinet. It cannot be lifted by hand.
4. Slowly remove the high-pressure water fittings from each end of the Attenuator. Assume there is pressure as you loosen them. Keep hands clear of the fitting. Leather gloves are recommended when removing high-pressure fittings.
5. Remove the four nuts holding the bracket around the Attenuator and remove the top bracket.
6. Carefully remove the Attenuator from the cabinet.
7. Reverse the procedure for installing the new Attenuator.

Note: Threads for all high-pressure connections must be lubricated with Blue Lubricant P/N 400001-1

5.15 Bleed-Down Valve Service [HBDV]

5.15.1 Hydraulic Bleed Down Valve Service [HBDV]

This service procedure is for the Bleed-Down Valve [P/N 301013]. Before performing this service procedure, you will need to purchase the [P/N 302008-1] repair kit.

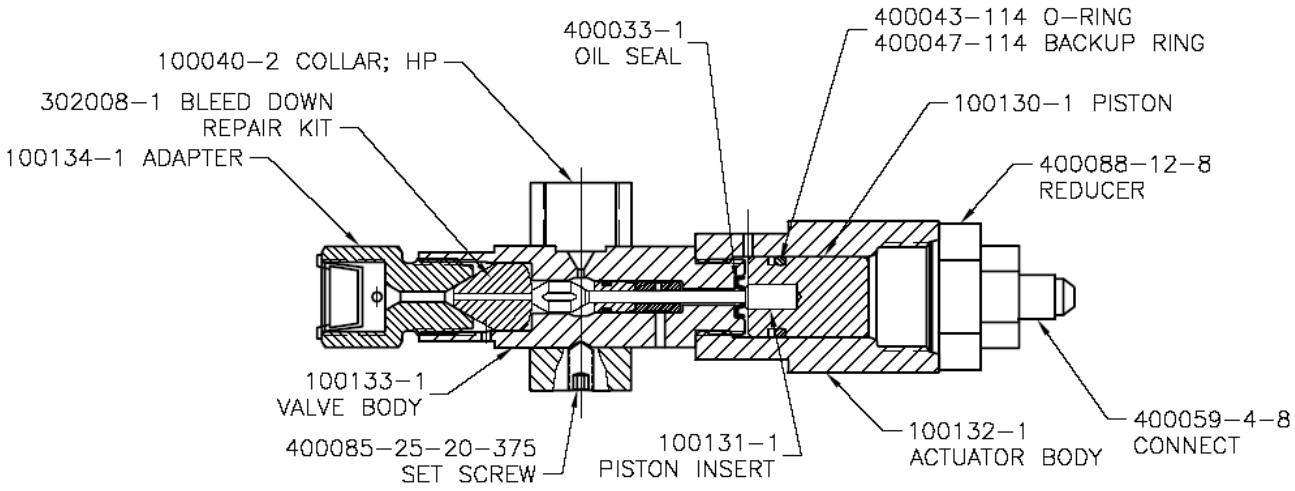


HIGH-PRESSURE BLEED-DOWN VALVE [HBDV]

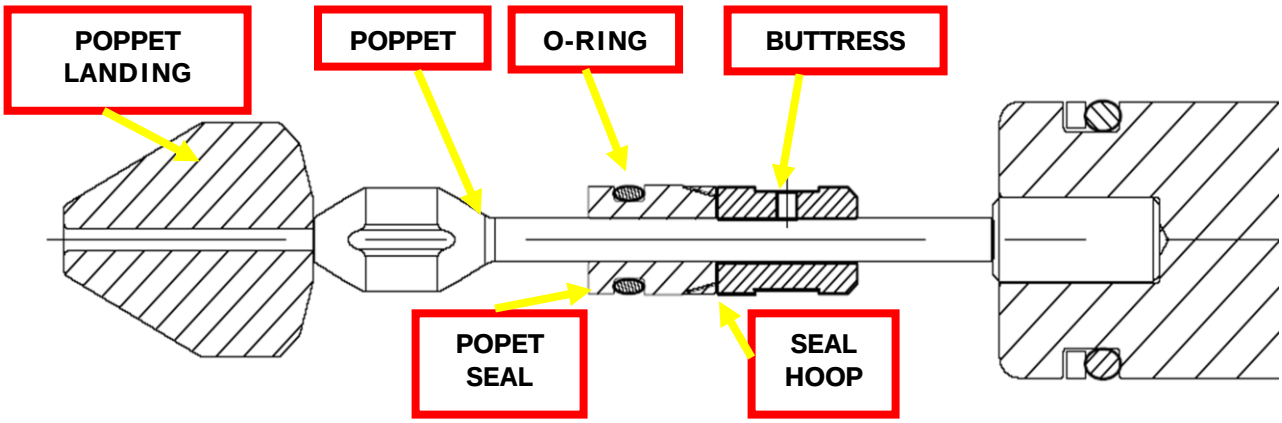
WARNING

Place the main electrical disconnect in the OFF position and bleed down all high-pressure lines. Place an "Out of Service" tag on the main electrical disconnect and lock it out. Failure to do so may result in damage to equipment or injury to personnel.

1. Shut down the system.
2. Remove the hydraulic hose from the oil port of the bleed-down valve.
3. Remove the gland nut connecting the water drain tubing to the bleed-down valve.
4. Remove the gland nut from the collar at the high-pressure port of the bleed-down valve.
5. Place the bleed-down valve on a clean workbench.
6. Separate the actuator body [100132-1] from the high-pressure valve body.



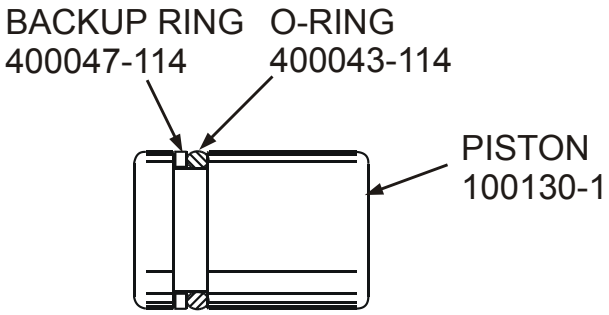
7. Remove the high-pressure collar [100040-2] from the high-pressure valve assembly.
8. Remove the adapter [100134-1] from the high-pressure valve body [100133-1].
9. Remove and discard the poppet landing [100084-1] from the high-pressure valve body.



10. Remove and discard the high pressure seal assembly [Poppet [100083-1], Poppet Seal [100082-1], Seal Hoop [100085-1], O-ring [400043-008], and Buttress [100081-1]] by inserting Valve Seal Extraction Tool [100187-E] through the oil seal [400033-1] and pushing on the high-pressure Poppet [100083-1].

Note: Do NOT remove the oil seal.

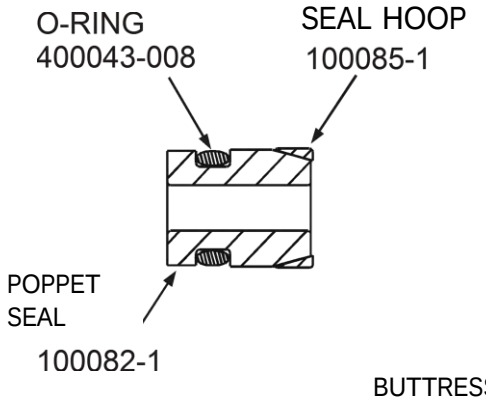
11. Push the piston insert [100131-1] and piston [100130-1] out of the actuator body through the oil port by using a soft-faced ¼" dowel" [or similar item].
12. Remove and discard the O-ring [400043-114] and backup ring [400047-114] from the piston.
13. Clean the remaining parts with an ultrasonic cleaner. Check the parts for nicks and burrs. Replace as necessary.
14. Lubricate a new O-ring, backup ring and the inner surface of the actuator body with Parker Super O-Lube [P/N 400001-1] or equivalent.
15. Install the new O-ring and backup ring on the piston as shown. [dished side of backup O-ring faces O-ring] Install the piston insert and the piston assembly into the actuator body until seated.



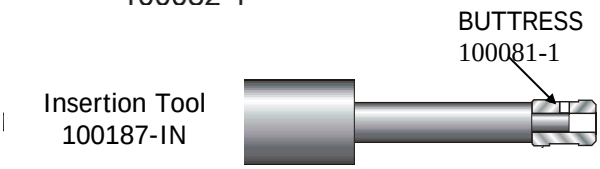
NOTE: Make sure the piston is aligned with the actuator body to prevent damage to the O-ring

16. Lubricate the poppet, poppet seal, seal hoop, O-ring, and buttress with White Food Grade Grease.

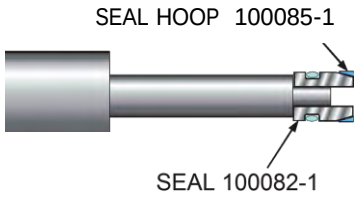
17. Install the O-ring and seal hoop onto the high pressure seal as shown.



18. Install the new buttress onto the installation tool as shown [chamfered side out], then insert the buttress into the high-pressure body using the installation tool.



19. Place the poppet seal assembly onto the installation tool as shown. Insert the high-pressure assembly into the high-pressure body using the installation tool.



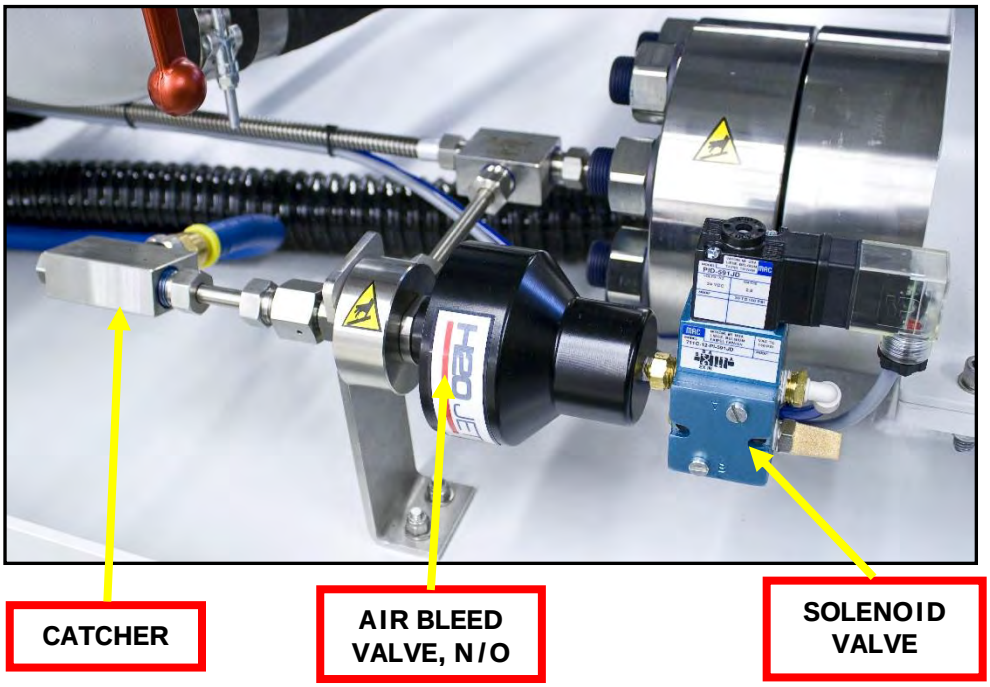
20. Lubricate the high-pressure stem with White Food Grade Grease.
21. Install the high-pressure stem tip, shaft end first, into the seal assembly, and then use a plastic or wood dowel to push the poppet through the seal assembly until it bottoms out.
22. Install the poppet landing into the high-pressure body.
23. Install the adapter. Torque to 35 ft-lbs [48 Nm]
24. Install the high-pressure collar.
25. Connect the high-pressure valve assembly to the actuator body.

NOTE: Remove the 4” high-pressure nipple from the tee and install on the collar to help align valve and collar. Then install the nipple in the tee.

26. Reinstall the bleed-down valve in the machine by attaching the gland nut to the high-pressure collar at the high pressure port of the valve. Torque the gland to 35 ft-lbs [48 Nm].
27. Install the gland nut connecting the water drain tubing to the bleed-down valve.
28. Reattach the hydraulic hose to the oil port of the bleed-down valve.
29. Place the intensifier pump in operation and check for water or hydraulic oil leaks. Correct leaks as necessary.

5.15.2 Air Bleed Down Valve Service

This service procedure is for the Air Bleed-Down Valve [P/N 301017-2]. Before performing this service procedure, you will need to purchase the [P/N 302001-1] repair kit.



Disassembly:

1. Shut down the system.

WARNING

Place the main electrical disconnect in the OFF position and bleed down all high-pressure lines. Place an "Out of Service" tag on the main electrical disconnect and lock it out. Failure to do so may result in damage to equipment or injury to personnel.

2. Remove the Air Bleed Valve from the pump.
3. Remove the Valve Adapter from the Valve Body (100048-1).
4. Remove the On/Off Valve Actuator from the Valve Body.
5. Remove the O-Ring (400043-014) from the outlet end of the Valve Body using a small straightened paperclip or similar tool. **See Figure 1.**

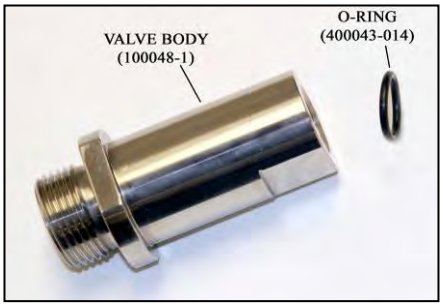


Figure 1

a. NOTE – this o-ring is not a sealing o-ring. It is only used to prevent the poppet seat from falling out during removal of the nozzle body.

6. Remove the Poppet Landing (100059-1) from the Valve Body. If tapping the body does not cause the seat to fall out, insert a straightened paperclip in the hole in the seat and gently loosen. Discard the Landing and O-Ring. **See Figure 2.**

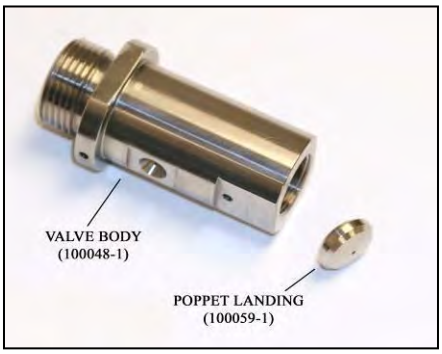


Figure 2

7. Remove the Valve Retainer Insert (301008-1) from the opposite end of the valve body. DO NOT DISCARD. **See Figure 3.**

8. Place the Seal Ejection Tool (100104-1) against the Poppet tip and push out the Poppet and Seal assembly. Discard the Poppet and Seal assembly.
See Figure 4.

9. Thoroughly clean any foreign material from the inside and outside of the Valve Body (100048-1). Inspect Valve Body inside diameter for scratches or pitting and replace if necessary.

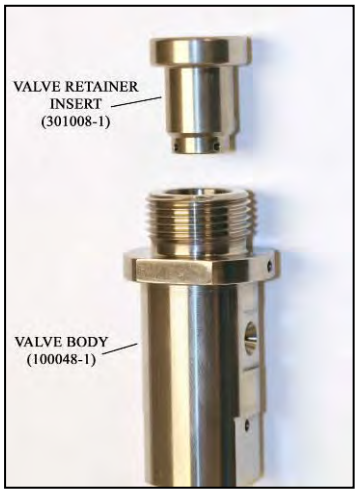


Figure 3

Assembly:

10. Apply a light coat of Food Grade Lube (400034-2) to the red Seal O-Ring (400042-006) and slide over the Poppet Seal (100061-1) groove. **See Figure 5**

11. Apply a light coat of Food Grade Lube to the shaft of the Poppet (100060-1). **See Figure 5**

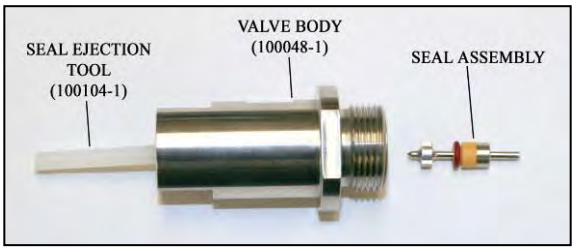


Figure 4

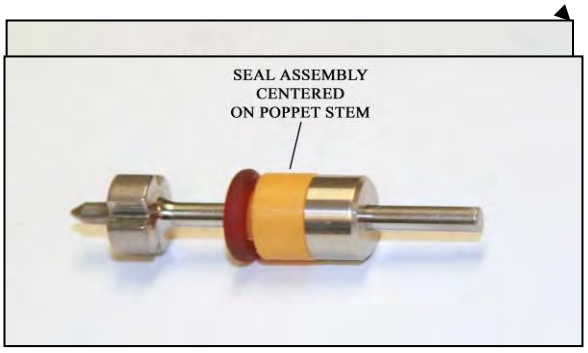


Figure 6

12. Slide Poppet Seal (with O-Ring installed) half way down the shaft of the Poppet with the Seal O-Ring facing tip of Poppet. **See Figure 5**

13. Slide the Seal Buttress (100062-1) on the poppet shaft with the chamfer facing away from the Poppet tip. The seal assembly and buttress should be centered as much as possible on the stem. **See Figure 6**
14. Insert the Poppet and Seal Assembly into the actuator end of the Valve Body, pointed tip first. **See Figure 7**
    a. NOTE – Do not force the Poppet and Seal Assembly into the Valve Body. O-Ring damage will occur and cause premature valve failure.
15. Gently slide the Valve Retainer Insert (301008-1) into the top of the Valve Body. In one smooth motion, press the Insert fully into the Valve Body until it bottoms out. **See Figure 8.**
16. Apply a thin coat of Blue Goop (400001-1) to the Poppet Landing and insert in the outlet end of the Valve Body. Push the O-Ring (400043-014) into the groove to hold the Poppet Landing in place. **See Figure 9.**
17. Apply Blue Goop to the threads of the Valve Adapter and screw into Valve Body outlet. Torque to 35-40 ft-lbs (47-54 N-m).
18. Apply Blue Goop to the threads on top of the Valve Body. Thread Valve Body into Air Actuator and torque to 35-40 ft-lbs (47-54 N-m).
19. Insert Valve Assembly into the mounting collar on system. Align the coned insert with the seat of the Valve body by carefully moving the valve assembly up and down slightly. You should feel the coned insert align with the seat.
20. Attach the pneumatic control line (air line) to the Solenoid Valve.
21. Turn on the high-pressure source and slowly raise the pressure, checking for leaks. Make sure the valve is operating properly by pressing the E-Stop button while the pump is at operating pressure. The valve should dump all the pressure in the HP lines.

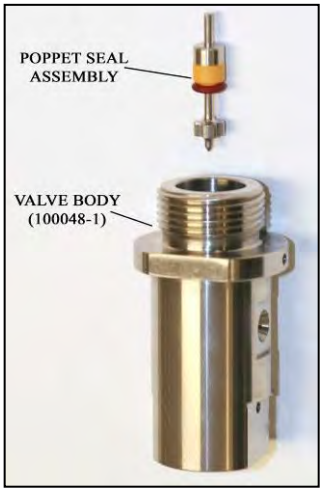


Figure 7

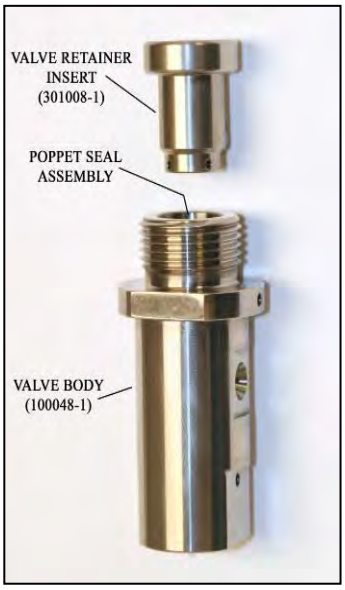


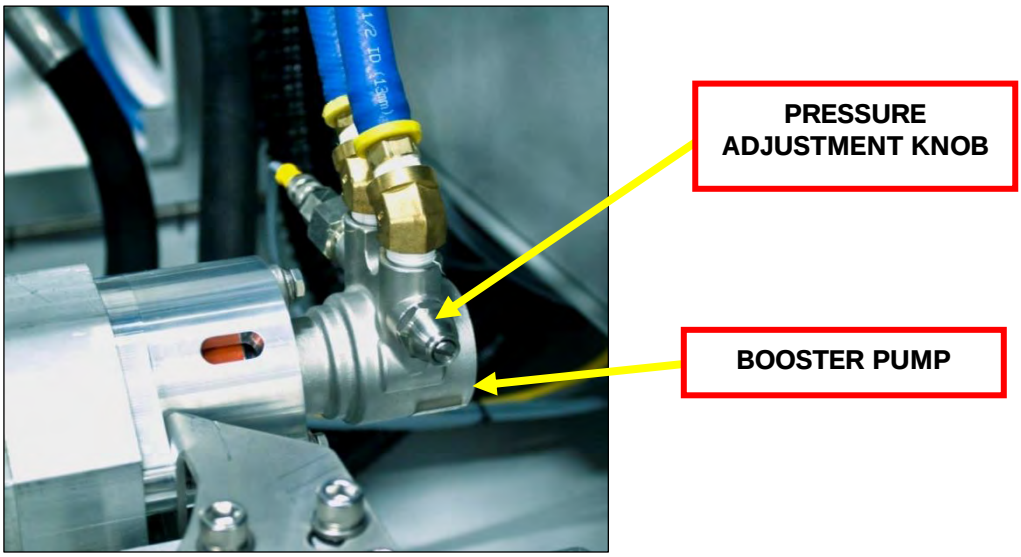
Figure 8

Figure 9

5.16 Water Booster Pump

5.16.1 Booster Pump Adjustment

If booster pump pressure, as read on the booster pump discharge pressure gauge **C** (see section 3.9.3) is less than 80 psi [5.8 bar], the booster pump or inlet water regulator needs to be adjusted (see section 3.9.5). Always check the filter condition before servicing the Water Booster Pump. Pressure drop is often caused by dirty filters.



Components:

Booster Pump Pressure control knob

Recommended Tools:

Flat blade screwdriver [to turn pressure control knob.]
Container to catch water spill
Rags

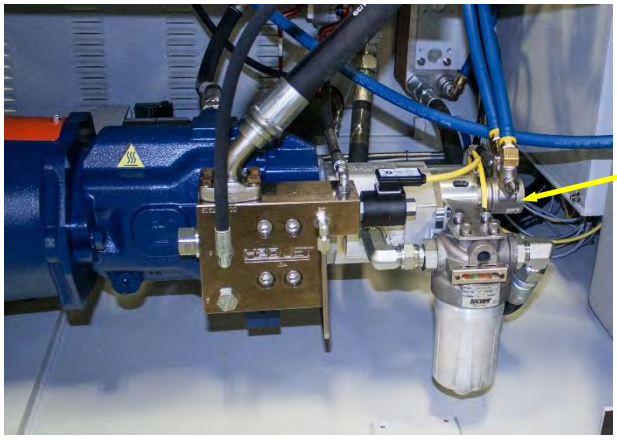
Booster Pump Adjustment Procedure

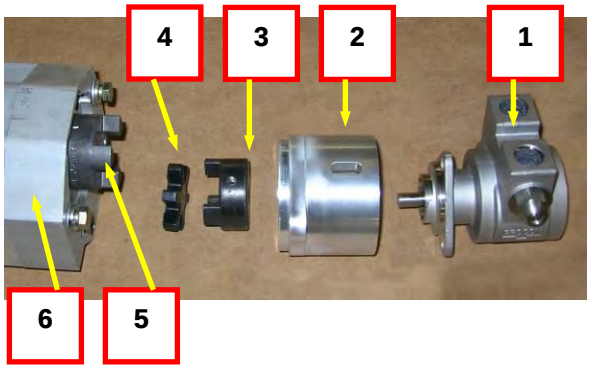
1. Turn on cutting water supply
2. Start the waterjet pump and observe booster discharge pressure
3. Stop the waterjet pump and press E-Stop button.
4. Locate the acorn nut from the side of the booster pump and turn the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure.
5. Restart the waterjet pump and observe the booster pump discharge pressure. The ideal pressure is 80-90 psi [5.8-6.2 bar]. Do not exceed 90 psi [6.2 bar] as damage to the filter bowls can occur.

   If necessary, repeat steps 3 and 5.

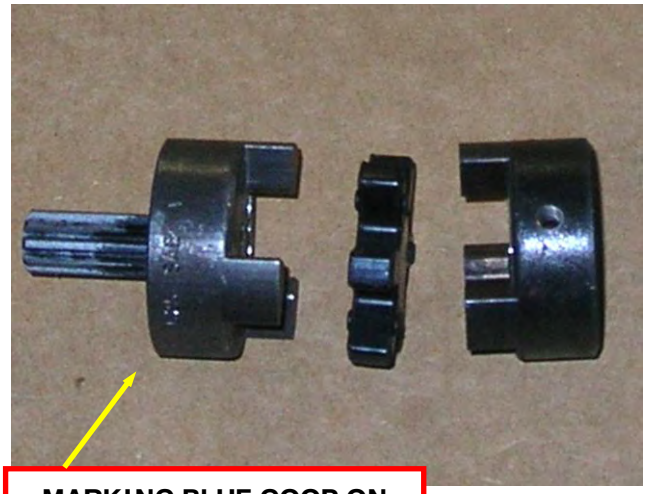
5.16.2 Booster Pump Repair / Replace

The Water Booster is serviceable and replaceable as a separate unit. If the Booster Pump output pressure falls below 45psi [3 bar] and cannot be restored after checking the condition of the water filters and the input pressure and volume it is likely the Booster Pump needs to be rebuilt or replaced. There is also an additional water filter in the line between the Booster Pump and the Intensifier(s). This is to keep Booster Pump debris from damaging the Intensifier[s] in the event of a catastrophic failure of the Booster Pump. The condition of this filter should also be checked before opening the Booster Pump. Checking the filter for gritty pieces is a quick way to determine if there has been a catastrophic failure of the Booster Pump. See page 66 for a detailed exploded view of the Booster Pump

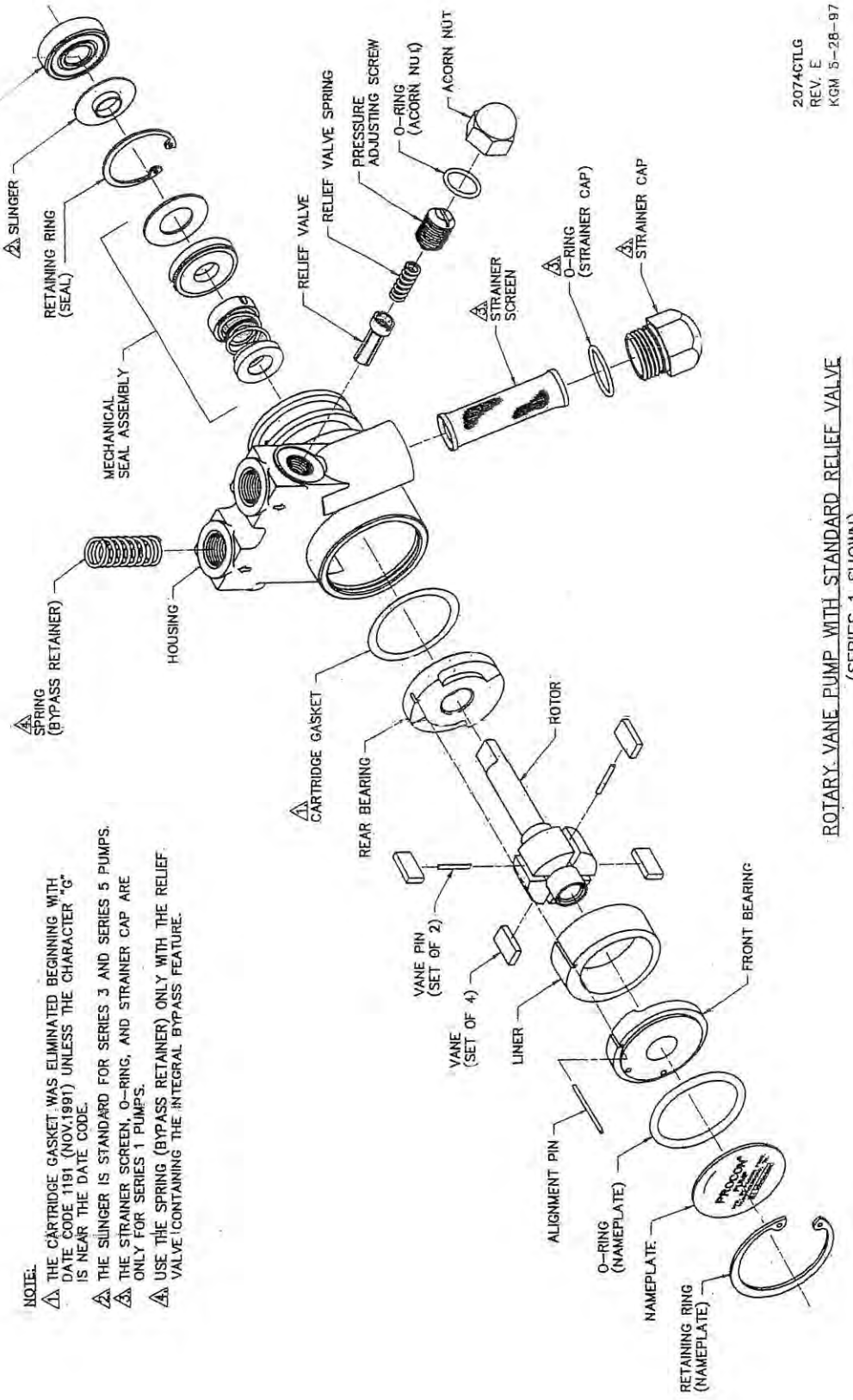




1. Disconnect and plug the inlet and outlet hoses to the Booster Pump (1). Be sure and unplug the temperature sensor.
2. Unbolt the Booster Pump Adaptor (2) from the Hydraulic Recirculation Pump (6) at the Hydraulic Pump side. The Booster Pump coupler halves (3 & 5) and the coupler insert (4) should simply separate inside the adaptor. Coupler section (5) has a splined shaft that inserts into the Hydraulic Recirculation Pump.
3. Turn the Booster Pump so the set screw aligns with the slot on the adaptor housing. Loosen the screw and remove the coupler.
4. Unbolt the Water Booster Pump from the adaptor housing.
5. Tearing down the Water Booster Pump requires a small press for the front nameplate. There is an o-ring behind it that makes removal of the retaining clip difficult.
6. After the faceplate is removed the rebuilding of the pump is straightforward according to the exploded drawing that comes with the rebuild kit.
7. There are two primary points to take note of during the reassembly. First, the vane pins on the 50HP pumps are flat on one side. When the pins are reinserted into the rotor make sure the flat sides face each other. This enables them to be placed closer to the center of the vane. The 100HP Dual Pump uses round pins and this is not an issue.



8. Second. The front and rear bearings on the pump insert have small holes on one side. The holes must go on the output side of the pump (right side facing the nameplate.
9. Use the press again to depress the nameplate so the retaining ring can be inserted into place.
10. Bolt the Booster Pump back onto the adaptor with the access slot facing up. Do not put the coupler on the Booster Pump first as it will not fit through the adaptor.
11. The coupler end with the splined shaft (5 above) must be checked for clearance. Put some Blue Goop or other marking material on the face that goes toward the Hydraulic Pump. Insert the shaft all the way in place and withdraw. Check to see if there is Blue Goop on the Hydraulic Pump face. If there is the coupler must be replaced. Clean the Goop off the coupler.
12. Line coupler part (3) on the Water Booster Pump shaft.
13. Place the coupler insert (4) on top of the first section.
14. Place the final coupler part with the splined shaft (4) on the coupler/Booster Pump assembly.
15. Insert the entire assembly into place on the Hydraulic Recirculation Pump.
16. Bolt into place.
17. Retighten the coupler set screw through the slot. If this no longer lines up you will have to jog the motor to find the screw through the slot.
18. Reattach the hoses and Temperature Sensor connection.
19. Follow the procedures in section 5.16 steps 15-18 for purging the lines of air before running the pump.



ROTARY VANE PUMP WITH STANDARD RELIEF VALVE
(SERIES 1 SHOWN)

NOTE:
1. THE CARTRIDGE GASKET WAS ELIMINATED BEGINNING WITH DATE CODE 1191 (NOV.1991) UNLESS THE CHARACTER "G" IS NEAR THE DATE CODE.
2. THE SLINGER IS STANDARD FOR SERIES 3 AND SERIES 5 PUMPS.
3. THE STRAINER SCREEN, O-RING, AND STRAINER CAP ARE ONLY FOR SERIES 1 PUMPS.
4. USE THE SPRING (BYPASS RETAINER) ONLY WITH THE RELIEF VALVE CONTAINING THE INTEGRAL BYPASS FEATURE.

5.17 Water Filter Service

1. Switch off main electrical disconnect
2. Shut the external intake valve for the Cutting Water Supply
3. Place a bucket under the filter housing.
4. Carefully unscrew the filter bowl nut using the special filter-housing wrench letting the water run into the bucket.
5. Remove the filter bowl completely and carefully wipe the inside clean
6. Remove both filter cartridges from the bottom of the housing as needed. The front filter (10 micron) is for the main water inlet and is first in the system. The rear filter (1 micron) is for the booster pump and is immediately before the intensifiers.
7. Carefully clean any residue from the inside of the housing with a clean shop rag.
8. Insert the 1 micron filter in the rear fitting. The end with the seals goes up. Keep the plastic wrap on the filter during installation to keep grease off the element. This will help extend the filter's life. Remember to remove the plastic before putting the bowl back on.
9. Insert the 10 micron filter in the front fitting. Again, the end with the seals goes up.
10. Screw the nut back on but only finger tight at first.
11. Now tighten the nuts down using the filter wrench.
12. Disconnect the water inlets from the intensifier end caps.
13. Insert a quick-connect fittings in each of these to purge air so water will freely flow out of them.
14. Turn the Cutting Water supply back on and allow it to run for three minutes to purge all air from the lines, filter and booster pump. Turn off the water and reconnect the fittings on the end caps.
15. Turn the water back on and check for leaks

CAUTION

Air must be purged from the filter and system before operating the pump. Operating the intensifier with air in the line can cause considerable damage as there would be no water resistance against the hydraulic oil pressure in the intensifier.

5.18 Heat Exchanger Service

An oil-to-water heat exchanger is used to control heat buildup in the hydraulic oil. The heat exchanger requires no routine maintenance.

If the hydraulic oil has a muddy appearance with no evidence of entrained air bubbles, this indicates that the oil is contaminated with water. Water in the oil can originate from contaminated oil being introduced into the reservoir, excessive condensation in the reservoir, a missing reservoir filler cap, and/or a leaky heat exchanger. The following procedure will help you determine if the heat exchanger is leaking water into the oil system.

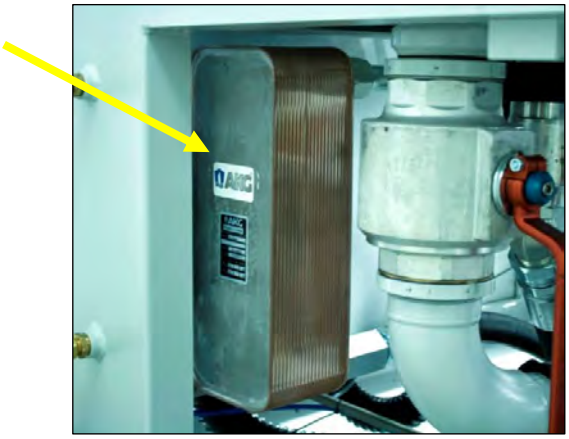
NOTE: A continual rise in the oil level is a sign of heat exchanger failure.

1. Shut down the system and shut off all water inlets.

WARNING

Place the main electrical disconnect in the OFF position and bleed down all high-pressure lines. Place an "Out of Service" tag on the main electrical disconnect and lock it out. Failure to do so may result in damage to equipment or injury to personnel.

2. Disconnect the water hoses from the heat exchanger.
3. Disconnect the hydraulic oil lines. Have a drip pan and several rags ready as oil will drain from the lines as they are detached. Support the heat exchanger as needed to minimize oil loss.



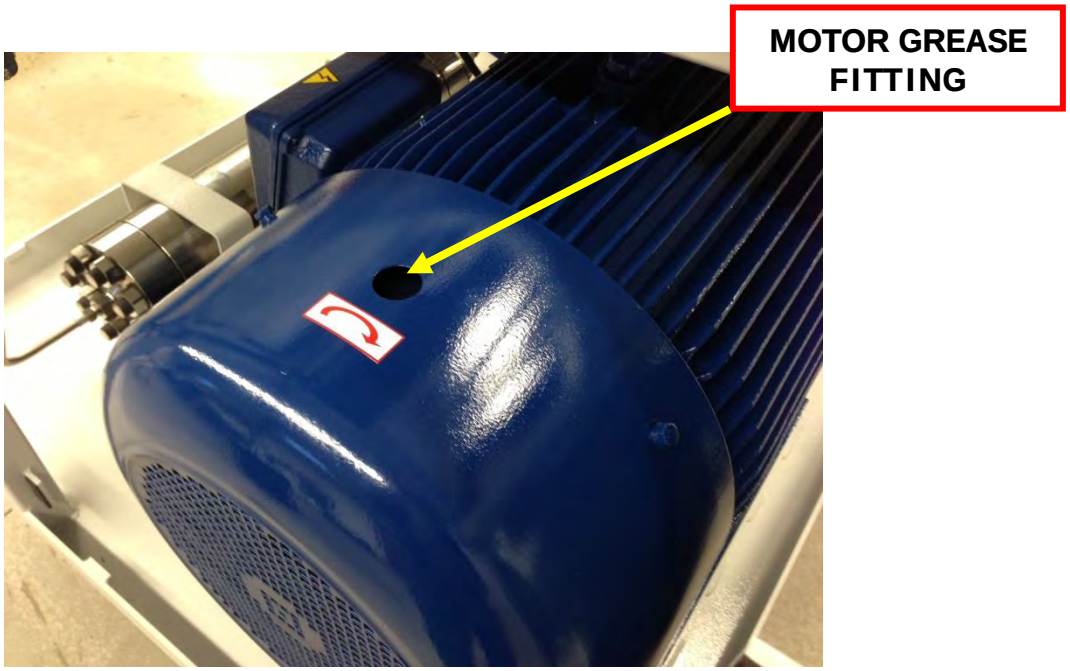
4. Remove the bolts that secure the heat exchanger to the support. Hold the heat exchanger level to minimize oil loss. Place the heat exchanger on a level workbench.
5. Insert a plug into one of the water ports and an air line connection into the other water port.
6. Top off the heat exchanger with oil through the open oil ports.
7. Connect an air line to the fitting attached to the heat exchanger. This air line must be regulated to a maximum of 150 psig [10.2 bar] air pressure, and must have an on/off valve within reach.
8. While watching the oil ports for air bubbles, slowly open the air valve and pressurize the heat exchanger. If the heat exchanger is leaking, the bubbles will be noticeable within a few minutes.
9. If the heat exchanger is defective, repair or replace the unit. If the heat exchanger is not defective, remove the fittings and reinstall the heat exchanger on the pump.

   If the heat exchanger is satisfactory, the source of water in the oil is most likely related either to water entering into the reservoir, or to excessive condensation forming in the reservoir.

5.19 Electric Motor Service

For Best Results, operate motor in a dry environment with the fan-end of the motor away from dust or other contaminates.

1. Shut down the system.
2. Replenish the bearing grease every 5,000 hours of operation. The recommended grease is Mobil Polyrex EM.
3. The motor should be inspected and cleaned every 6 months. In severe environments, clean the fan cover more frequently to ensure proper airflow over the motor. This will prevent the motor from overheating.



5.20 Revision History

Date	Rev. Id.	Description of Change	Written by	Checked by	Approved by
May 3, 2007	A	Tie-Rod tightening torque changed to 120ft-lbs, was 140-155. Spin On Filter changing procedure implemented.	M. Huntley	JN	HA
Sept, 18, 2007	B	Updated Bleed Down Valve Service to represent new style poppet	M. Huntley	JN	HA
May 18, 2007	D	Changed Oil requirements from ISO 68 to ISO 46	M. Huntley	JN	HA
Jan 4, 2012	F	Added diagrams of check valve tolerances to section 5.9.	L. Jorgensen	MH	HA
Oct 23 2012	G	Changed Oil Requirements, Added Motor Grease Schedule	M.Huntley	MH	HA
Dec 05, 2012	J	Updated Tie Rod Torque Procedure	M.Huntley	MH	HA
Dec 17, 2012	K	Updated Check Valve Procedure	L. Jorgensen	MH	HA
Oct 22, 2013	L	Added Air Bleed Service	M.Huntley	M.H.	H.A.
Feb 28, 2014	M	Updated Oil Filter Service Procedure and Photos	L. Jorgensen	M.H.	H.A.
Apr 14, 2014	N	Updated Shift Sensor Screw Torque From 160 in-lb to 6 ft-lb	L. Jorgensen	M.H.	H.A.
Apr 8, 2015	P	Complete manual update.	L. Jorgensen	M.H.	

6. Parts and Assembly List

6.1 Major Service and Repair Parts for H2O Jet Pumps.

More parts and assemblies are listed in the High Pressure Waterjet Components Catalog

Description	40/60K	Item #
Intensifiers		
Full Intensifier Assembly Electric Shift	60K	301020-3-3-HL
	40K	301020-5-3-HL
Intensifier Short Block	60K	301003-3-3
	40K	301003-4-4
Pilot and Shift Valves		
Pilot Valve, Electronic	60/40	400054-1
Shift Valve Assembly (Electric)	60/40	301018-2
Shift Sensor	60/40	301011-3
Intensifier Parts, Seals and Kits		
Piston and Plunger Assembly	60K	301005-3
	40K	301005-4
Check Valve Assembly	60K	301002-3
	40K	301002-4
Check Valve Repair Kit	60/40	302003-2
Piston Assembly	60K	301023-1
	40K	301023-2
Piston	60K	100176-1
	40K	100176-2
Piston Seal Kit	60/40	302013-1
Plunger	60K	100013-1
	40K	100013-2
Intensifier Hydraulic Seal Kit	60K	302007-3
	40K	302007-4
High Pressure Seal Kit	60K	302004-1
	40K	302004-2

Description	Item #
Other Assemblies, Parts and Kits	
Attenuator	301025-1
Hydraulic Bleed Down Valve Assembly	301013-1
Hydraulic Bleed Down Valve Repair Kit	302008-1
Air Actuated Bleed Down Valve Assembly	301017-2
Air Actuated Bleed Down Valve Repair Kit	302001-1
Water Filter (1 micron)	400023-1-1S
Water Filter (10 micron)	400023-1-10S
Hydraulic Return Filter	606210-6-F (50hp) 606210-9-F (100hp)
Flat Plate Heat Exchanger	606045-2
Tools for Intensifier Work	
End Cap Spanner Wrench	400025-1
H2O Jet HP Cylinder Wrench	301027-1
HP Seal Installation Tool Kit 4-pcs	302015-1
Firing Pin Insertion Tool	301038-1
Intensifier Assembly Bench	301037-1
Bleed Down Valve Seal Insertion and Removal Tools Kit	302016-1

6.1.1 Recommended Spare Parts for H2O Jet Pumps

Values represent the recommended quantity of spare parts that should be kept on hand

60K, ELECTRONIC SHIFT

Item #	Description	Single Pump	Redundant Pump	Dual Pump
	Intensifier Parts, Seals and Kits			
302003-2	Check Valve Repair Kit	**2**	**2**	**4**
100009-1	Check Valve Body, 60K	**2**	**2**	**4**
100051-2	Shift Pins	**2**	**2**	**4**
302013-1	Piston Seal Kit	**1**	**1**	**2**
302007-3	Intensifier Hydraulic Seal Kit, 60K	**2**	**2**	**4**
302004-1	High Pressure Seal Kit, 60K	**2**	**2**	**4**
	Other Assemblies, Parts and Kits			
302008-1	Bleed Down Valve Repair Kit	**1**	**1**	**1**
606048-1	Proportional Valve with Coil	**1**	**1**	**2**
400023-1-1S	Water Filter (1 micron)	**1**	**1**	**1**
400023-1-10S	Water Filter (10 micron)	**1**	**1**	**1**
606210-6-F	Hydraulic Return Filter Cartridge 6" (10-50HP)	**1**	**1**	**0**
606210-9-F	Hydraulic Return Filter Cartridge 9" (100HP)	**0**	**0**	**1**

40K, ELECTRONIC SHIFT

Item #	Description	Single Pump	Redundant Pump	Dual Pump
	Intensifier Parts, Seals and Kits			
302003-2	Check Valve Repair Kit	**2**	**2**	**4**
100009-2	Check Valve Body, 40K	**2**	**2**	**4**
100051-2	Shift Pins	**2**	**2**	**4**
302013-1	Piston Seal Kit	**1**	**1**	**2**
302007-4	Intensifier Hydraulic Seal Kit, 40K	**2**	**2**	**4**
302004-2	High Pressure Seal Kit, 40K	**2**	**2**	**4**
	Other Assemblies, Parts and Kits			
302008-1	Bleed Down Valve Repair Kit	**1**	**1**	**1**
606048-1	Proportional Valve with Coil	**1**	**1**	**2**
400023-1-1S	Water Filter (1 micron)	**1**	**1**	**1**
400023-1-10S	Water Filter (10 micron)	**1**	**1**	**1**
606210-6-F	Hydraulic Return Filter Cartridge 6" (10-50HP)	**1**	**1**	**0**
606210-9-F	Hydraulic Return Filter Cartridge 9" (100HP)	**0**	**0**	**1**

6.2 Repair Component Visual List

6.2.1 Intensifiers

Intensifier, Electric Shift
60K 301020-3-3-HL
40K 301020-5-3-HL

Intensifier, Short Block
60K 301003-3-3
40K 301003-4-4

6.2.2 Pilot and Shift Valves

Pilot Valve, Electric
400054-1

Shift Valve Assembly, Electric
301018-2

Shift Sensor
301011-3

6.2.3 Intensifier Parts, Seals and Kits

Piston and Plunger Assembly
60K 301005-3
40K 301005-4

Check Valve Assembly
60K 301002-3
40K 3-1002-4

Check Valve Repair Kit
302003-2

Hi-Load Piston Assembly
60K 301023-1
40K 301023-2

Hi-Load Piston
60K 100176-1
40K 100176-2

Piston Seal Kit 60/40K
302013-1

Plunger
60K 100013-1
40K 100013-2

Intensifier Hydraulic Seal Kit
60K 302007-3
40K 302007-4

High Pressure Seal Kit
60K 302004-1
40K 302004-2

6.2.4 Other Assemblies, Parts and Kits

Air Actuated Bleed Down Valve Assembly
301051-1

Air Actuated Bleed Down Valve Repair Kit
302001-1

Hydraulic Bleed Down Valve Assembly
301013-1

Hydraulic Bleed Down Valve Repair Kit
302008-1

Attenuator
301025-1

Water Filter
(1 micron) 400023-1-1S
(10 micron) 400023-1-10S

Hydraulic Return Filter Cartridge
606210-6-F (50HP)
606210-9-F (100HP)

Flat Plate Heat Exchanger
606045-2

6.2.5 Tools for Intensifier Work

End Cap Spanner Wrench
400025-1

H2O Jet HP Cylinder Wrench
301027-1

HP Seal Installation Took Kit (4-pcs)
302015-1

Firing Pin Insertion Tool
301038-1

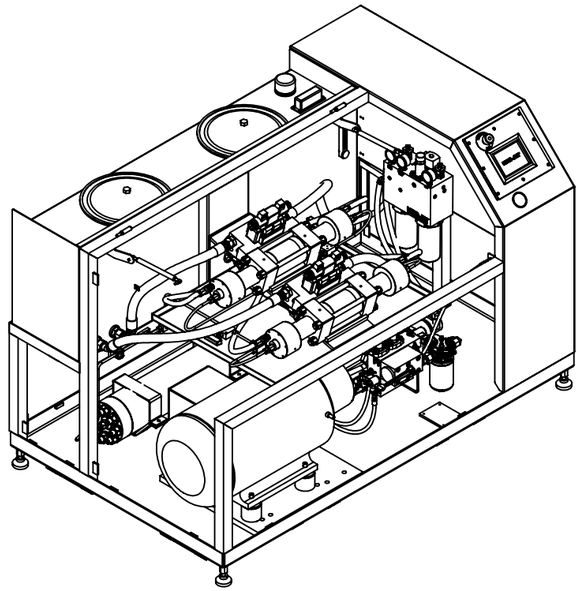
Intensifier Assembly Bench
301037-1

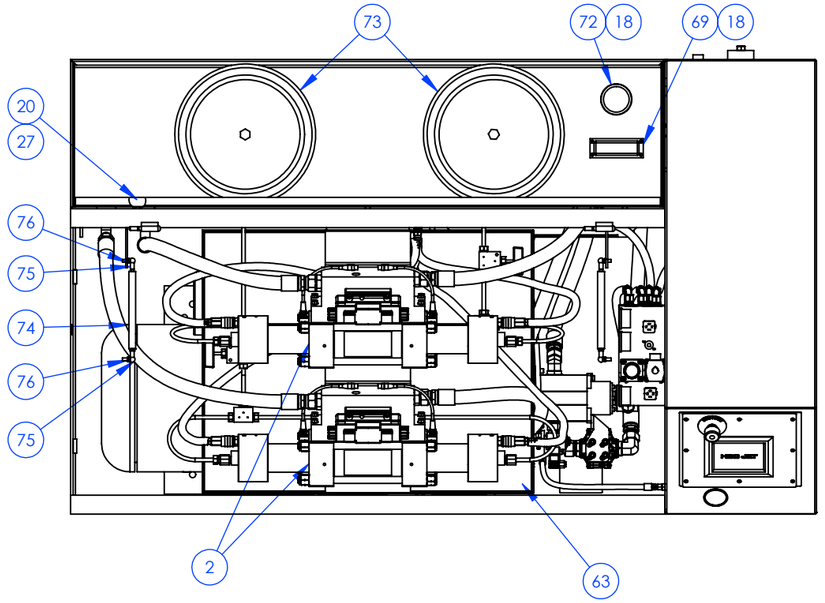
Bleed Down Valve Seal Insertion and Removal Tool Kit
302016-1

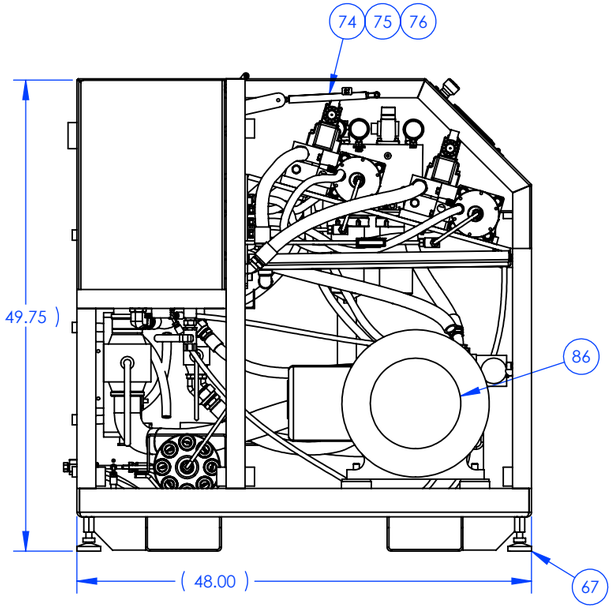
Pump Service Tool Kit
302018-1

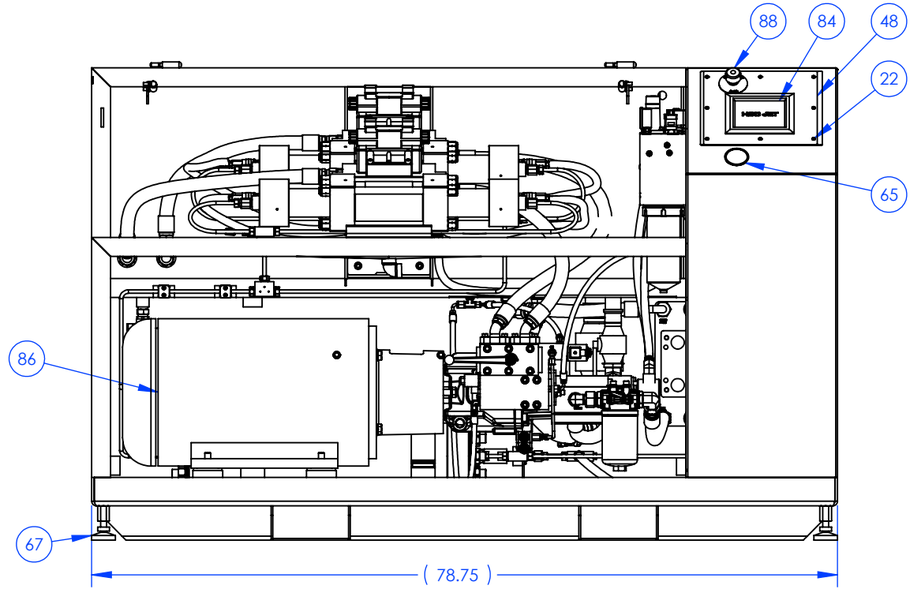
6.3 Revision History

Date	Rev. Id.	Description of Change	Written by	Checked by	Approved by
May 8, 2006	0	First Publication	P. Spencer Norby	JN	HA
May 3, 2007	A	Updated Filter Part Number	M. Huntley	JN	HA
March 23, 2009	B	Updated Intensifier PN pg 4, 301020-3-3, 301020-5-3	M. Huntley	JN	HA
March 25, 2009	C	Updated Filter Part Number	M. Huntley	JN	HA
May 18, 2015	D	Complete Manual Update	L. Jorgensen	M.H.	H.A.









NOTES:
1. ASSEMBLY SHOWN WITH DOORS AND TOP LID REMOVED FOR CLARITY.
2. ELECTRICAL CONDUIT NOT SHOWN FOR CLARITY.
3. SEE PAGE 5 OF 5 FOR BILL OF MATERIALS.

ECN #	Date	Rev	Reason for Changes	Drwn By	Chk By	Apvd By

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES AND DEGREES
DIAMETERS ON A COMMON CENTERLINE TO BE TRUE POSITION WITHIN .010.
REMOVE BURRS AND BREAK SHARP CORNERS AND FILLET RADII .030 MAXIMUM

ALL MACHINED SURFACES TO: 63
TOERANCES PER ANSI Y15.5

DIMENSIONAL	X.XXX	± .005
	X.XX	± .010
	X.X	± .030
ANGULAR	X.X	± .5
	X	± 1

H2O JET™

DRAWN: M.H.	TITLE: PUMP, ADVANTAGE, 50HP REDUNDANT, 60K -MAIN FRAME ASSEMBLY-	REF. NR. 303002-1	
CHECKED: J.N.		MADE FROM: -	
APPRVD: H.A			
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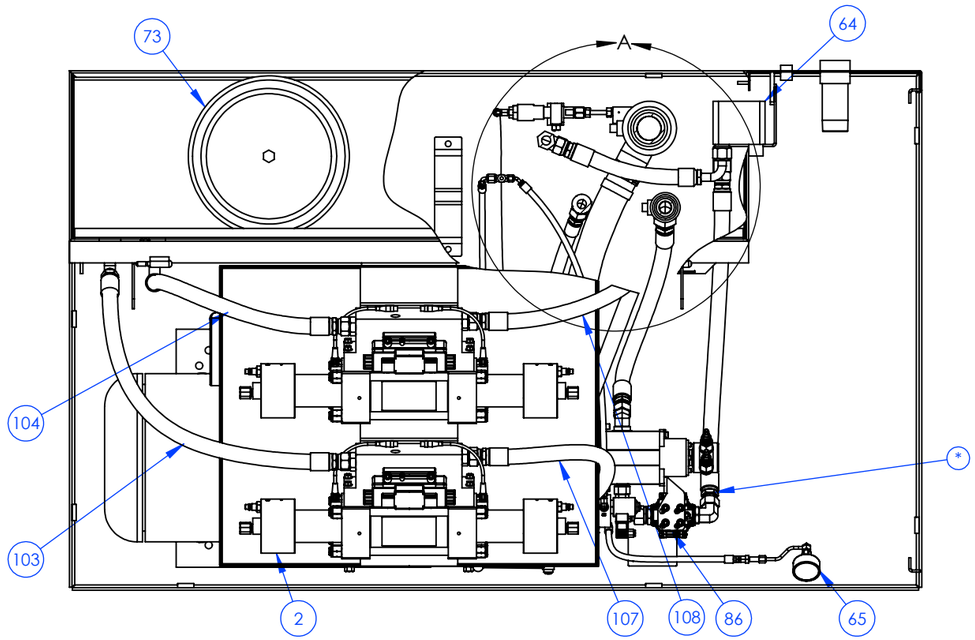
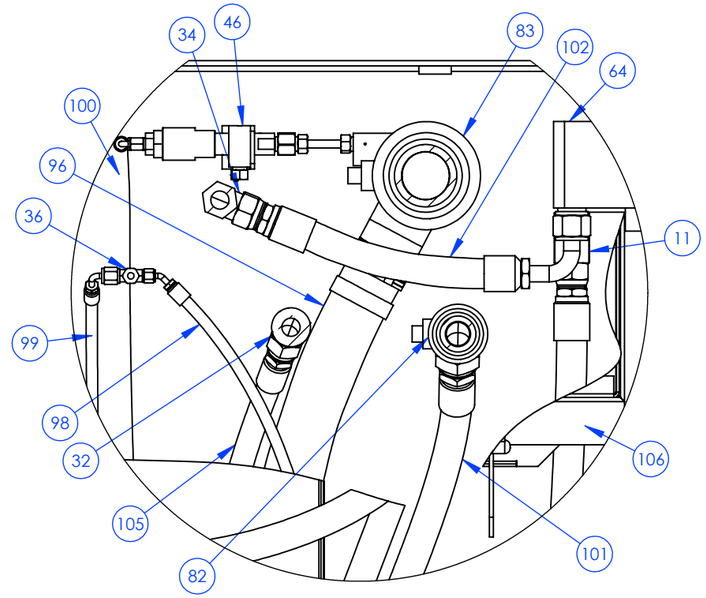
DATE: 5/12/2008			





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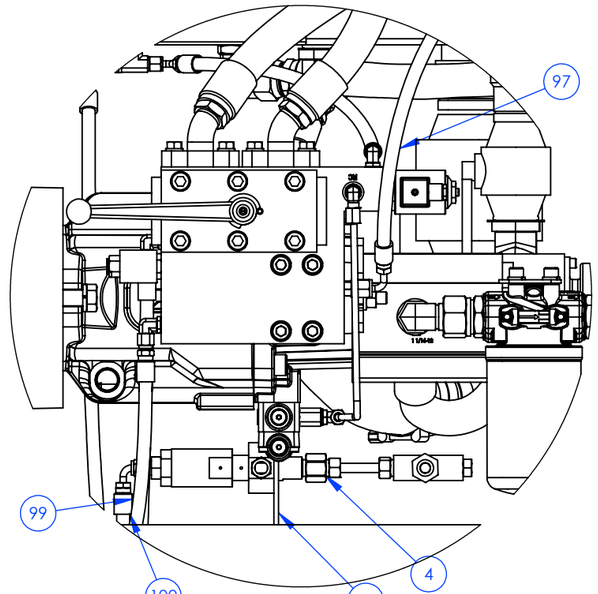

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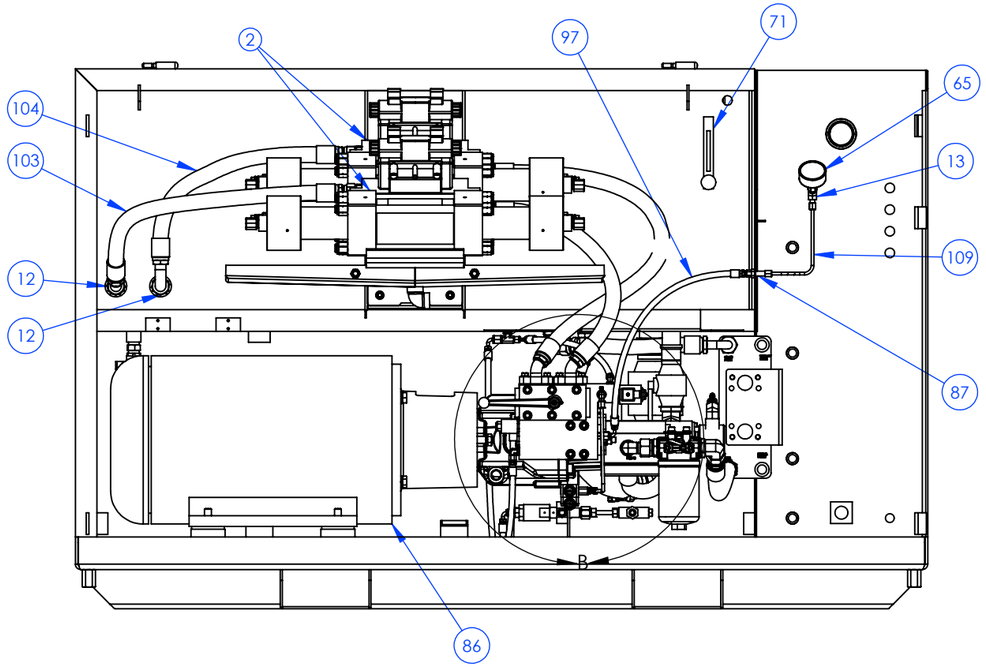

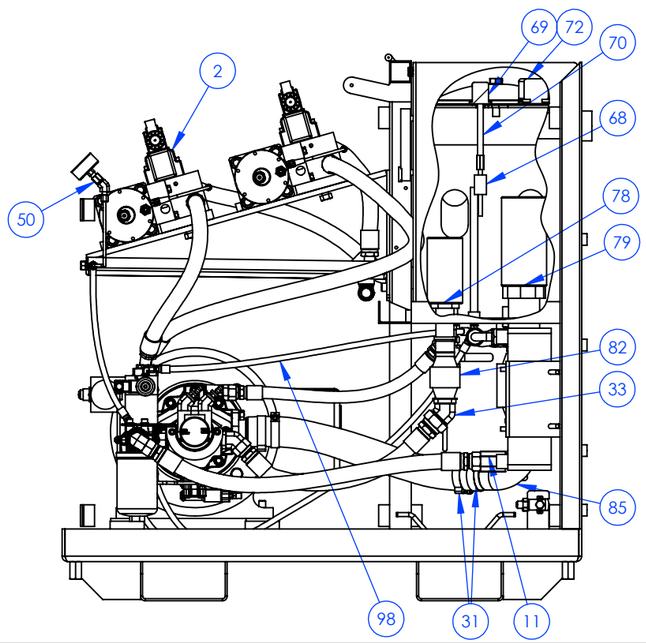

NOTES:
1. PORTIONS OF FRAME NOT SHOWN FOR CLARITY.
2. SEE PAGE 5 OF 5 FOR BILL OF MATERIALS.

ECN #	Date	Rev	Reason for Changes	Drwn By	Chk By	Apvd By

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES AND DEGREES
DIAMETERS ON A COMMON CENTERLINE
TO BE TRUE POSITION WITHIN .010.
REMOVE BURRS AND BREAK SHARP CORNERS
AND FILLET RADII .030 MAXIMUM

ALL MACHINED SURFACES TO: 63
TOERANCES PER ANSI Y15.5

DIMENSIONAL	X.XXX	± .005
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	X.X	± .030
ANGULAR	X.X	± .5
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H2O JET™

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CHECKED: J.N.			MADE FROM: -
APPRVD: H.A			
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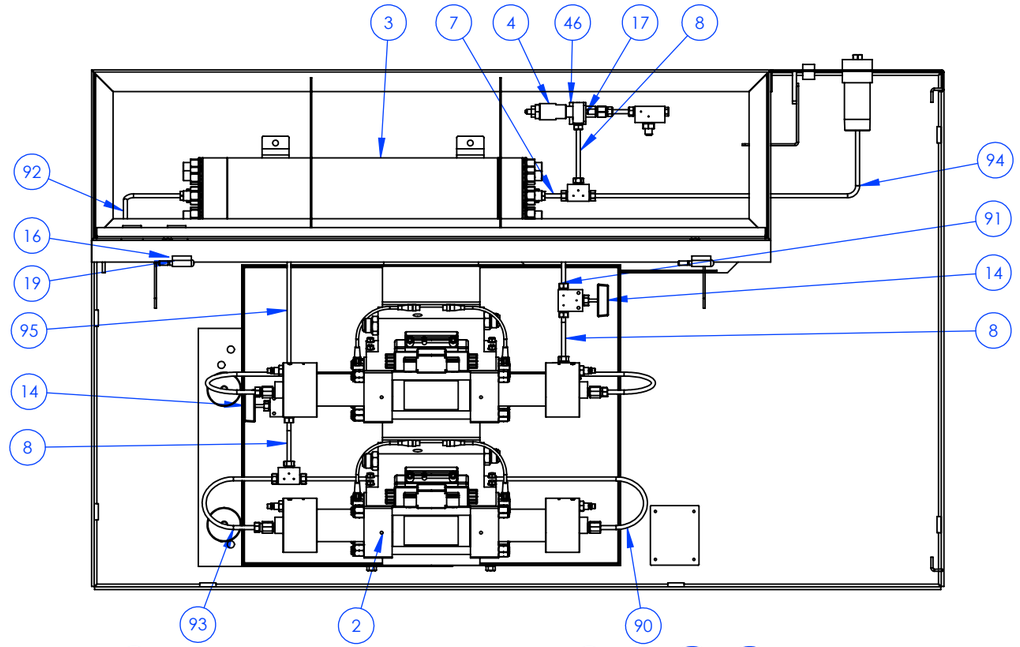
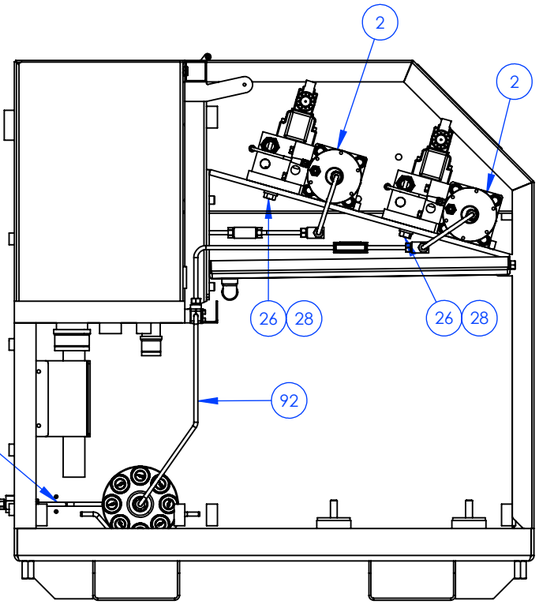
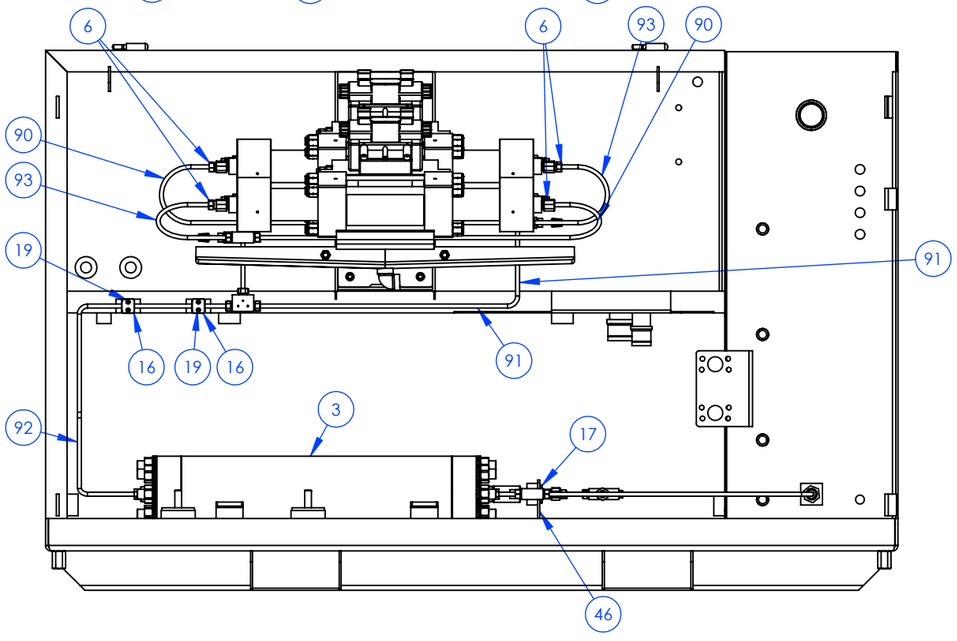
DATE: 5/12/2008			







NOTES:
1. PORTIONS OF FRAME NOT SHOWN FOR CLARITY.
2. SEE PAGE 5 OF 5 FOR BILL OF MATERIALS.

ECN #	Date	Rev	Reason for Changes	Drwn By	Chk By	Apvd By

UNLESS OTHERWISE SPECIFIED:

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DIAMETERS ON A COMMON CENTERLINE
TO BE TRUE POSITION WITHIN .010.
REMOVE BURRS AND BREAK SHARP CORNERS
AND FILLET RADII .030 MAXIMUM

ALL MACHINED SURFACES TO: 63
TOERANCES PER ANSI Y15.5

DIMENSIONAL	X.XXX	± .005
	X.XX	± .010
	X.X	± .030
ANGULAR	X.X	± .5
	X	± 1

H2O JET™

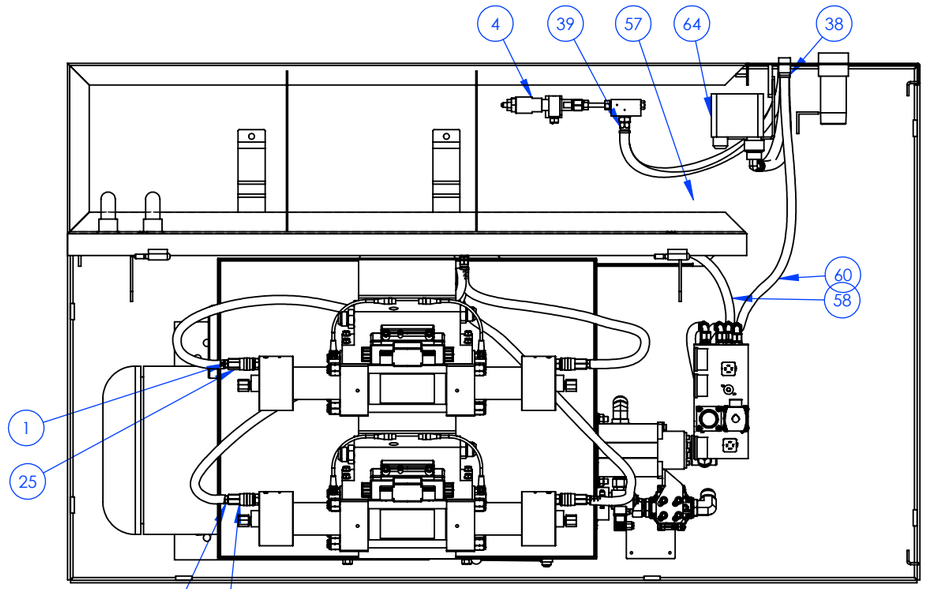
DRAWN:	M.H.
CHECKED:	J.N.
APPRVD:	H.A
SCALE:	1:16
DATE:	5/12/2008

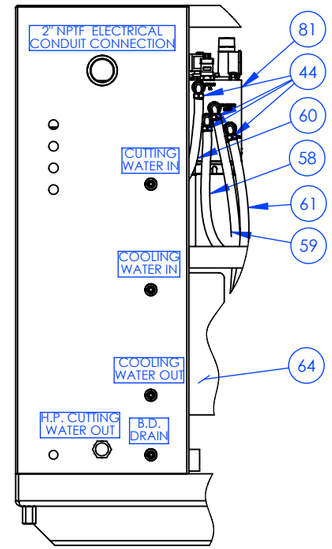
TITLE: **PUMP, ADVANTAGE, 50HP REDUNDANT, 60K -HIGH PRESSURE LINE-**

REF. NR. 303002-1

MADE FROM: -

SIZE **B** | DWG. NO. 303002-1-A-3 | REV **0** | SHEET 3 OF 5





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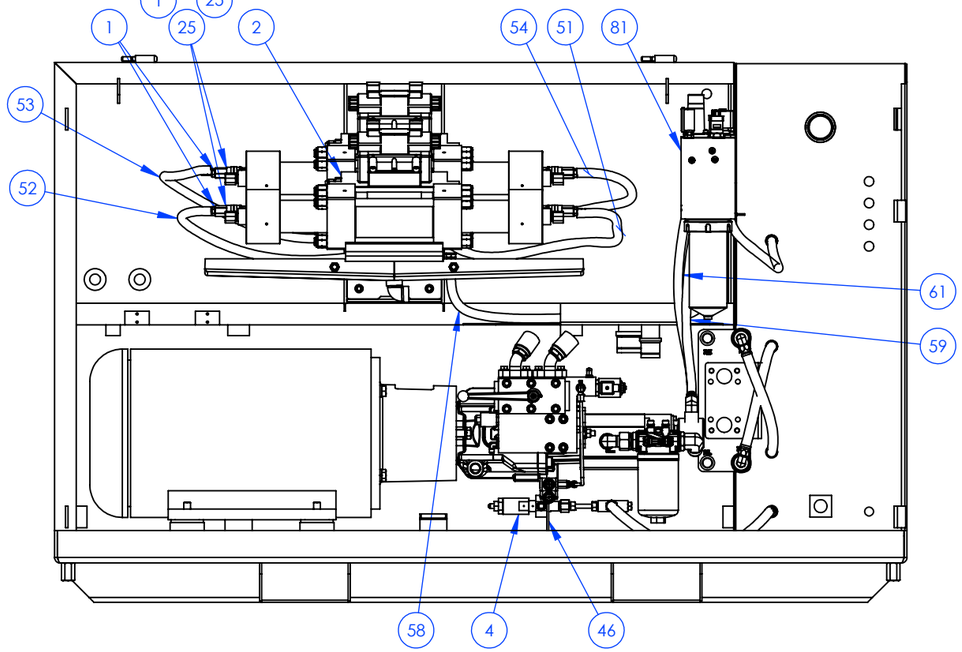

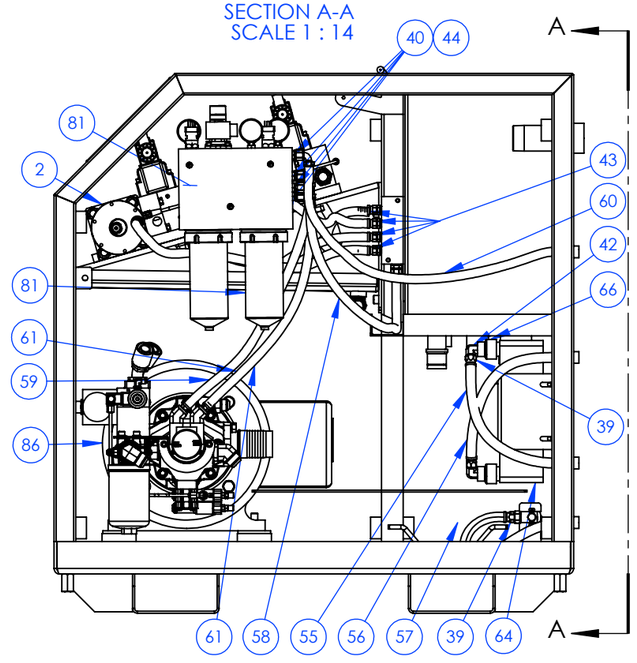

NOTES:
1. PORTIONS OF FRAME NOT SHOWN FOR CLARITY.
2. SEE PAGE 5 OF 5 FOR BILL OF MATERIALS.

ECN #	Date	Rev	Reason for Changes	Drwn By	Chk By	Apvd By

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES AND DEGREES
DIAMETERS ON A COMMON CENTERLINE
TO BE TRUE POSITION WITHIN .010.
REMOVE BURRS AND BREAK SHARP CORNERS
AND FILLET RADII .030 MAXIMUM

ALL MACHINED SURFACES TO: 63
TOERANCES PER ANSI Y15.5

DIMENSIONAL	X.XXX	± .005
	X.XX	± .010
	X.X	± .030
ANGULAR	X.X	± .5
	X	± 1

H2O JET™

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CHECKED: J.N.			MADE FROM: -
APPRVD: H.A			
SCALE: 1:14	SIZE B	DWG. NO. 303002-1-A-4	REV 0 / SHEET 4 OF 5
DATE: 5/12/2008			

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	4	100015-2-A1	HOSE BARB, QUICK DISCONNECT FITTING, 3/8"
2	2	301020-3-3-HL	INTENSIFIER, 60K, ELECTRONIC SHIFT, H2O 2PC CHECK VALVE ASSY, HI-LOAD PISTON
3	1	301025-1	ATTENUATOR ASSEMBLY, 60K
4	1	301028-1	HYDRAULIC AUTO BLEED DOWN WITH CATCHER ASSEMBLY
5	3	400004-5-13	HEX NUT, 1/2"-13 NC, STAINLESS
6	4	400005-2	GLAND NUT, HP 3/8"
7	1	400010-3	NIPPLE, HP PIPE, 3/8" OD x 3" LG
8	3	400010-6	NIPPLE, HP, 3/8" O.D. 6" LONG
9	4	400012-2	TEE, HP, 3/8"
10	1	400014-2	BULKHEAD FITTING, HP, 3/8"
11	1	400016-2	CHECK VALVE, 5 PSI, #16 JIC M X #16 JIC F
12	2	400059-16	FITTING, PARKER, 16 F5OX-S, STRAIGHT THD CONNECTOR, 16 MSAE TO 16 MJIC
13	1	400059-4-45	FITTING, ADAPTER, 45DEG ELBOW, PARKER 2505-4-4, 1/4" NPTF TO 4 MJIC
14	2	400072-2	HAND VALVE, 2 WAY, 3/8"
15	1	400074-2	GROMMET, RUBBER, 1.75" ID X 2" PANEL
16	2	400082-2	CLAMP SET, 3/8" HP TUBING
17	2	400085-10-32-.5	SCREW, SHCS, SS, 10-32 X .5"
18	10	400085-10-32-.875	SCREW, SHCS, SS, 10-32 x .875
19	4	400085-25-20-1.5	SOCKET HEAD CAP SCREW, SS, 1/4"-20 X 1.5"
20	3	400085-5-13-1	SCREW, SHCS, SS, 1/2-13 X 1.0"
21	6	400085-50-13-1.0	SOCKET HEAD CAP SCREW, 1/2-13 X 1.0" LONG, SS
22	8	400086-10-32-5	SCREW, SBHCS, SS, 10-32 X .5"
23	3	400087-5	WASHER, FLAT, 1/2", 18-8 STAINLESS
24	3	400087-5-13-2	STUD, FT, 1/2"-13 X 2" SS
25	4	400089-1	QUICK DISCONNECT, STAINLESS STEEL, 3/8" NPTF
26	4	400093-625-11-2.25	HEX HEAD BOLT 0.6250-11x2.25" LG
27	3	400101-5	WASHER, LOCK, 1/2", HEAVY
28	4	400101-75	WASHER, LOCK, 3/4" SS
29	4	400133-625	WASHER, FENDER, .518ID X 3" OD
30	1	400312-75	BRASS BALL VALVE, 3/4" NPT F
31	4	400314-250	T-BOLT HOSE CLAMP, 2.5" HC-250
32	1	400320-16-45	FITTING, 45DEG ELBOW, PARKER, 16 V5OX-S, 16 MSAE TO 16 MJIC
33	1	400320-20	ELBOW, 45DEG, #20 MSAE X #20 MJIC
34	1	400321-16-90	FITTING, 90 DEG ELBOW, PARKER: 16 C5OX-S, #16 MSAE TO #16 MJIC
35	1	400321-4-90	FITTING, 90 DEG ELBOW, PARKER: 4 C5OX-S, #4 MSAE TO #4 MJIC
36	1	400323-4-4-6	TEE FITTING, # 6 MSAE X#4 MJIC X #4 MJIC
37	1	400330-12-12	FITTING, PARKER, NIPPLE, .75 MNPT HEX NIPPLE
38	4	400333-500-5	FITTING, PARKER, HOSE BARB, 8 MNPT TO 8 MBARB (.500 HOSE)
39	4	400335-500	FITTING, BARB , PARKER, #8 FJIC TO #8 HOSE BARB PUSH LOCK
40	8	400336-375-AL	ADAPTER, 3/8" MNPT X 3/8" MJIC, ALUMINIUM
41	1	400336-500-500	ADAPTER, 1/2" NPT X 1/2" JIC/SAE BRASS
42	2	400336-500-90	FITTING, 90 DEG ELBOW, PARKER: 8 CTX-S, #8 (.500) MNPT TO #8 MJIC
43	4	400348-6-6	HOSE FITTING, 3/8 FJIC TO 3/8 M PUSH LOCK BARB
44	4	400349-8-8-AL	PUSH LOCK FITTING, 90 DEG, 1/2" JIC X 1/2" HOSE BARB
45	1	605001-8-A	ADVANTAGE FRAME COMPLETE, REMOVABLE TANK/PAN DESIGN
46	1	605006-1-D	BRACKET, BLEED DOWN VALVE
47	4	605007-3	MOTOR VIBRATION ISOLATOR, SMP-30/50 SKID PUMP
48	1	605010-4	COVER PLATE, OPERATOR CONSOLE, FLUSH MOUNT
49	11	605011-1	LATCH, LIFT & TURN, COMPRESSION LATCH
50	1	605021-1	ORIFICE STYLE PRESSURE SNUBBER, 303SS, 1/4" NPT, .015"
51	1	605040-.375	HOSE LP WATER, JUNCTION BLOCK TO FRONT INTENSIFIER, RIGHT, 48"
52	1	605040-.375	HOSE LP WATER, JUNCTION BLOCK FRONT INENSIFIER, LEFT, 48"
53	1	605040-.375	HOSE LP WATER, JUNCTION BLOCK TO REAR INTENSIFIER, LEFT, 40"
54	1	605040-.375	HOSE LP WATER, JUNCTION BLOCK TO REAR INTENSIFIER, RIGHT, 40"
55	1	605040-.500	HOSE, COOLING WATER OUT, FROM HEAT EXCHANGER TO BACK PANEL, 50HP, SINGLE, 17"
56	1	605040-.500	HOSE, COOLING WATER IN, FROM BACK PANEL TO HEAT EXCHANGER, 50HP, SINGLE, 17"
57	1	605040-.500	HOSE,WATER BLEED DOWNT, FROM BLEED DOWN ASSY TO BACK PANEL, 50HP, SINGLE, 30"
58	1	605040-.500	HOSE, LP WATER, WATER FILTER MANIFOLD TO JUNCTION BLOCK, 40"
59	1	605040-.500	HOSE, LP WATER,WATER FILTER MANIFOLD TO BOOSTER PUMP, 50HP, 32"
60	1	605040-.500	HOSE, LP WATER, WATER FILTER MANIFOLD INLET, 32"
61	1	605040-.500	HOSE, LP WATER, BOOSTER PUMP TO WATER FILTER MANIFOLD, 50HP, 30"
62	4	605049-6-A	THREADED STUD, 5/8-11 X 5.38", 50HP ADV
63	1	605053-1-A	INTENSIFIER PLATE/PAN, REMOVABLE, STD ADV FRAME
64	1	606045-2	AKG HEAT EXCHANGER, 40 PLATES, P4-27641
65	1	606050-1	GAUGE, HYDRAULIC, 0-5000PSI/BAR, #4 SAE REAR
66	2	606093-16-8	FITTING, PARKER, 16 F5OX-S, REDUDER, 1 FNPT TO .5 FNPT
67	4	606100-3	LEVELING FEET, PUMP, 5/8-11 x 2.0" LG
68	1	606103-2-140	TANK LEVEL/TEMPERATURE SWITCH - APCO 140 DEG
69	1	606103-3	TANK LEVEL/ TEMPERATURE SWITCH -APCO
70	1	606103-7	PIPE NIPPLE THREADED, BRASS, 1/4" X 10"
71	1	606104-2	TANK LEVEL SIGHT/TEMPERATURE GAUGE , APPLIED INDUSTRIAL TECH: G620-05-A-1
72	1	606109-1	FILTER BREATHER, BAYONET STYLE, 10 MICRON
73	2	606110-14	END COVER, HYDRAULIC RESERVOIR, LDI INDUSTRIAL: 5060-14-S
74	2	606112-1	GAS SPRING, ADJUSTABLE FORCE, TOP PUMP COVER
75	4	606113-1	END FITTING, GAS STRUT, .39 BALL RECIEVER
76	4	606114-1	BALL STUD, GAS STRUT .39 WITH 5/16" X 18 THREAD
77	8	606115-1	HANDLE, POCKET PULL, FLUSH
78	1	606115-20	STRAINER, PUMP FILTER SYSTEM, 1.25" NPT, 100 MESH, 3 PSI RELIEF
79	1	606115-40	STRAINER, PUMP FILTER SYSTEM, 2.5" NPT, 100 MESH, 3 PSI RELIEF
80	1	606118-3	INLET WATER MANIFOLD, JUNCTION, ADVANTAGE
81	1	606120-4-A	LP, WATER FILTER MANIFOLD
82	1	606135-20	VALVE, BALL, 1.25 SAE ORB, DMIC:BVVAL-1250S-4323
83	1	606135-40	VALVE, BALL, 2.5 SAE ORB, DMIC: BVAL-2500S-4321
84	1	606152-3	TOUCHSCREEN, CTC 5" VGA (320x240) 4.7" DIAG. MICROLOGIX 1200 DRIVER
85	1	606153-1	SUCTION ELBOW, DMIC: BSE-25HB-25S11
86	1	606198-1R	PUMP/MOTOR ASSY, 50HP, WORLDWIDE/CASAPPA
87	1	606201-4	FITTING, BULKHEAD, PARKER 4 WTX-S, 4 MJIC TO 4 MJIC
88	1	610008-1	EMERGENCY STOP BUTTON, RED PUSH BUTTON, TWIST RELEASE
89	1	610008-2	EMERGENY STOP RING TAG
90	2	610030-1	TUBING, HP, 3/8", LOWER INTENSIFIER RIGHT END TO TEE/UPPER INTENSIFIER LEFT END TO TEE
91	1	610030-10	TUBING, HP, 3/8", UPPER INTENSIFIER HAND VALVE TO JUNCTION BLOCK
92	1	610030-11	TUBING, HP, 3/8", JUNCTION BLOCK TO ATTENUATOR
93	2	610030-2	TUBING, HP, 3/8", LOWER INTENSIFIER LEFT END TO TEE/UPPER INTENSIFIER RIGHT END TO TEE
94	1	610030-8	TUBING, HP, 3/8", BLEED DOWN VALVE TEE TO BULK HEAD FITTING
95	1	610030-9	TUBING, HP, 3/8", LOWER INTENSIFIER HAND VALVE TO JUNCTION BLOCK
96	1	620000-2	HOSE, HYDRAULIC, SUCTION, 2.5", 50HP
97	1	620000-30-1	HOSE, HYDRAULIC, PUMP MANIFOLD TO GAUGE BULKHEAD, 50HP REDUNDANT
98	1	620000-30-3-A	HOSE, HYDRAULIC, PROPORTIONAL VALVE DRAIN TO TANK, 50HP REDUNDANT
99	1	620000-30-4	HOSE, HYDRAULIC, BLEED DOWN DRAIN TO TANK, 50HP REDUNDANT
100	1	620000-30-5	HOSE, HYDRAULIC, MANIFOLD TO BLEED DOWN VALVE, 50HP REDUNDANT
101	1	620000-31-1	HOSE, HYDRAULIC, SUCTION, TANK TO RECIRC. PUMP, 50HP
102	1	620000-31-2	HOSE, HYDRAULIC, COOLING OUT, FROM HEAT EXCHANGER TO RESERVOIR, 50HP, SINGLE
103	1	620000-31-3	HOSE, HYDRAULIC, RETURN LINE, FROM FRONT INTENSIFIER TO TANK
104	1	620000-31-4	HOSE, HYDRAULIC, RETURN LINE, FROM REAR INTENSIFIER TO TANK
105	1	620000-32-1	HOSE, HYDRAULIC, CASE DRAIN PUMP TO TANK, 50HP
106	1	620000-32-2	HOSE, HYDRAULIC, OIL FILTER TO HEAT EXCHANGER, 50HP
107	1	620000-33-2	HOSE, HYDRAULIC, PRESSURE LINE FROM MANIFOLD TO FRONT INTENSIFIER, 50HP REDUNDANT
108	1	620000-33-4	HOSE, HYDRAULIC, PRESSURE LINE FROM MANIFOLD TO REAR INTENSIFIER, 50HP REDUNDANT
109	1	620001-2	TUBING, HYDRAULIC, 1/4", GAUGE BULKHEAD TO GAUGE

UNLESS OTHERWISE SPECIFIED:

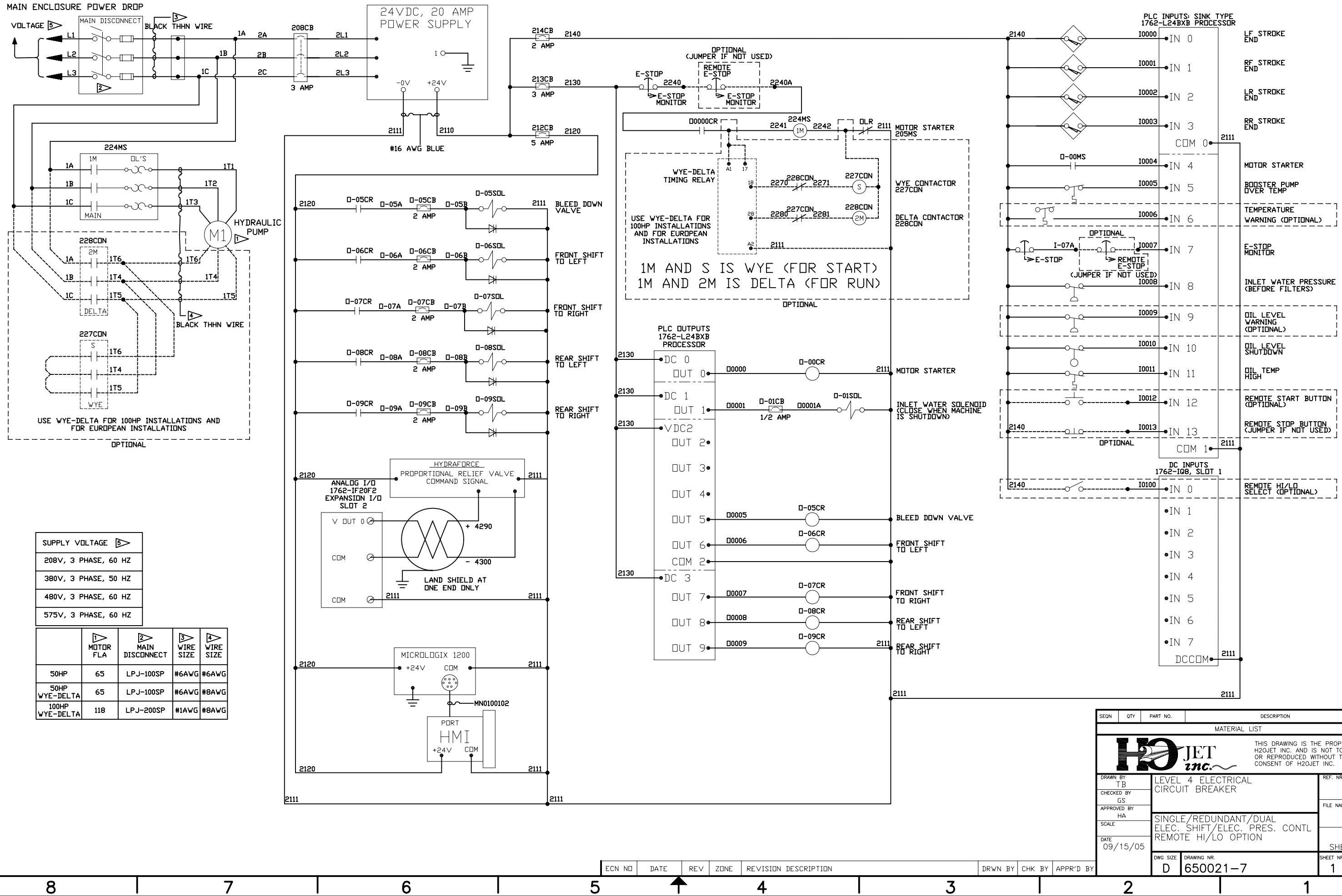
DIMENSIONS ARE IN INCHES AND DEGREES
DIAMETERS ON A COMMON CENTERLINE
TO BE TRUE POSITION WITHIN .010.
REMOVE BURRS AND BREAK SHARP CORNERS
AND FILLET RADII .030 MAXIMUM

ALL MACHINED SURFACES TO: 63
TOERANCES PER ANSI Y15.5

DIMENSIONAL	X.XXX	± .005
	X.XX	± .010
	X.X	± .030
ANGULAR	X.X	± .5
	X	± 1

H2O JET™

DRAWN: -	TITLE: PUMP, ADVANTAGE, 50HP REDUNDANT, 60K -BILL OF MATERIALS-		REF. NR. -
CHECKED: -			MADE FROM: -
APPRVD: H.A			
SCALE: NTS	SIZE B	DWG. NO. 303002-1-A	REV 0
DATE: 4/21/2008			SHEET 5 OF 5



SUPPLY VOLTAGE 5
208V, 3 PHASE, 60 HZ
380V, 3 PHASE, 50 HZ
480V, 3 PHASE, 60 HZ
575V, 3 PHASE, 60 HZ

	1 MOTOR FLA	2 MAIN DISCONNECT	3 WIRE SIZE	4 WIRE SIZE
50HP	65	LPJ-100SP	#6AWG	#6AWG
50HP WYE-DELTA	65	LPJ-100SP	#6AWG	#8AWG
100HP WYE-DELTA	118	LPJ-200SP	#1AWG	#8AWG

SEQN	QTY	PART NO.	DESCRIPTION

MATERIAL LIST

DRAWN BY: TB	LEVEL 4 ELECTRICAL CIRCUIT BREAKER	REF. NR.	
CHECKED BY: GS		FILE NAME	
APPROVED BY: HA	SINGLE/REDUNDANT/DUAL ELEC. SHIFT/ELEC. PRES. CONTL REMOTE HI/LO OPTION		
SCALE			SHEET 1OF1
DATE: 09/15/05	DWG SIZE: D / DRAWING NR.: 650021-7	SHEET NR.: 1	REV.: 0

ECN NO	DATE	REV	ZONE	REVISION DESCRIPTION	DRWN BY	CHK BY	APPR'D BY