MAXIEM®
BUILT BY OMAX

User's Guide

OMAX
21409 72nd Avenue South
Kent, WA USA 98032

Information: 877-629-4365
Technical Support: 866-452-5291
www.omax.com
techsupport@omax.com

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OMAX Corporation

Technical Publications

21409 72nd Avenue South

Kent, WA, USA 98032

OMAX Corporation is continually improving their equipment to bring you the best in abrasive waterjet machining technology. For that reason, your abrasive waterjet may differ slightly from what is described in this document. If you have any questions, please feel free to contact us at 1-800-838-0343 or e-mail us at techsupport@omax.com. You can also receive technical support on-line at: Web: http://www.omax.com (user name and password required for access)

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Original Instructions in English

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Chapter 1

Safety First

This chapter describes safety labels that may appear on your OMAX equipment. If ignored, physical injury, death, or equipment damage may occur. Read the safety instructions before you use your abrasive waterjet.

Safety Labels

Machine Safety

Wear Gloves
Bacteria in the tank water can build up. A minor break in the skin can introduce harmful bacteria into a wound. Always wear protective gloves if you have cuts or open wounds on your hands. When setting up material for cutting, wear gloves that provide protection against sharp metal edges.

Read this Manual
Do not attempt to operate this machine until you have read and understand all safety precautions and operating instructions.

Eye Protection
Always wear approved safety goggles whenever cutting. Regular glasses do not provide sufficient eye protection! Have an eyewash station located near the work area in the event abrasive spray splashes into your eyes. The garnet abrasive is not a chemical irritant, but if not quickly washed out, it can injure an eye just as any sand would. In addition, tank water could contain particles from the material or chemicals irritants.

Ear Protection
Always wear hearing protection while in the vicinity of the abrasive waterjet. When cutting in air, noise levels can exceed 120 dB.

Flying Debris/Loud Noise
Eye and ear protection are required during operation.

Watch Your Hands and Fingers
Never place your hands or fingers in areas where they are in danger of being pinched or crushed during equipment operation.

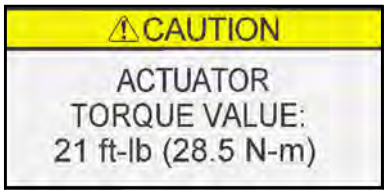
Step Hazard
Never step, stand or walk on the support slats. They are weakened with cutting and may collapse under your weight.

Never operate the equipment with protective guards or covers removed or rendered inoperative.

Never place your hands in the vicinity of the nozzle while cutting.

Seek immediate medical attention in the event of an abrasive waterjet injury. Injuries caused by high-pressure abrasive waterjets are serious. Do not delay!

Removing the abrasive feed hose from the nozzle while under pressure will blow abrasive particles into the air, getting into eyes and could contaminate tools and machines.



Ensure that system is locked-out prior to servicing the on/off valve. Do not attempt to turn ON the pump unless the on/off valve is installed and torqued to the required settings. Read the user's guide prior to servicing this device.

Electrical Safety

Electrical Hazard
Indicates the presence of life-threatening voltages. Never access areas labeled as such without first taking appropriate safety precautions: locking out power, verifying no voltage is present on circuits prior to maintenance activities, etc.

Lock Out Power
Never do maintenance on the abrasive waterjet equipment with the main AC power ON, unlocked, or while the pump is operating. Always follow standard lockout/tagout procedures, and lock out the main pump power at its source.

Safety Precautions

Always observe the following safety precautions while operating or servicing your equipment. Carefully operated, the abrasive waterjet is a safe tool. When operated carelessly, serious injury can result. Never make unauthorized alterations to the equipment or components.

Table Safety Requirements

Injuries involving contact with the water should receive immediate attention. Use antibacterial chemicals in the tank water to reduce this hazard.

Seek immediate medical attention in the event of an abrasive waterjet injury. Inform the physician of the cause of the injury, what type of abrasive waterjet project was being performed at the time of the accident, and the source of the water.

Lockout/Tagout Procedure

WARNING! ***OMAX recommends the implementation of practices and procedures to shut down equipment, isolate it from its energy source(s), and prevent the release of potentially hazardous energy while maintenance and servicing activities are being performed.***

Disposing of Waste Materials

Dispose of cutting wastes properly and in accordance with all local and federal regulations. The abrasive waterjet produces two types of waste: the water used for cutting, and the solid material that accumulates in the catcher tank. Although the garnet abrasive itself is inert, the waste deposited from the material being cut may require special handling.

In abrasive waterjet cutting, garnet particles are accelerated with high-pressure water to strike the material creating a residue of abrasive grit and eroded particles from the work-piece. Eventually, this residual sludge settles to the catcher tank bottom and accumulates until it must be removed for disposal. Depending upon the material makeup of this sludge, different disposal constraints will be imposed by the various local and federal regulations. For example, when cutting toxic materials, such as lead or radioactive metals, appropriate measures for the safe disposal of this type of contaminated water and sludge must be rigidly followed. Always consult with your local utilities company about sewage or water treatment requirements and proper sludge disposal procedures.

Adequate Shop Ventilation

Machining certain types of material such as titanium with an abrasive waterjet produces sparks. Therefore, do not operate your abrasive waterjet in an explosive atmosphere or allow explosive or flammable gasses to accumulate in the work area. Proper ventilation in your job shop will assist in dissipating the accumulation of gas, vapor, and fumes. When you cut aluminum, the fine particles in the tank react with the water to generate hydrogen gases. Normally, hydrogen bubbles to the surface and escapes into the shop in harmless, low concentrations. Take care that an ignition source (e.g., open flame, electrostatic discharge) is not nearby when operating any feature on your abrasive waterjet system.

Equipment Safety Features

The abrasive waterjet provides several built-in safety features.

Emergency Stop Switch (E-stop)

The pump and table controller are equipped with emergency stop switches. The E-stop is engaged by pushing it in. Once engaged, it immediately shuts down the pump unit and abrasive waterjet.

Overpressure Protection

During operation, pump pressure is monitored to prevent an overpressure condition. If the pump exceeds the factory set maximum pressure limit, the control shuts down the pump unit. In addition to the software maximum pressure limit, all pumps are equipped with a factory set Safety Valve to provide a hard-plumbed, over-pressure relief valve.

Electrical Protection

The variable frequency drive (VFD) provides electrical protection as well as speed control for the pump's main drive motor. The DIN rail-mounted contactor and circuit breaker provide short-circuit protection to the charge pump motor. Circuit breakers protect the internal transformer. A 0.5 A fuse protects the pump keypad.

Electrical Disconnect

Electrical disconnect that cuts off and isolates the equipment from its main electrical supply is provided as standard equipment on all machines sold in countries where installation of this electrical disconnect is mandatory. This disconnect is provided as an optional accessory in other countries where installation of this device is not required.

Access Control Circuit

The Access Control Circuit (ACC), if applicable, is designed to create a designated safety zone around the abrasive waterjet that protects operators from injury during use. The access control circuitry continually monitors the closure status of two external switch contacts. The breaking of contact with either switch immediately trips the safety circuit, disabling the cutting process until the cause of the violation is corrected and the access control circuit reset.

Sound Level Map of MAXIEM Abrasive Waterjets

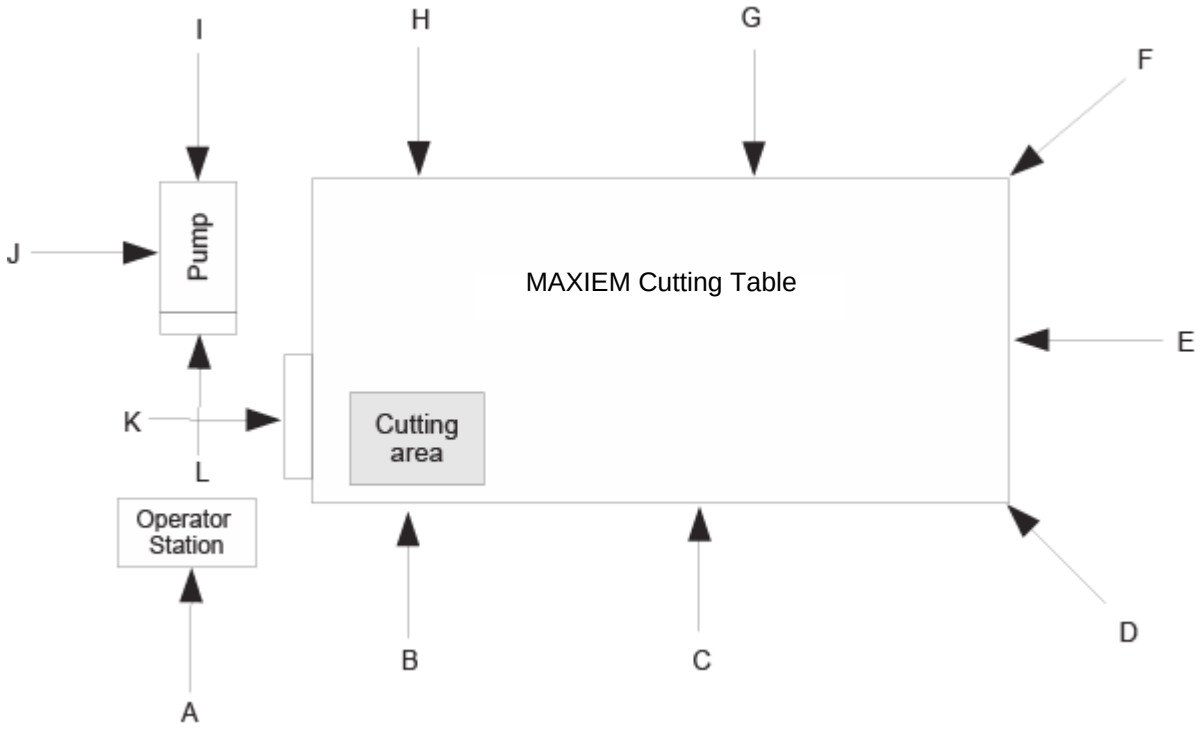


Figure 1-1: Airborne Noise Emission Sound Pressure Level (dB A)

** Arrows represent 1 m horizontal distance and 1.6 m vertical distance from floor.*

*** Safety barriers in place.*

A	B	C	D	E	F	G
Amb. 68.7	Amb. 69.8	Amb. 65.5	Amb. 65.4	Amb. 65.3	Amb. 65.1	Amb. 65.2
78.7	79.6	77.2	75.2	75.9	76.1	77.3
78.8	79.8	77.5	75.4	76.1	76.2	76.9
78.5	79.8	77.8	75.4	76.1	75.9	76.8

H	I	J	K	L
Amb. 65.1	Amb. 65.8	Amb. 69.4	Amb. 69.6	Amb. 69.3
78.8	78.8	79.4	79.8	79.5
78.5	78.9	79.4	79.7	79.7
78.6	78.9	79.2	79.7	79.6

Safety Checklist

Safety Checklist Topics	
Safety Labels	
	Wear Gloves
	Electrical Hazard; Danger – 480 Volts
	Lock Out Power
	Eye Protection - Approved Safety Goggles/Eyewash Station
	Ear Protection
	Flying Debris/Loud Noise
	Danger – Watch your hands and fingers
	Warning – Keep hands away from jet
	Warning – Worn slats
	Warning – Pinch points
Safety Precautions	
	Material handling; do not allow nozzle movement while handling material in the tank
	Cutting under water
	Treat injuries with caution; WJTA Warning Card – medical attention for any abrasive waterjet injury
	Special handling of hazardous materials
	Prevent slipping due to water spills
	Use adequate ventilation. Do not operate in an explosive atmosphere or near an ignition source
	Use only approved work platforms
	Use a splash guard to reduce splash, spray, and noise level
	Use proper lifting equipment
	Remove power from equipment when not in use
	Operate equipment only after reading equipment manuals and receiving qualified instruction
	Be able to quickly access the emergency stop switch
	Start pump only when all guards are in place
	Maintain protective guards and shutdown devices on/around pump
	Immediately notify repair personnel if leaks are found in pump fittings or connections
	Follow manufacturer's recommendations for servicing and use only original manufacturer replacement parts
	Follow periodic maintenance schedule that ensures proper equipment operation
	Following maintenance activities, clear all tools and rags from around the equipment before starting. Be aware of trip hazards (cords/cables, etc.).
	Do not start equipment unless you know how to stop it
	Never open or do maintenance on the equipment with the main disconnect ON or while the pump is operating. Always follow lockout/tagout procedures
	Do not make unauthorized alterations to the equipment or components
	Keep a minimum of 16 in. (40 cm) between you and high-pressure components.
	Do not use silica sand as a cutting abrasive. Silica dust produced by the cutting process can lead to silicosis, a serious lung disease
	Do not operate the machine in close proximity to other machines; water can spray or splash out of the cutting table area
Equipment Safety Features	
	Emergency (E-stop) Switches
	Overpressure Protection safety valve and software shutdown
	Electrical Protection
	Electrical Disconnect
	VFD / DIN rail mounted contactor and circuit breaker (short-circuit protection to the charge pump motor). Circuit breakers protect internal transformer, A 0.5 A fuse protects pump keypad

Date_____

Students Name_____Signature[1]_____

[1] *By signing this document, I acknowledge receipt and review of this Safety Checklist and understand items contained within. This document will be kept on file at OMAX in the customer records.*

Chapter 2

Introduction

Abrasive Waterjet Components

Refer to the OMAX web site (www.omax.com) for machine sizes and specifications.

Figure 2-1

- **High-pressure Pump**

  ① 20, 30, 40 hp pump

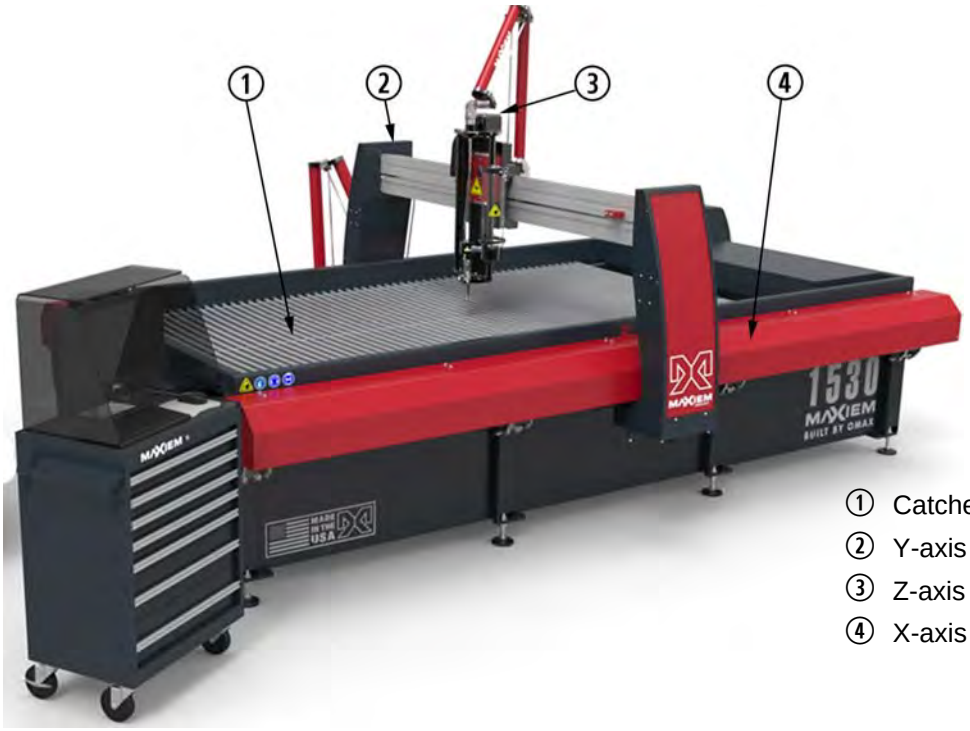
- **Table**

  ② Operator workstation
  ③ Catcher tank
  ④ Y-axis bridge
  ⑤ Z-axis assembly and abrasive hopper

- **Intelli-MAX Standard Software**
  - **Layout** for drawing parts
  - **Make** for cutting parts
  - Help user reference
  - Parts Online

Cutting Table

Motion System and Tank



① Catcher tank
② Y-axis bridge
③ Z-axis assembly
④ X-axis drive rails (covered)

Figure 2-2

Abrasive Delivery and Motorized Z-axis

① Z-axis assembly
② High-pressure water line
③ On/off valve
④ Nozzle assembly
⑤ Abrasive hopper
⑥ Y-axis bridge
⑦ Abrasive feed tube

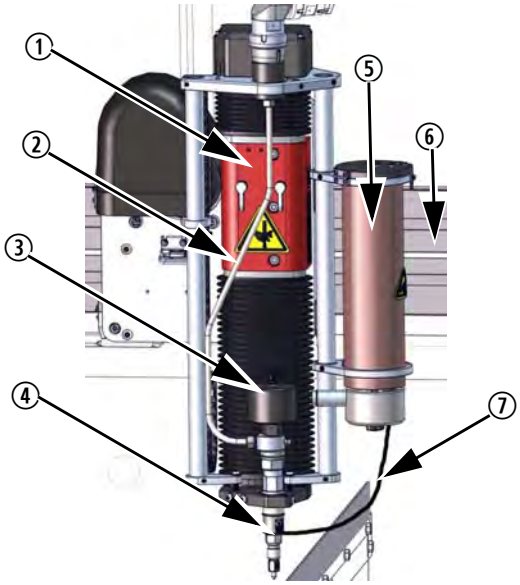


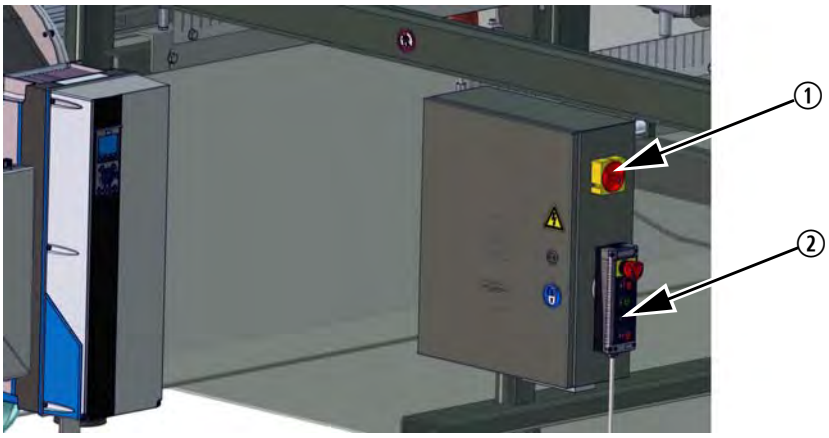
Figure 2-3

Operator Workstation

① Display monitor with computer
② Keyboard
③ Mouse
④ Toolbox

Figure 2-4

Power Controls



① Power switch
② Pendant controller

Figure 2-5

- The Power switch turns power ON or shuts OFF power to the operator workstation.
- The pendant controller can be placed near where the operator is working and provides motor Start/ Stop/Pause functions.

Pumps

High-pressure Pump

This pump provides high-pressure water required to cut parts. The pump's major drive components include the Variable Frequency Drive (VFD), the main electric motor, the belt drive between the motor and the pump, and the crankshaft to drive the high-pressure pump. The VFD varies the electric motor speed and therefore the pump speed.

There are various pump sizes available for the abrasive waterjet, all capable of producing up to 50,000 psi. Refer to the OMAX website (www.omax.com) for additional information.

① Variable frequency drive
② Filter pressure gauges
③ Water filters
④ Water storage tank
⑤ Charge pump
⑥ Electric motor
⑦ Pump control box

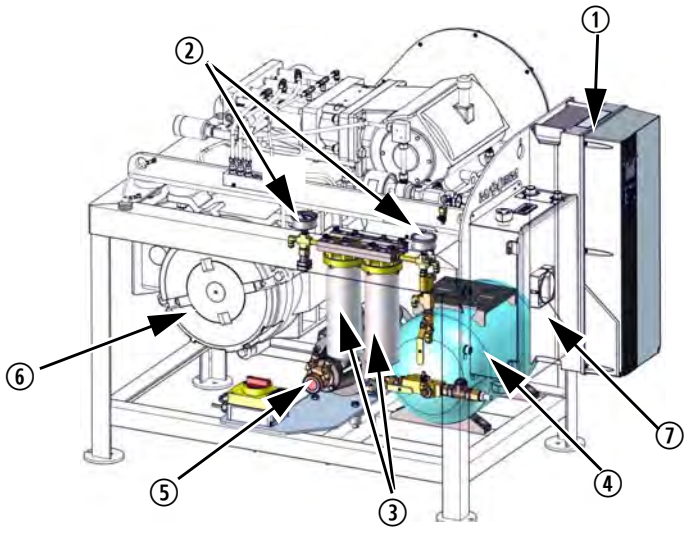
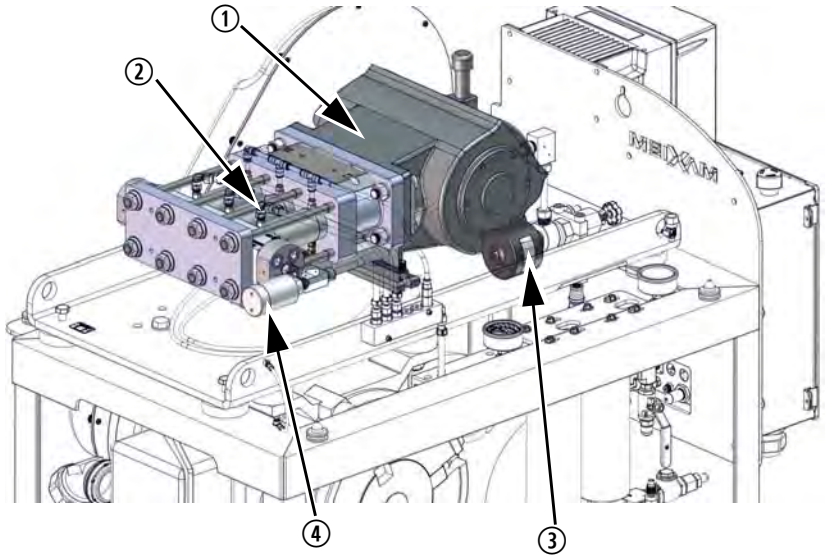


Figure 2-6



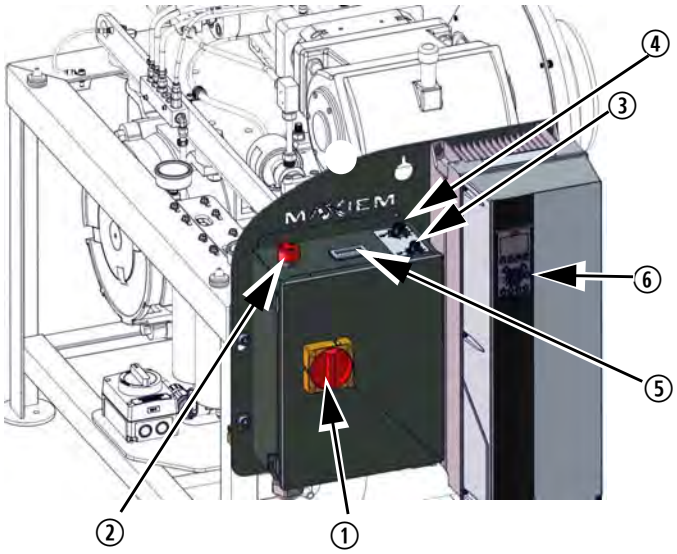
① Crankcase
② High-pressure wet end
③ On/off valve
④ Safety valve

Figure 2-7

Operator Controls

Pump power box
Contains power switch, E-stop, and pump rpm controls.

Variable Frequency Drive
The Variable Frequency Drive controls are usually remoted to the operator workstation.

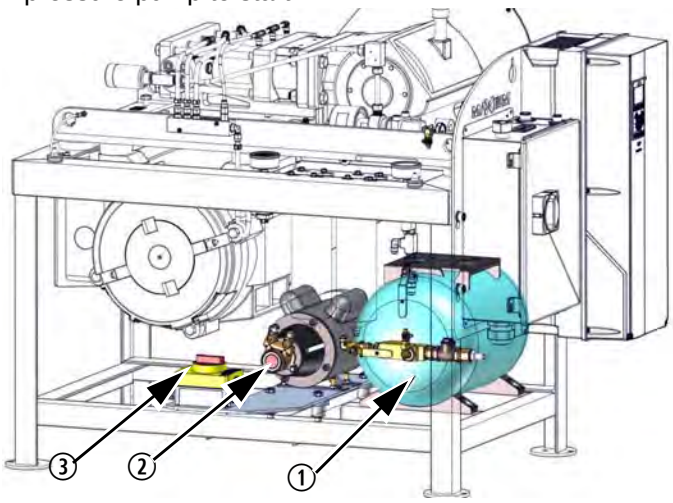


① Power switch
② E-stop switch
③ Low-pressure adjustment
④ High-pressure adjustment
⑤ RPM display
⑥ VFD keypad

Figure 2-8

Charge Pump

The charge pump boosts incoming water pressure to a level required for pump operation (125 psi for 20 and 30 hp pumps; 150 psi for 40 hp). This pump is also responsible for circulating water through the system cooling lines to purge any hot water and cool wet end components before the high-pressure pump is started. Cooler water increases the life of the high-pressure pump seals. The charge pump must be running for the high-pressure pump to start.



① Water storage tank
② Charge pump
③ Charge pump power switch

Figure 2-9

Intelli-MAX® Standard Software

Intelli-MAX Layout Standard

Layout includes a full range of drawing and editing tools. Files from other CAD programs can be imported into **Layout**. **Layout** creates an OMAX Routed Data file (ORD/OMX) which includes the machine cutting path and routing instructions for use in **Make**.

Intelli-MAX Make Standard

Make controls the cutting process. It calculates the speed of the abrasive waterjet for optimum results and controls all machining operations. **Make** also calculates how much time and abrasive will be required to machine the part, and allows you to review the exact path of the nozzle, even when not connected to the abrasive waterjet.

Intelli-MAX Standard Help Files

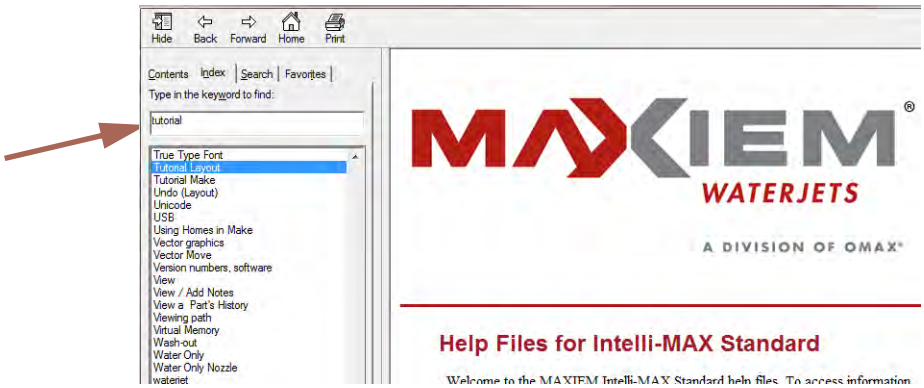
Help files documenting features of **Layout** and **Make** are included with the Intelli-MAX Standard software.

To access the Help files:

1. Click **Help** when using a command. Many **Layout** and **Make** commands provide context sensitive **Help** that opens the help file to the specific topic describing that command.
2. Press **F1** while in either **Layout** or **Make**.
3. On the **Help** menu, click **Help with**.

Tutorial

Tutorial topics are provided in the Intelli-MAX Standard Suite to help you learn to use **Make** and **Layout**. In Help, click the **Index** tab and type “tutorial.”

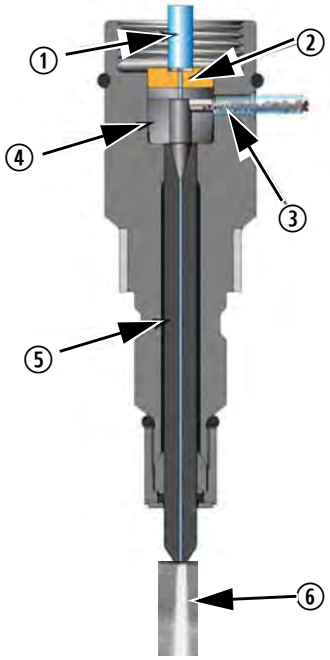


Chapter 3

Abrasive Waterjet Operation

Overview

An abrasive waterjet uses water pressurized to more than 40,000 pounds per square inch (psi). This high-pressure water enters at the top of the cutting nozzle and is forced through an orifice assembly containing a round jewel with a small hole in it. This fast moving stream moves into a larger chamber where the speed of the water creates a suction that draws in the flow of abrasive. This water stream plus abrasive moves into the mixing tube. The mixing tube has a small hole through the center that contains the water and abrasive as they mix. The water and abrasive are combined into a high-speed slurry at the bottom of the mixing tube. This slurry becomes the cutting tool as the tube focuses the jet stream at high velocity out of the bottom of the tube and into the material being machined.



① High-pressure water flow
② Orifice/jewel
③ Abrasive tube inlet
④ Mixing chamber
⑤ Mixing tube
⑥ Jet stream

Figure 3-1

Drawing a Part

Intelli-MAX Standard **Layout** creates part geometry using lines, arcs, and shapes such as for rectangles and circles. Once drawn, a cutting speed (quality) is assigned to each segment of the drawing. The higher the quality chosen, the slower the cutting speed, and the smoother the edge finish of the part.

Layout can import files from other drawing programs. Parts can also be created from photographs and other drawing sources using the **Layout** tracing feature.

To draw a part in **Layout** follow these steps:

1. In Windows, click **Start**, click **Programs**, click **OMAX Layout and Make**, and then click **Intelli-MAX Standard Layout**.
2. Draw the part using the **Draw** and **Edit** tools.
3. Click **Quality** on the toolbar and assign a cut quality to your drawing.
4. On the **Special** toolbar, click **Clean** to clean up the drawing.
5. On the **File** menu, click **Save As** and type a name for the file.

6. On the **Draw** toolbar, add lead ins, lead outs, and traverses to the drawing.
   - Lead ins are typically drawn longer; lead outs are drawn shorter.
   - The side of the entity where you placed the lead in/out determines whether the nozzle pierces on the left or right side of the entity.
   - The nozzle travels in the direction of the least sharp turn (the widest angle) on the lead in.
   - Always verify the lead in and lead out configurations in **Layout**.
   - Use a 90° lead in and lead out on square corners.
   - Use a narrow angle on the lead in to minimize witness marks or blemishes.
   - Path the part to avoid collisions.
7. On the **Special** toolbar, click **Path** to convert the drawing file to a machine tool path.
8. Click **Check for Problems** and resolve any problems found.
9. Save the machine tool path as an ORD/OMX file.

Determining Quality

Each entity in a drawing is assigned a quality value which controls how quickly the cutting nozzle moves when it cuts the piece. The slower the cutting nozzle moves, the higher the quality of a cut.

Figure 3-2 shows how the surface finish changes with the quality assigned. As the quality number goes lower, the cutting speed becomes faster, and the cut surface becomes less smooth.

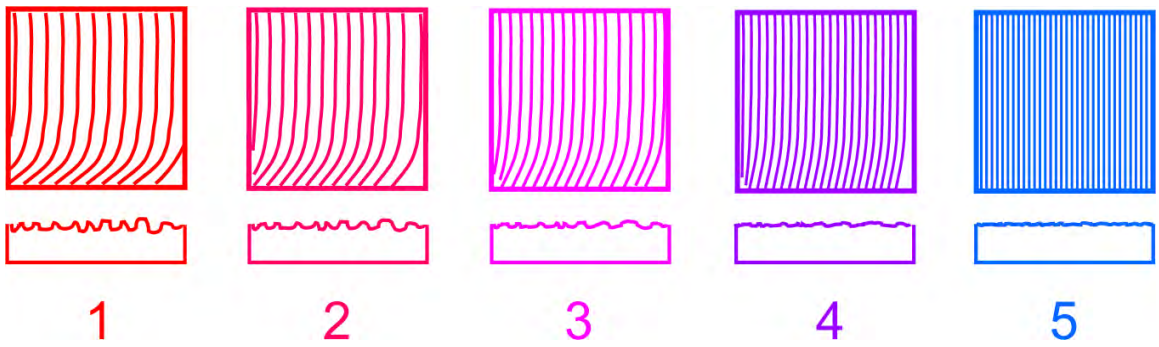


Figure 3-2

Making the Part

Once the tool path is defined and the ORD/OMX file created, Intelli-MAX **Make** controls movement of the abrasive waterjet and the cutting of the part. Before beginning the machining operation, you can preview how the part will be cut, how long it will take to make the part, and the amount of abrasive required.

Configuring Intelli-MAX Make Standard

If the drawing was developed using a PC other than the abrasive waterjet workstation, you must move it to the workstation by either copying it onto a USB drive and inserting in into one of the USB ports on the workstation, or moving it across your network to the controller.

1. On the desktop, click the **Make** shortcut to open **Make**.
2. Click **Change Path Setup** and follow the path to where drawing file is stored. Click the **ORD** or **OMX** file to open the machining file.

3. Click **Change Path Setup**, and under **Enter your Material Setup here,** select your **Material** from the drop-down list.

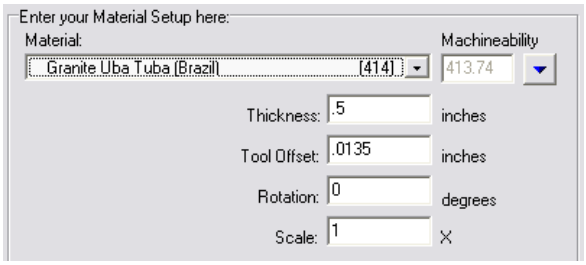


Figure 3-3

Clamping and Positioning Materials

WARNING! ***Always be careful when handling material on the cutting table.***

Large clamping forces are not ordinarily needed to secure material to the cutting table, but the material must not be allowed to move as it is being machined. A primary cause for out-of-tolerance parts is the material moves while being cut.

A small downward force, about one pound (4 N·m), is exerted on the material from the jet stream; however, a much larger upward force is exerted from all the air forced down with the jet stream. Once released, this air pushes upwards against the material.

The best way to secure material is to clamp it against a frame or tank wall. Never clamp material to the slats themselves. Slats can move, moving the material with them. Use slats only for vertical support. The larger the surface area of the material being cut, the more securely it must be clamped since the upward force from the jet stream's captured air will have more material to push upon.

Note: *Use tabs on the material or waterjet brick to hold small parts preventing them from slipping past the slats and down into the tank.*

Ensuring Clean and Quiet Machining

Always place a splash guard on the nozzle when machining to reduce cutting noise and splash and protect the Z-axis assembly components.

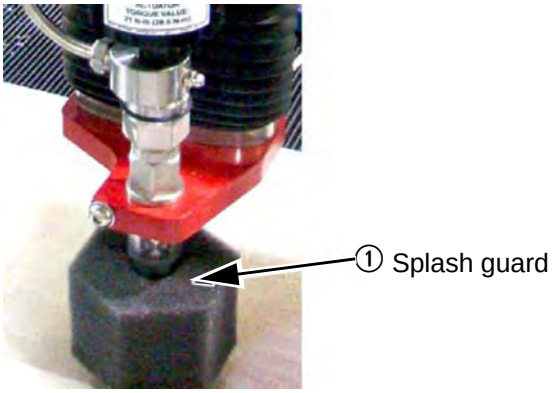


Figure 3-4

If too much abrasive accumulates on a part while machining, wash away the deposits with a hose while the jet stream continues the cut.

Adding water to the catcher tank so that it is above the top of the material will also reduce noise levels while cutting.

Startup Checklist

When starting the equipment, follow these steps to ensure that all equipment startup tasks are completed in the required sequence.

WARNING! ***Safety First - always wear eye, ear, and hand-protection devices when operating the equipment.***

1.	Turn power **ON** at main breaker box
2.	Open air supply valve
3.	Open water supply valve
4.	Open the charge pump water outlet valve
5.	Turn charge pump power **ON**
6.	Turn high-pressure pump power **ON**
7.	Turn table controller main power **ON**
8.	Press **ON** the table controller green power switch before the PC boots; if not, also press the **Reset** button
9.	Verify cooling water flow from the cooling return lines
10.	Open water flush valve as needed to flush warm water out of the system.
11.	Allow water to run for 15 minutes or until water temperature is 70° F (21.1° C) or less prior to operating the pump at high pressure
12.	When the charge pump exiting water goes below 70° F (21.1° C), close the charge pump water flush valve
13.	Start Intelli-MAX **Make**
14.	Auto home table to ensure that absolute home position is correct
15.	Verify soft limits are set and enabled
16.	Verify correct nozzle orifice and mixing tube size
17.	Position nozzle between slats, 1 to 1.5 in. (2.54 - 3.8 cm) maximum above the water level
18.	Perform nozzle low-pressure water test. Click **Test**, **Low**, and **Water Only**
19.	Verify straight and narrow jet stream
20.	Adjust and record pump rpm and pressure
21.	Stop nozzle low-pressure test
22.	Start nozzle high-pressure test. Click **Test**, **High**, and **Water Only**
23.	Verify straight and narrow jet stream
24.	Adjust and record pump rpm and pressure
25.	Verify pump filter pressure
26.	Inspect high-pressure system plumbing for leaks
27.	Stop nozzle high-pressure test
28.	Adjust ADO pressure as needed

29.	Start water and abrasive test. Click **Test**, **High**, and **Water and Abrasive**
30.	Confirm increased sound level and stream diameter
31.	Stop water and abrasive test
32.	Verify correct abrasive size and type
33.	Measure abrasive flow rate
34.	Pressurize the bulk feed hopper (if applicable)
35.	Verify level of abrasive in hopper
36.	Verify condition of abrasive feed tube
37.	Enter **Setup**, **Pump and Nozzle** settings
38.	Verify high and low-pressure values set to match pump values recorded previously
39.	Verify **Event & Relay Timing** settings for application
40.	Cut kerf check part and adjust tool offset as needed

Starting the Abrasive Waterjet

Sources

Before powering up this equipment, ensure operators have access to the required protection devices (safety glasses, ear plugs, and gloves).

1. Turn the main power breaker **ON**.
2. Open the air supply valve
3. Open the water supply valve.

Pumps

Pump control is shared between **Make** (**Auto On**) and the VFD keypad (**Hand On**). Ensure that it is in the **Auto On** mode for cutting operation. The high-pressure pump starts when the table controller and VFD are powered up. Make these checks first:

- Visually inspect **external pump components** for damaged parts, leaks, and other conditions that could prevent safe and proper operation.
- Ensure the area around the pump is clear of tools and other objects that could obstruct immediate access to controls functions, hindering safety.
- Verify the **oil level** in the pump **crankcase** is sufficient for operation (3 quarts required).
- Ensure the **pump cover** and **belt cover** are in place and properly secured.
- Ensure the **nozzle** and **mixing tube** are the correct sizes and installed properly.
- Ensure you are familiar with the location and function of the controls.

4. Open the charge pump **water outlet valve.**
5. Turn the **charge pump** power **ON**.
6. Turn the **high-pressure pump** power **ON**.

Table Controls

7. Power up the **computer** and verify Microsoft Windows starts properly.
8. The **pendant ON** button should be pressed **before** Windows fully starts. If not, press the **Reset** button to activate the drive motors.

Figure 3-5

Cooling Water

9. Verify cooling water flows from the **cooling return lines**.
10. Open the **water flush valve** to purge warm water from the charge pump plumbing.
11. Run the **charge pump** for at least 15 minutes then measure the temperature of the water exiting the **cooling housing assembly**. It must always be maintained between 70° F (21.1° C) and 40° F (4.4° C).

WARNING! ***If the inlet water is above 60° F (15.6° C), pump seal life is shortened. If the temperature is above 70° F (21.1° C), a chiller is required for pump operation.***

12. When the charge pump exiting water goes below 70° F (21.1° C), close the **charge pump water flush valve**.

Software Startup

13. Click the Intelli-MAX **Make** Standard icon on the desktop to open **Make**.

Auto Home the Table

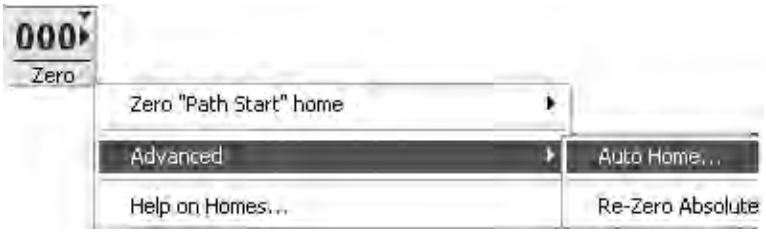
There are two types of limits that restrict the area of nozzle movement on a table's cutting surface.

Absolute Home Limits define the physical movement of the X and Y-axes on the machine. These are hardware limits that are set using physical stops installed on the ends of the X and Y-axis rail assemblies (Y=0, X=0 points). Although the cutting head can be commanded to reach these absolute limits, this seldom is done since this frequently is where the cutting head would crash into the side of the table and cause serious equipment damage, especially if the crash is done at full speed.

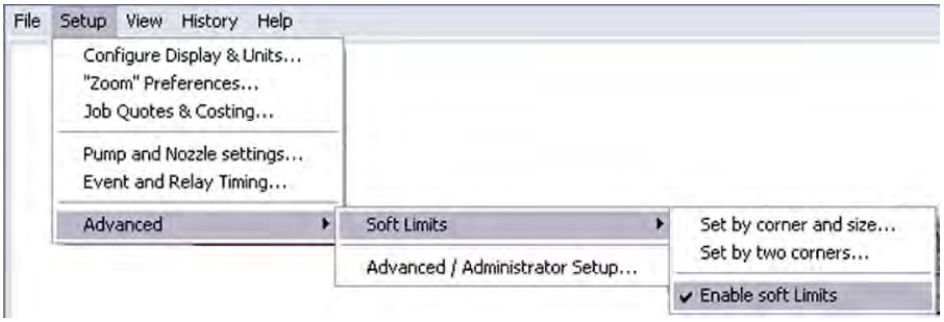
Soft Limits are defined in software to prevent the cutting head from reaching the table's absolute limits or to avoid hitting other fixtures placed within the cutting area. These limits should be set to create a smaller working area within the available maximum travel area. When a soft limit is reached, a controlled stop is immediately initiated that prevents further cutting head movement. Whenever nozzle movement is commanded that will exceed a defined soft limit, a message warns the operator that set limits will be exceeded. When using the keyboard to move the cutting head manually and a soft limit is reached, the software immediately halts head movement using a controlled slowdown and stop that prevents the nozzle from exceeding a user-defined soft limit.

Auto homing is the process of locating a table's Absolute Home limits. All home positions and soft limits are points relative to Absolute Home. Absolute Home is the only home position that can be lost. Resetting Absolute Home resets all other homes to their correct positions. It is important that Auto Home be run to rezero Absolute Home at the beginning of each work day and whenever you shut down for maintenance or restart the table controller, or when the machine has faulted.

14. Auto Home the table:
    a. Move the machining head so that it is 5 to 12 in. (10 to 30.5 cm) from the **hard stops**. The **hard stops** are located in the lower left corner of the machine (near where the operator would stand when at the controller, unless specified otherwise).
    b. Prior to auto homing the machine, ensure the Z-axis height is sufficient to prevent the **nozzle** from striking the table sides. Also ensure that the **nozzle** is within 1 ft (30.5 cm) of the Home position.
    c. In **Make**, right-click **Zero**, point to **Advanced,** and click **Auto Home**.



    d. After reading the warning, click **OK** to start the automatic homing process. This will take a minute or so.
    e. **Make** asks to zero the Absolute Home to this position. Click **Yes**. The machine now moves in the X-axis direction until it gently contacts the X-axis hard stop. After making contact, it moves back slightly. It then moves in the Y-axis direction until it gently contacts the Y-axis hard stop and then moves back a slight distance.
15. On the **Setup** menu, point to **Advanced**, then **Soft Limits**, and click **Enable soft Limits t**o place a check next to it.



Nozzle Assembly

16. Verify the **nozzle mixing tube**, and **nozzle orifice** are correctly matched to the size of the pump motor being used. The following table values are examples.

Pump Motor Size	Nozzle Orifice	Nozzle Mixing Tube	Maximum Pressure (psi)
M20	0.011 in. (0.279 mm)	0.030 in. (0.76 mm)	50,000 (3448 bar)
M30	0.014 in. (0.356 mm)	0.030 in. (0.76 mm)	50,000 (3448 bar)
Dual M30	2x 0.010 in. (0.254 mm)	0.021in. (0.533 mm)	50,000 (3448 bar)
M40	0.015 in. (0.38 mm)	0.042 in. (1.07 mm)	50,000 (3448 bar)
Dual M40	2x 0.011 in. (0.279 mm)	0.030 in. (0.76 mm)	50,000 (3448 bar)

The 15 lb hopper comes with a -13 abrasive orifice that provides an approximate abrasive flow rate of 0.70 lb/min with 80 mesh abrasive.

Caution: ***You must measure the actual abrasive flow rate for this and any other abrasive orifices that are used and enter the actual data in Make in Pump and Nozzle Settings.***

Caution: ***Changing the nozzle orifice size also requires adjustment of the adjustable dump orifice (ADO) to reduce pressure spikes which lead to premature plumbing failures. Refer to*** **Verify Pump and Nozzle Settings** ***(page 3-17) for instructions.***

Pump and Nozzle Tests

Gather the following information and enter into the **Pump and Nozzle Settings** in **Make.** Prior to starting the high-pressure pump, verify everyone is clear of the high-pressure cutting nozzle.

Setting High-pressure Pump RPM and Pressure

The pump rpm determines cutting pressure and may be adjusted up or down using either the VFD keypad buttons while the pump is in the **Hand On** (local) mode or using the pump's high or low-pressure knobs adjustment while the pump is in **Auto On** mode (remote) and **Make** is operating in **Test** mode.

① High-pressure knob

② Low-pressure knob

③ RPM display

④ E-stop switch

Figure 3-6

WARNING! ***Pump overpressure protection is disabled when operating in Hand On mode.***

Adjust Pump RPM in Hand On Mode

When in **Hand On** mode, only the dump valve is opened. The nozzle can be activated only when in **Auto On** mode using **Make**. The **Make** software has no control over high-pressure pump operation while the pump is in the **Hand On** mode. For pump control using **Make**, place the pump in the **Auto On** mode. Likewise, when in the **Auto On** mode, the pump keypad has no control.

1. Press **Hand On** to start the **high-pressure pump**.
2. To increase the high-pressure value displayed, turn the **high-pressure knob** clockwise.
3. To decrease the high-pressure value displayed, turn the **high-pressure knob** counterclockwise.
4. When finished, press **OFF** on the **keypad** to shut down the **high-pressure pump**.

Preset Pump PSI Value in Auto On Mode

To preset the pump psi value for high-pressure cutting or low-pressure piercing when in the **Auto On** mode, in **Make,** under **Action,** click **Test** to select a nozzle test.

Caution: ***Do not operate the abrasive waterjet for more than several seconds when the nozzle is above the water surface at a distance greater than 1.5 in. (3.81 cm). Air entrapment in the water increases with nozzle height, eventually allowing the jet stream to strike the tank bottom with sufficient force to cut a hole through the bottom. This applies to using "Test Nozzle" and cutting thick materials at a high quality setting. Always make sure the tank water level is immediately below the work piece. Placing a plate of scrap material on the tank bottom is a way to provide better protection.***

WARNING! ***Ensure the cutting nozzle is positioned between slats, 1 to 1.5 in. (2.54 - 3.8 cm) above the water level.***

Nozzle Test - Low-pressure

(steps 17 - 21 on startup checklist)

1. Remove the hopper end of the **abrasive feed tube** from the **abrasive flow gate**.
2. Press the **keypad Auto On** button so that **REM** appears in the **keypad display** top, left-hand corner.
3. In **Make**, click the **Test** button to display the **Test Pump and Nozzle** options:

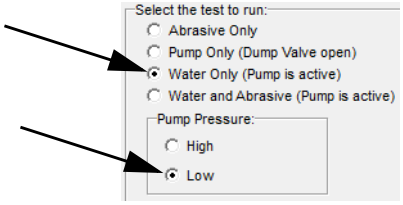


Figure 3-7

4. Select **Water Only** and **Low** Pump Pressure**.**

WARNING! ***The cutting head is about to turn ON. For safety, ensure that the nozzle is positioned correctly and everyone is clear of the cutting area.***

5. Click **Start Test** to start the nozzle test in the low-pressure mode.

6. Use the **Low pressure adjustment knob** on the **high-pressure pump** to set the desired preset low-pressure cutting pressure. This setting is useful for piercing brittle materials or etching and scribing materials at reduced pressure. The **Low** pressure mode can be activated from **Make** while the pump is in the **Auto On** mode. Record the values for rpm and pressure in low-pressure mode.
7. When the jet stream begins, pinch the loose end of the **abrasive feed tube** to block air flow through the **feed tube**. Air from this tube interferes with the jet stream, making inspection difficult. Examine the quality of the jet stream as illustrated below.

Figure 3-8

8. Compare the effect that a damaged **orifice** and worn **mixing tube** have on the quality of a nozzle's jet stream.

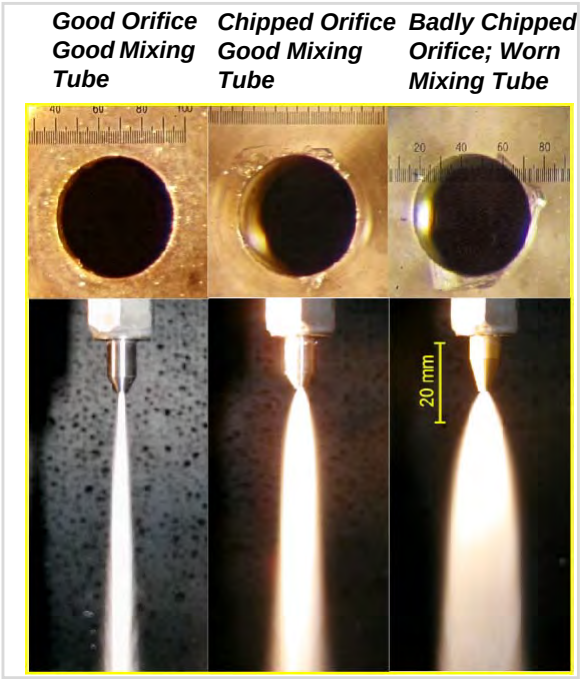


Figure 3-9

9. Click **Stop** to end the low-pressure test.

Nozzle Test - High-pressure

(steps 22 - 27 on startup checklist)

1. Return to the **Pump and Nozzle** test options and select **Water Only** and **High** Pump Pressure.

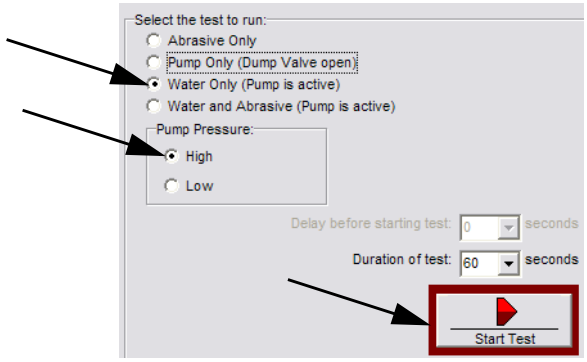


Figure 3-10

WARNING! ***The cutting head is about to turn ON. For safety, ensure that the nozzle is positioned correctly and everyone is clear of the cutting area.***

2. Click **Start Test** to start the nozzle test in high-pressure mode. Test will run for one minute unless the **Stop** button is clicked.
3. When the jet stream test begins, pinch the **abrasive feed tube** until blocked to examine the quality of the jet stream, verifying that it is straight and narrow as illustrated previously.
4. During the jet stream test, adjust **high-pressure pump** rpm to achieve the desired high-pressure. Use the **High-pressure adjustment knob** on the pump to set the cutting high-pressure. The high-pressure setting is the value that the pump normally returns to when started. The high-pressure mode can be activated from **Make** while the pump is in the **Auto On** mode. Record the pump rpm and psi values from the **pump display** for the high-pressure test.
5. During the test, also check the pump's two **water pressure gauges** at high rpm. The difference between the two gauge readings must not exceed 20 psi. If it is more than this, the water filters most likely require replacing.
6. Click **Stop** to end the **high-pressure pump** test.

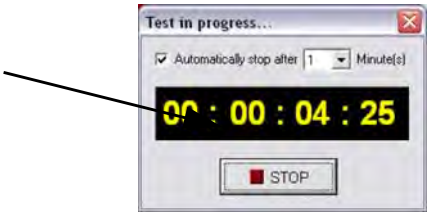


Figure 3-11

Stopping the High-pressure Pump

During normal cutting operation, **Make** automatically starts and stops the high-pressure pump as required. The pump can also be stopped using the keypad when in **Hand On** mode and pressing the **Stop** button, or by pressing the **Pause** button located on the pendant controller

The pump can be immediately stopped at any time by pressing any of the Emergency Stop switches, located either on the pump control box or the pendant controller.

Caution: ***The emergency stop switch should be used for emergency stops only. When activated, all nozzle positioning information is lost which then requires re-homing, resetting soft limits, etc.***

Recover following an emergency stop:

1. Manually pull the **Emergency Stop switch** back to its original position.
2. Reset the equipment by pressing the **Reset** button.
3. Re-establish the machine limits and auto home positions.
4. When applicable, power **ON** any attached abrasive waterjet accessories.
5. Click the **Make** icon on the desktop to open **Make**.
6. Auto Home the machine to ensure that the machine's zero (Absolute Home) position is set.

Adjustable Dump Orifice (ADO)

ADO pressure requires readjusting anytime a different sized orifice is installed in the nozzle, or a defective or worn jewel is replaced. It is recommended that this pressure be verified during machine startup.

Caution: ***The ADO was not designed to close completely as a "needle valve" would. NEVER screw the adjustment knob all the way in clockwise and force the tapered stem into the tapered seat. Doing so may jam the stem into the seat, requiring the ADO be disassembled to unjam the stem.***

1. Ensure the **ADO** pressure is not more than 1-2 kpsi below nozzle cutting pressure.
2. Power up both the **high-pressure pump** and the **table controller**.
3. Remove the **pump top cover** to access the **adjustment knob** on the **ADO**.

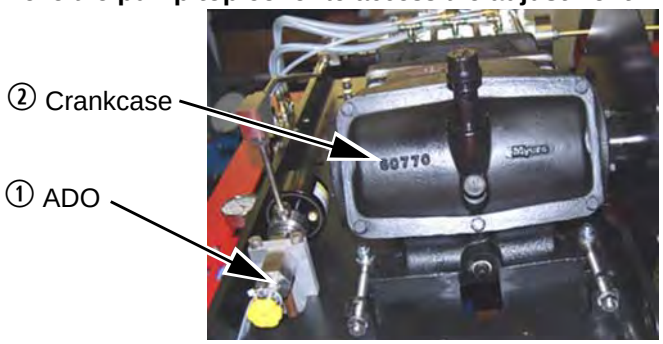
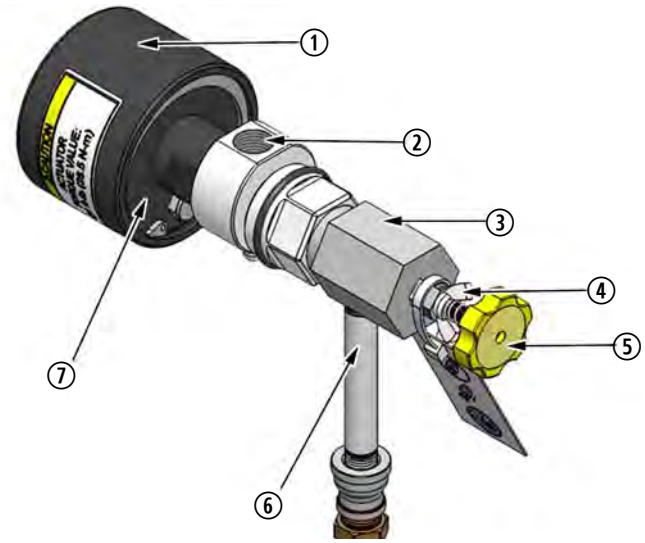


Figure 3-12



① On/off valve
② High-pressure water inlet
③ ADO body
④ Wing nut
⑤ Pressure adjustment knob
⑥ Low-pressure water drain
⑦ Air actuator

Figure 3-13

4. To ensure the **tapered stem** is correctly positioned once the pump starts, screw the **wing nut** ③ clockwise towards the **adjustment knob** ① until the **spring** makes initial contact with both the **wing nut** and **knob**.

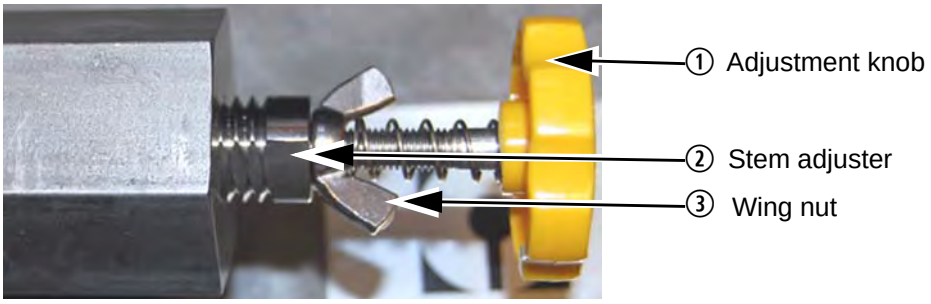


Figure 3-14

5. Screw the **adjustment knob** toward the **ADO body** until the **wing nut** makes initial contact with the **stem adjuster**.
6. Hold the **adjustment knob**, preventing it from turning, and screw the **wing nut** back toward the **knob**, leaving approximately a 1/4 in. (0.635 cm) gap ① between the **stem adjuster** and **wing nut**. This gap provides the necessary adjustment room for the **knob**. If not enough gap is available, the **wing nut** will contact the **stem adjuster** too soon, preventing the **knob** from being adjusted any further. If this happens, simply unscrew the **wing nut** away from the **ADO body** to allow more adjustment travel.

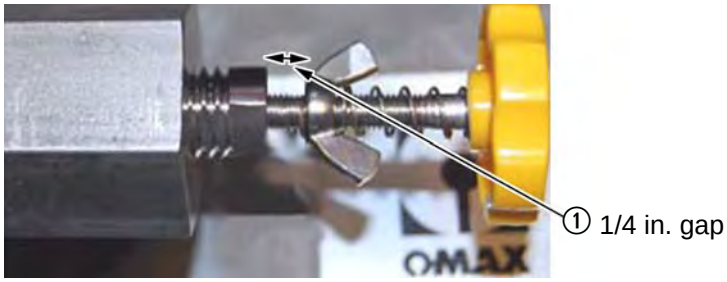


Figure 3-15

Caution: ***The safety valve may activate due to excessive pressure if the pump runs with the nozzle OFF and the ADO valve pressure too high.***

7. Click **Test** and then select **Pump Only (Dump Valve open)** and **High** Pump Pressure.

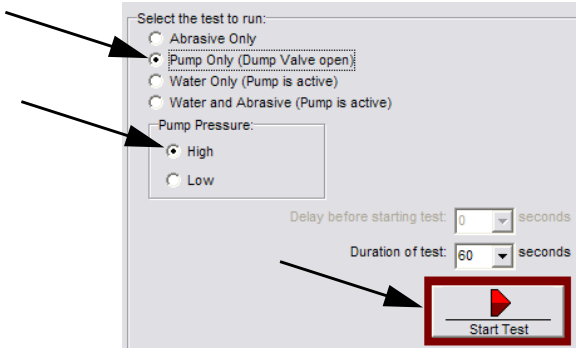


Figure 3-16

8. Click **Start Test** to activate the **high-pressure pump**.

9. Turn the **ADO pressure adjustment knob** until the pressure indicated on the pump display panel is within 1 - 2 kpsi of the **nozzle** high-pressure value. An Allen wrench inserted into the end of the knob will assist in fine tuning the **ADO** pressure adjustment.

3/16 in.

Figure 3-17

Note: *The ADO pressure adjustment can equal the nozzle pressure, but must never be allowed to exceed nozzle pressure. Also, ADO pressure should not be more than 2 kpsi below nozzle pressure.*

WARNING! ***Never continue unscrewing the adjustment knob until it detaches itself from the ADO body while the water is under pressure.***

10. Once the correct pressure is reached, hold the **adjustment knob** in place to prevent it from rotating, then tighten the **wing nut** to lock the **knob** in position. This should be done while the **pump** is running at high pressure.
11. Click **Stop** to halt the test.

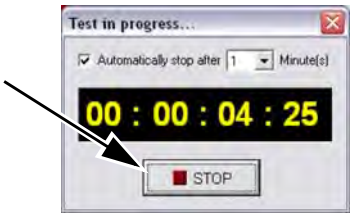


Figure 3-18

12. Replace the **pump cover**.

    Adjustment of the ADO pressure is complete.

Removing a Stuck Tapered Stem From the Tapered Seat

1. Shut the **high-pressure pump** and **charge pump** down and lock out all air, power and water sources.
2. Bleed off residual air pressure from the system by allowing the **on/off valve** on the **nozzle** to open and ensure there is no stored energy (pressurized water) in the **high-pressure lines**. Open the **air nozzle** to drain the air.
3. Remove the **on/off valve** from the **ADO** to expose the seat of the **ADO**.
4. Rotate the **adjustment knob** on the **ADO** counterclockwise to back out the **adjustment screw**. Be sure to back the **screw** out enough to allow for the dislodging of the **tapered stem**.
5. Insert a **pin**, 0.049 in. to 0.055 in. diameter (1.24 to 1.397 mm) into the opening of the **tapered seat** and using a small hammer, tap loose the **tapered stem** from the **tapered seat**.
6. Reassemble the **on/off valve** onto the **ADO**.

Water and Abrasive

(steps 29 - 31 on startup checklist)

WARNING! ***Ensure the cutting nozzle is positioned between slats, 1 to 1.5 in. (2.54 - 3.8 cm) above the water level.***

Caution: ***Do not operate the abrasive waterjet for more than several seconds when the nozzle is above the water surface at a distance greater than 1.5 in. (3.81 cm). Air entrapment in the water increases with nozzle height, eventually allowing the jet stream to strike the tank bottom with sufficient force to cut a hole through the bottom. This applies to using "Test Nozzle" and cutting thick materials at a high quality setting. Always make sure the tank water level is immediately below the work piece. Placing a plate of scrap material on the tank bottom is a way to provide better protection.***

1. Click the **Test** button to display the test options.
2. Select **High** and **Water and Abrasive** then click **Start Test**.

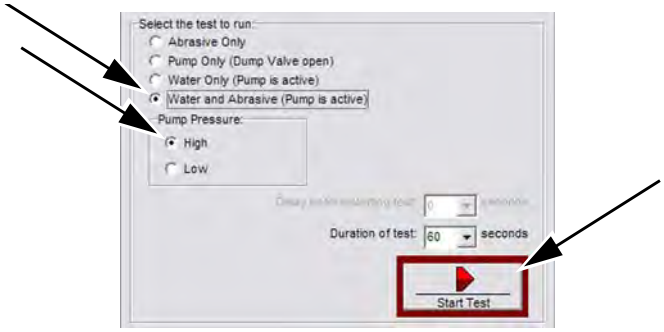


Figure 3-19

3. Verify an increase in the sound level and stream diameter from the abrasive flow.
4. Verify **abrasive** is flowing from **abrasive feed tube** into the **nozzle**.
5. Click **Stop** to end the **Water and Abrasive** test.

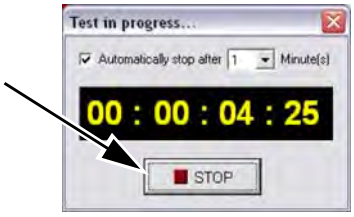


Figure 3-20

Verify Abrasive

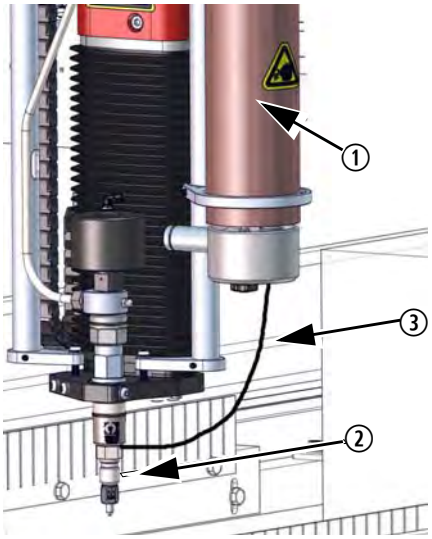
(steps 32 - 36 on startup checklist)

1. Check **abrasive** package to verify **abrasive** type and mesh. Write down this information to enter into **Pump and Nozzle Settings** later.
2. Verify **abrasive** level in **hopper**; add as needed.
3. Pressurize the **bulk feed hopper** (if applicable).

Measure the Abrasive Flow Rate

The abrasive flow rate should be measured once a week minimum, or anytime there are operational or environmental changes.

1. Remove the **abrasive tube** ③ from the bottom of the **hopper** ①.



① Abrasive hopper
② Nozzle
③ Abrasive tube

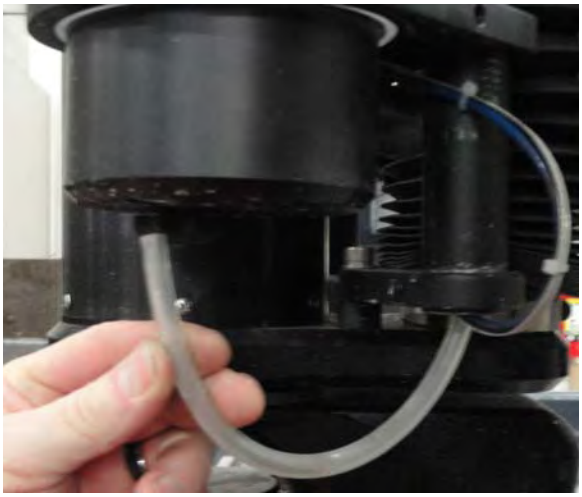


Figure 3-21

2. Remove the **hopper cap**.

Figure 3-22

3. Remove the **abrasive feed block**.

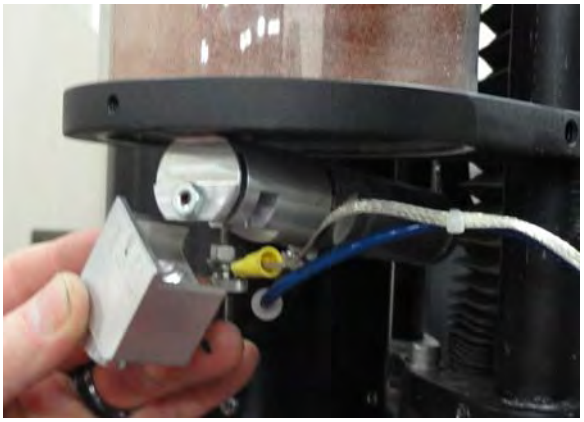


Figure 3-23

4. Place a container directly below the **abrasive valve** to catch the **abrasive** as it is released from the **valve**.
5. Click the **Test** button to display the test options.
6. Select **Abrasive Only** then click **Start Test** to begin the abrasive flow. The abrasive flow automatically stops after one minute.

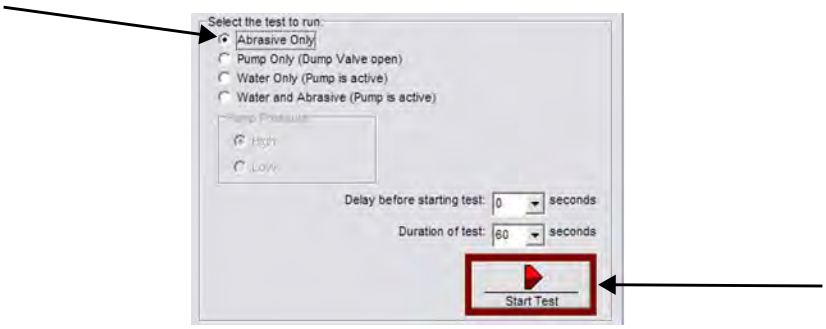


Figure 3-24

7. With an accurate scale, weigh the **abrasive** collected in the container during the one minute flow and record the **abrasive** weight in pounds. **Do not include the weight of the container!**
8. Replace the **abrasive feed block**, the **hopper cap**, and the **abrasive tube** in the order removed.
9. Verify condition of **abrasive feed tubes**. Verify there are no worn spots, cracks, or partial blockages. Replace as needed.

Software Configuration

(steps 37 - 39 on start up checklist)

Verify Pump and Nozzle Settings

1. Ensure data in **Pump and Nozzle Settings** in **Setup** match the actual measured values.

Caution: ***It is critical that the software settings match the actual MEASURED values for the pump pressures and abrasive flow rate, and that the nozzle setup exactly match the nozzle installed on the machine. If not properly matched, the cutting ability of the machine is compromised.***

2. In **Make,** click **Setup** and select **Pump and Nozzle Settings.**

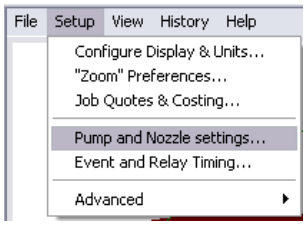


Figure 3-25

3. Correct any values being displayed that differ from those recorded during testing.

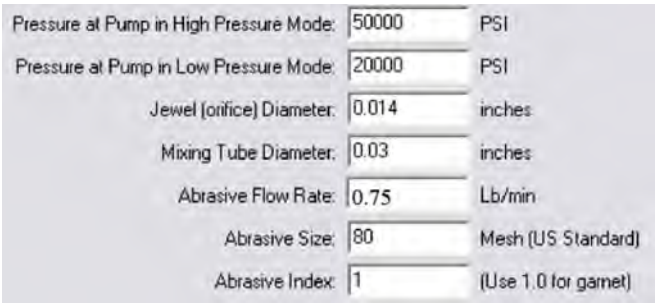


Figure 3-26

4. Click **OK** to save any changes.

Verify Event and Relay Timing

1. On the **Setup** menu, click **Event & Relay Timing**. Make sure that values displayed are correct for the machine and cutting application. To determine values for **Event & Relay Timing**, it is best to start with the default values and adjust these values to match your own requirements.

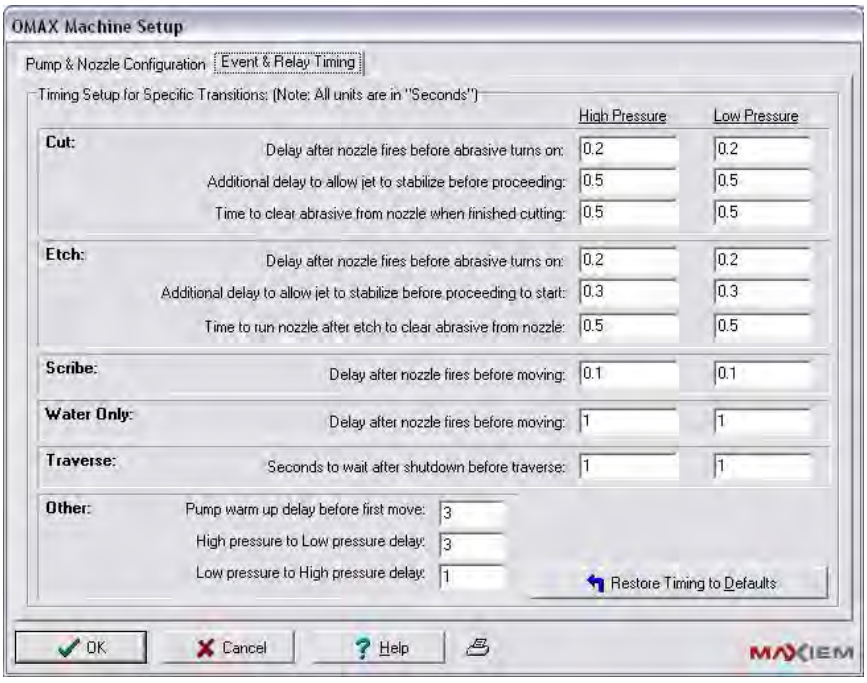


Figure 3-27

2. Click **OK** to save any changes made.

Kerf Check

Cut a kerf check part and adjust the tool offset as needed.

1. Kerf check part files are located in the Sample Files, **Kerf_Check_Parts** folder.
2. Measure the cut part against the drawing dimensions.
3. Adjust **Tool Offset** as needed.

Note: *The Tool Offset will change as the mixing tube wears and becomes larger.*

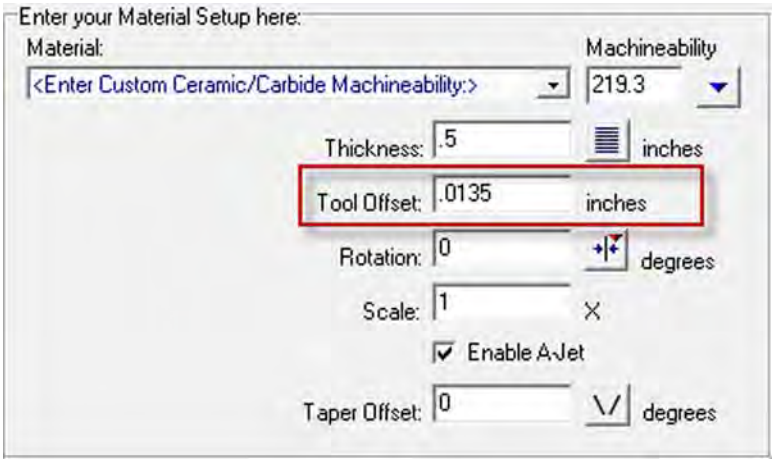


Figure 3-28

Cutting the Part

1. Move the **nozzle** to an out-of-way area on the table that allows room for the material to be placed and secured to the table.

Note: *Refer to "Keyboard Shortcuts" in the **Make** Help files for the X, Y, and Z-axis movement commands.*

2. Place the material to be cut on the **slats** and use adequate fixturing to secure the material flat and stable during cutting.
3. Position the **nozzle** to begin the cut and set the **Path Start Home** to zero.

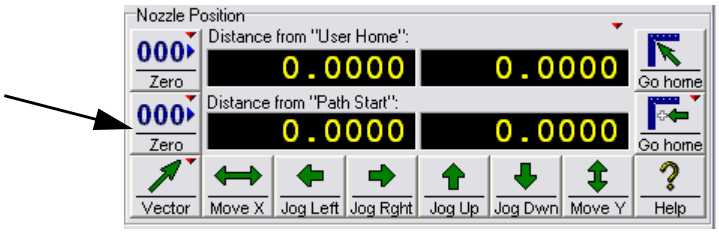


Figure 3-29

Note: *The distance from Path Start zeroes automatically when **Begin Machining** is clicked.*

4. Set the **nozzle** stand-off:

a. Adjust the **nozzle stand-off** at 0.040 - 0.060 in. (1.02 - 1.52 mm) above the material by placing a gauge between it and the material being cut and adjusting the **Z-axis** up or down appropriately. You must use 0.08 in. (2.032 mm) if you are using an **A-Jet**.

WARNING! ***Do not run the tip of the mixing tube down into the stand-off gauge as this may damage the mixing tube.***

b. When adjusted, click **View/Show Z Coordinates** to display the **Z Height** window.

c. On the **Z Height** display, click the **00>** button to set the **Z Height** coordinates to zero.

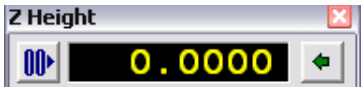
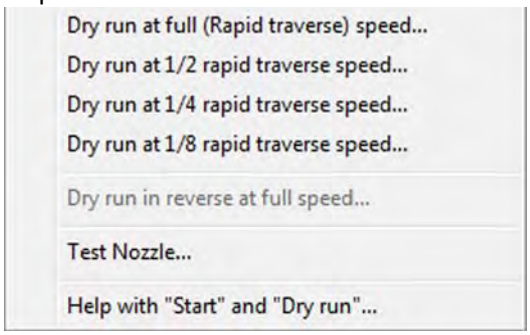


Figure 3-30

5. Conduct a dry run to verify the cutting path:

a. Click **Begin Machining** to display the **Path Control** window.

b. Right-click **Start** to display the options window.



c. Click **Dry run at full (Rapid traverse) speed...** (or another speed of your choice) to start the dry run.

d. Verify the **nozzle** travels over the material to be cut as expected.

e. If necessary, correct the **Path Start Home** position and try another dry run.

6. Raise the **nozzle** using the **Z Height** adjustment and attach the **nozzle splash guard**.

7. Lower the **nozzle** to its zero Z-axis coordinates by clicking the arrow on the right side of the **Z Height** window.

8. Click **Begin Machining**.

Caution: ***Always remain near the equipment during the cutting process. Use the Pause button to halt operation if needed. In the event of a serious problem, use the Emergency Stop switch to immediately halt operations.***

9. Once machining stops, **Close** the **Path Control** window, raise the **nozzle**, rinse the **abrasive** from the cut material, and remove the cut part(s) from the machine.

Tips for Effective Cutting

- **Use a nozzle stand-off between 0.040 in. (1.0 mm) and 0.060 in. (1.5 mm). For the A-Jet you must use 0.080 in. (2.032 mm).**
  The closer the nozzle is to the material being cut, the less the taper. Increasing the stand-off increases the taper. Smaller stand-off distances increase the likelihood of plugging the nozzle during piercing.
- **Keep contaminants out of the abrasive**
  Contaminants in the abrasive material clog the mixing tube. Contaminants include drops of water, bits of paper, metal shavings, dirt, and other debris.
- **Measure the tool offset regularly**
  The tool offset (half the width of the kerf) will gradually increase as the mixing tube in the abrasive waterjet nozzle wears. Frequently measuring and adjusting the tool offset helps maintain a high degree of accuracy in your parts. Cut a kerf check part to verify the offset.
- **Ensure slats have a uniform height**
  If the height of all slats is not uniform, the part can rock up and down as it is machined, affecting accuracy.
- **Avoid machining along a slat top**
  To minimize excessive tank spray and to extend slat life, try to place the material so the abrasive waterjet is not cutting along a slat.
- **Rotate slats regularly**
  Most parts are cut in the same area of the machine. Slats located in this area tend to wear first. Rotating slats distributes wear and extends their usefulness.
- **Orient the short direction of a part parallel to slats**
  Try to arrange drawings so that the shortest dimension runs parallel to the slats. This keeps the finished part from slipping between the slats.
- **Be careful of parts that tilt** - the cutting nozzle could crash into them.
- **Cut parts so they are supported** by as many slats as possible.
- **Be wary of parts with heavy ends** that may tilt even when supported by many slats.
- **Reposition weights during a traverse or planned pause points**
  You can insert planned pause points into the tool path using **XData** or wait until the machine does a rapid traverse before you stop machining and reposition weights. Right-click **Pause** in **Make,** and click **Pause at Start of next traverse**, or **Pause at end of next traverse**.
- **Do not precut material**
  Big sheets of material are easier to clamp into place and weight down. Small pieces of material can be difficult to weight properly; there may not be enough room for both the part and the weights.
- **Place sensitive material between sacrificial material**
  When cutting parts that are sensitive to scratching, place the part between pieces of a sacrificial material. The bottom of the part being machined is especially vulnerable to splash-back and frosting.
- **Put sacrificial material on material that may delaminate**
  Cover the top of material that may delaminate during piercing with sacrificial material. This ensures the abrasive is completely flowing before it reaches the good material.
- **Start at the edge of materials that cannot be pierced**
  Some materials cannot be easily pierced. For example, weak granites can be pierced, but may chip

or crack. When cutting these material types, cuts must be started from an edge of the material. Other materials, such as glass, can be pierced using low-pressure.

- **Avoid material with deep scratches**
  For the best possible surface finish, use stock that does not have deep scratches on the surface. Scratches on the surface can deflect the abrasive stream and cause irregularities on the bottom of the part.
- **Do not always make parts in the same location**
  Using the identical location wears out slats in that area more quickly and can cut through the tank. Make parts in different table areas to even slat wear.

Equipment Shutdown Checklist

Follow these steps to ensure that all equipment shutdown tasks are completed in the required sequence.

WARNING! ***Safety First - always wear eye, ear, and hand-protection devices when operating the equipment.***

1.	Position nozzle between slats, 1 to 1.5 in. (2.54 - 3.8 cm) maximum above water level
2.	Start nozzle high-pressure test. Click **Test**, **High**, and **Water**
3.	Run for 20 seconds to clear all abrasives
4.	Stop nozzle high-pressure test
5.	Position nozzle at desired location for shut down
6.	Remove USB flash drive
7.	Close Intelli-MAX **Make** software
8.	Exit Windows. Click **Start**, and then **Shut down**
9.	Verify table controller shutdown (black monitor screen)
10.	Turn **OFF** main table controller power
11.	Depressurize bulk feed hopper (if applicable)
12.	Power **OFF** other accessories (if applicable)
13.	Turn **OFF** charge pump
14.	Turn **OFF** high-pressure pump
15.	Close main water supply valve
16.	Close main air supply valve
17.	Turn **OFF** main electrical breaker box
18.	Clean machine

The equipment is now properly shut down.

Shut Down the Abrasive Waterjet

1. Position the **nozzle** between two table **slats** at 1 (2.54 cm) to 1.5 inches (3.8 cm) above the water surface.

Caution: ***Do not operate the abrasive waterjet for more than several seconds when the nozzle is above the water surface at a distance greater than 1.5 inches (3.8 cm). Air entrapment in the water increases with nozzle height, eventually allowing the jet stream to strike the tank at full force and possibly cut a hole through the tank bottom.***

2. Allow the **pump** to run for approximately 20 seconds with Water Only to clear all **abrasive** from the **nozzle**.
    a. Click the **Test** button to display the **Test Pump and Nozzle** options.

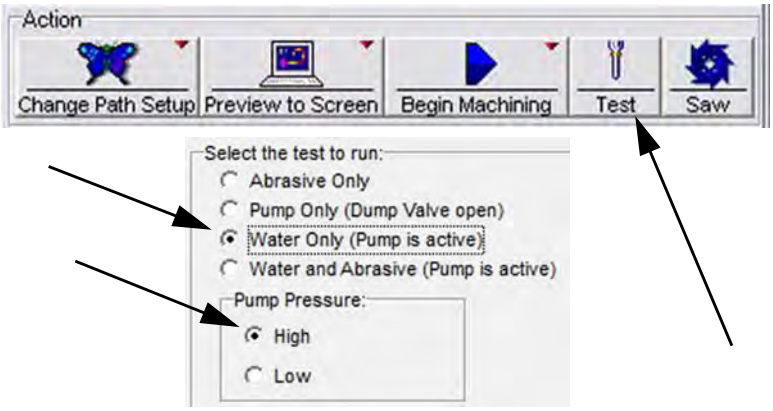


Figure 3-31

    b. Select **Water Only** and **High** Pump Pressure**.**

WARNING! ***The cutting head is about to turn ON. For safety, ensure that the nozzle is positioned correctly and everyone is clear of the cutting area.***

    c. Click **Start Test** to start the test.
    d. After approximately 20 seconds, click **STOP.**

Figure 3-32

3. Position **nozzle** at desired location for shut down.
4. Remove **USB flash drive** from computer (if needed).
5. Close **Make** and all other software applications running on computer.
6. Exit Windows, click **Start**, and then click **Shut down**.
7. Verify **table controller** shutdown (black monitor screen).
8. Turn **OFF** main **table controller** power.
9. Depressurize **bulk hopper** (if applicable).
10. Power **OFF** any other accessories.
11. Turn **OFF charge pump**.
12. Turn **OFF high-pressure pump**.
13. Close water and air supply valves.
14. Turn **OFF** main electrical breaker box.

15. Clean **machine** and work area. Remove any debris in **catcher tank**.

Chapter 4

Pump and Table Maintenance

Follow the maintenance schedule to ensure reliable equipment performance and accuracy. The frequency of most maintenance activities is based upon the length of time the equipment has been in operation; however, harsher than normal environmental conditions can require these activities be scheduled more frequently than indicated in the maintenance checklist.

Alignment Caution!

Machine X and Y-carriages were carefully aligned at the factory using highly accurate test instruments and alignment procedures. The nuts and bolts used to secure these components are critical in maintaining their alignment and should **Never** be adjusted or removed during table maintenance or any other reason. Doing so will permanently upset the alignment and cutting accuracy of your machine. Always contact OMAX Technical Support if you are unsure about the disassembly of any carriage components.

Tools Required for Pump and Table Maintenance

Tool Required	Nozzle Assembly	Dual on/ off Valve	Pump	Table
Open End Wrench				
1/4 in.		X		
½ in.			X	
5/8 in.			X	
9/16 in.			X	
11/16 in.	X			
13/16 in.		X	X	
7/8 in.			X	
1 in.	X	X	X	
1-1/4 in.	X			
1-1/2 in.		X	X	
Crow's Foot Wrench				
5/8 in.			X	
¾ in., 3/8 in. drive			X	
1-1/8 in.		X		
Sockets				
15/16 in. (24 mm); ½ in. drive			X	
Ratchet Wrench				
½ in.			X	
Breaker Bar				
½ in. drive			X	
3/8 in. drive			X	
Torque Wrenches				
175 ft-lb (237 N·m)			X	

Tool Required	Nozzle Assembly	Dual on/ off Valve	Pump	Table
250 in-lb (28.2 N·m)		X	X	X
100 ft-lb (136 N·m)		X	X	
Allen Wrenches				
3/32 in.			X	
3/16 in.			X	
3 mm		X		
5 mm				X
6 mm				X
8 mm			X	
14 mm			X	
Pliers				
Channel lock			X	
Needle nose		X	X	
External snap ring			X	
Internal snap ring			X	
Screwdrivers				
(2) Large flat-blade			X	
Small flat-blade			X	
3/16 in. flat tip			X	X
Lubricants				
Anti-seize P/N 202563 (see Caution below)*	X		X	
Lubriplate P/N 201304		X	X	X
Extreme Pressure Lube P/N 202496			X	
Blue Goop anti-galling compound P/N 302692		X	X	
Arctic Grease P/N 304368				X
Jet-Lube Temp-Guard (Synthetic Molydisulfide) P/N 309325				X
Special Tools				
Check valve removal tool			X	
Removal/installation tool				X
0.124 in. diameter anti-rotation pin, (1/8 in. x 2-3/4 in.)			X	
Spanner wrench P/N 304512				X
Filter seal removal tool				X
Inspection Tools				
Magnifying glass (or microscope)			X	
1 in. (2.54 cm) micrometer			X	
Other				
Arbor press	X		X	
Soft-jawed vise			X	X
Soft-blow mallet			X	
Propane torch			X	

Tool Required	Nozzle Assembly	Dual on/ off Valve	Pump	Table
Grease gun			X	X
Scale for weighing abrasive flow			X	
Ultrasonic cleaner			X	
10 in. crescent wrench			X	

* **Caution:** *Only use the recommended anti-seize compound, P/N 202563. Some anti-seize compounds contain larger metallic particles that could cause damage to pump components.*

Using Blue Goop

All stainless steel, high-pressure fittings require the application of a quality thread lubricant such as Blue Goop.

Note: *Blue Goop functions as a lubricant; it is not a thread sealer.*

This lubricant prevents stainless steel components from galling and seizing. Excessive amounts of Blue Goop lubricant introduces a variety of unnecessary machine problems such as the contamination and fouling of machine components. To avoid this, OMAX recommends applying Blue Goop using the following procedure:

1. Prior to applying Blue Goop, squeeze the tube contents back-and-forth to work the oil throughout the goop since the oil and solids tend to separate.
2. Use an acid brush to apply Blue Goop onto each component that requires lubrication.
3. Apply the Blue Goop at the start of the male threads. When threading on the female component, the Blue Goop becomes evenly distributed.

Caution: ***A small amount of Blue Goop goes a long way. Use it sparingly!***

Figure 4-1

WARNING! ***Properly preparing and connecting ultra high-pressure (UHP) tubing and fittings is critical in maintaining a safe and leak-free high-pressure system.***

Creating a High-pressure Seal

Maintaining proper cone angles on the body and tube is critical in creating a high-pressure seal. This seal is created when the angled (59º) metal edges of the tube cone seat presses against the metal edges inside the body cone which has a slightly larger angle (60º). This slight difference in angles between the body and tube cones creates a tight, metal-to-metal seal between both components.

The following components are typical in a ultra high-pressure fitting:

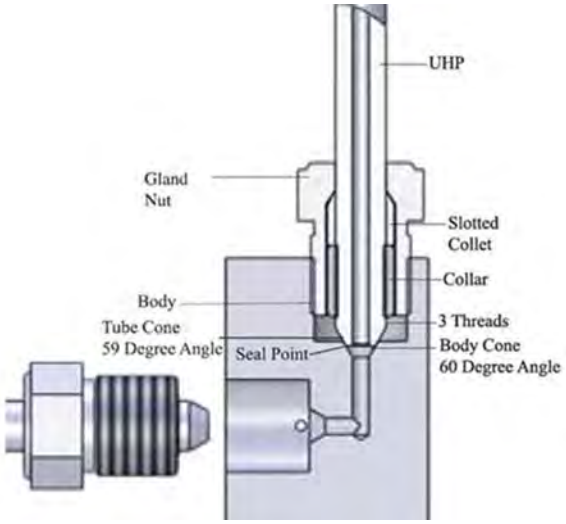


Figure 4-2

Assembling Ultra High-pressure Fittings

Caution: ***Always use two wrenches when tightening UHP fittings!***

1. After the **tubing** and **body** have been properly coned and threaded, slip the **gland nut** onto the **tubing**.
2. Slide the **slotted collet** onto the **tubing**, taper side into the **gland nut**.
3. Screw the **collar** onto the threaded end of **tubing**, observing the Three Thread Rule.

Three Thread Rule

Always allow three screw threads to be exposed either on the end of the tubing or between the collar and coned end of the tubing. This allows the tube to fully seat inside the coned body and create the required seal.

1. Apply a small amount of Blue Goop to the **gland nut** threads.
2. Insert the **tubing** into the **body cone**, making sure the mating surfaces are aligned.
3. Screw the **gland nut** into the connection until finger-tight.
4. Finally, tighten the **gland nut** (use two wrenches) to its specified torque value.

Description	Torque Value
1/4 in. tube, coning and threading, 60 kpsi	25 lb-ft, 34 N·m
3/8 in. tube, coning and threading, 60 kpsi	60 lb-ft, 68 N·m
M8 clamp bar screws	10 - 12 lb-ft, 13.6 - 16.3 N·m

Note: **Do not** *over-tighten the gland nut. This could obstruct the end of the tube and restrict flow.*
Do not *apply a thread sealer such as Loctite or Teflon tape to UHP fittings. The metal-to-metal contact between the coned tube angle and the body cone angle creates the high-pressure seal, not the fitting threads.*

WARNING! ***Do not try to adjust a fitting while still under high pressure. Injury and/or a damaged system component could result.***

Pump and Table Maintenance Overview

The following maintenance activities and schedules are provided to aid in the development of a successful system maintenance program. Please refer to your user's guide for instructions on how to perform the maintenance activities listed.

	Task	Frequency
	Pump Power-end Maintenance	High-pressure Pump
	Change crankcase oil, check belt tension	After first 50 hours of operation
	Change crankcase oil, check belt tension	Every 300 hours after first oil change
	Lubricate main electric motor bearings	6 months for continuous high ambient temperature; dirty or moist locations; high vibrations
		Seasonally (each year) if idle 6 months or more
		Annually if continuous operation
		Every 3 years if 5,000 hours per year
	Replace electrical enclosure air filters	Approximately once per month, or more frequently if required based on shop conditions to maintain adequate air flow
	Inspect and adjust tension or replace belt	Periodically inspect, adjust tension, and replace as needed
	Pump Water Filtration	
	Change pump prefilter and final filter	Whenever the difference in the pressure between the inlet and outlet filter gauges is equal to, or greater than 20 psi
	Change wall 20 in. prefilter (3 micron course) (if applicable)	Monthly or as needed until an interval can be established
	Change wall 20 in. prefilter (1 micron fine) (if applicable)	Monthly or as needed until an interval can be established
	Wet end Maintenance	
	Pump rebuild	**M20**, **M30** Rebuild every 500 hours, alternate minor/major rebuild kits
		M40 Major rebuild kit every 500 hours
	Install overhaul kit	2,000 hours
	Replace plunger assemblies	2,000 hours or if plungers are “rubbed” or damaged
	Replace liquid displacers	2,500 hours or when lip diameter is out of specification
	Replace cylinders	**M20, M30** - 4,000 hours
		M40 - 3,500 hours
	Replace manifold	**M20, M30** - 5,000 hours
		M40 - 4,500 hours
	Other Pump Maintenance	
	Rebuild dump valve	When leaking occurs (drips from the dump valve discharge hose indicate a dump valve on/off valve stem to seat failure)
		An immediate dead head may be a clogged dump valve; rebuild the dump valve
	Lubricate pump dump on/off valve air actuator assembly O-ring	Inspect O-ring on a weekly basis (or other frequency determined based on number of on/off cycles); lubricate the O-ring with Lubriplate; replace the O-ring as needed based on wear
	Rebuild safety valve	When leaking occurs, replace if safety valve continues to leak after rebuild

	Task	Frequency
	Rebuild adjustable dump orifice assembly	When cold water leaking occurs at the adjustable orifice (dump valve) when the nozzle is running
	High-pressure Plumbing System	
	Rebuild or replace swivel	Rebuild if any leaks; replace if leaking continues after rebuild or if damaged
	Rebuild on/off valve	Water entering the abrasive feed tube when the nozzle first fires (leaky seal)
		Water drips from the mixing tube (leaky valve stem)
		Water leaks 180 degrees from where the UHP plumbing enters the dual on/off valve (bad valve seal)
		Water drips from the UHP nipple on the dual on/off valve (loose fitting, cracked body or fitting)
	Lubricate nozzle on/off valve air actuator assembly O-ring	Inspect O-ring on a weekly basis (or other frequency determined based on number of on/off cycles); lubricate the O-ring with Lubriplate; replace the O-ring as needed based on wear
	High-pressure lines and fittings	Replace if damaged or if continued leaking occurs; do not try to repair
	Operator Workstation	
	Clean keyboard and mouse	As needed
	Clean monitor screen	As necessary for sharp viewing
	Reboot PC controller	Daily
	Run Windows defragmenter program	Monthly
	Update Intelli-MAX software	When updates are released by OMAX
	Tank	
	Wash away abrasive accumulation from equipment working area	Daily and as often as required to maintain a clean working environment
	Remove all garnet, sludge, and slugs from the tank bottom	Whenever abrasive particles begin to excessively accumulate on the material being machined
	Inspect individual slats	Rotate monthly or more frequently if needed; replace when excessively scored and no longer stable
	Clean the outlet water filter	Check monthly or more frequently if needed
	Run tank cleaning program	As needed when using a solids removal system
	Add anti-bacterial chemicals to the tank water (controls tank odor and bacteria growth)	Only use if needed to control tank odor and bacteria growth; ***__Do not add to the tank if using a Water Recycling System (WRS)__***
	Table	
	Lubricate Z-axis shafts (left and right)	Yearly, or as needed to maintain smooth operation
	Lubricate the Z-axis lead screw	Yearly, or as needed to maintain smooth operation
	Wipe down X and Y-rails	Daily, or as needed to maintain uninterrupted operation
	Wipe down X and Y magnetic encoder strips	Daily, or as needed to maintain uninterrupted operation
	Clean nozzle orifice (or the whole nozzle body if using the MAXJET 5i)	Clean the jewel/nozzle orifice assembly once a week minimum to prevent mineral buildup in the jewel assembly
	Change the last chance nozzle filter	Once per week (or more frequently if needed)
	Abrasive tubing (hopper to nozzle)	Inspect weekly, replace as needed

	Task	Frequency
	Rebuild the nozzle* *If using the MAXJET 5i integrated diamond nozzle, replace the whole nozzle body - do not rebuild	As required to maintain cutting quality, or when reaches useful life
	Rotate/replace nozzle mixing tube	Rotate 90 degrees (one quarter turn) every 8 hours of cutting to even out wear; replace as needed

Note: *The hours listed in this checklist for recommended pump maintenance scheduling are NOT warranty hours. Please refer to the warranty provided on the website for more information*

Note: *Repeat the time durations shown for your particular pump after every rebuild kit.*

Belt Maintenance

The heavy-duty belt connecting the high-pressure pump with the electric motor occasionally requires re-tensioning or replacement. Periodically inspect the belt, looking for cracks, frays, or other wear spots. If you see cracks, frays, or damaged/missing teeth, the belt should be replaced immediately.

To inspect the pump belt:

1. Disconnect the pump's main AC power source.
2. Turn **OFF** the charge pump water supply.
3. Lift off the **pump cover** ①.
4. Remove the **belt guard** ②.

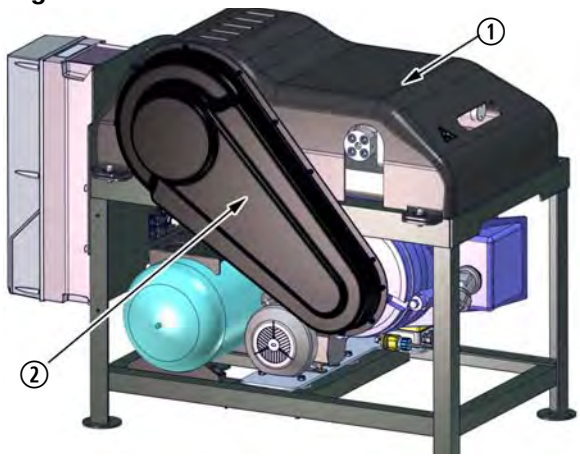


Figure 4-3

5. Inspect the **belt** for wear, cracks, or signs of damage.

Note: *A small amount of blue powder seen inside the cover guard from belt operation is normal.*

6. Press down on the center of the **belt** ③ between the **large** ① and **small** ② **pulleys** to verify proper deflection with the specified force applied.

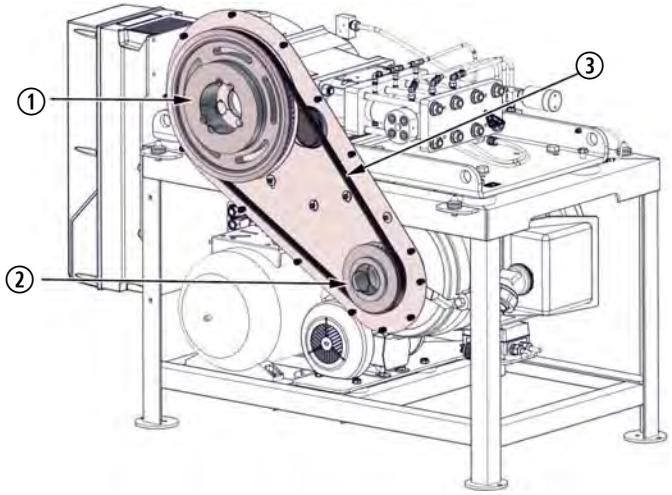


Figure 4-4

The belt should deflect 1/4 in. - 5/8 in. (6.5 -16 mm) when pushed with a force of approximately 34 - 37 lb (15 - 17 kg) midway between the pulleys. If the belt deflects more or less than 1/4 in. - 5/8 in. (6.5 -16 mm) when pushed, the belt may require its tension adjusted or replacement. Contact OMAX Technical Support for additional information.

Caution: ***A too loose or overly-tightened belt will shorten its life.***

Lubricating the Electric Motor

Use these recommended high-quality ball bearing lubricants:

Consistency	Type	Typical Lubrication
Medium	Polyurea	Shell Dolium R and/or Chevron SR1 2
	Sodium-Calcium	Lubriko M6

To lubricate the electric motor ball bearings:

1. Disconnect the pump AC power source.
2. Access the shaft-end of the **motor**.
   a. Remove outside **belt guard cover**.
   b. Remove **inside back plate** and **shaft guard**.
3. Locate **grease fittings** ② located on each of the motor ends.

4. Remove **pipe plugs** ① located opposite the **grease fittings**.

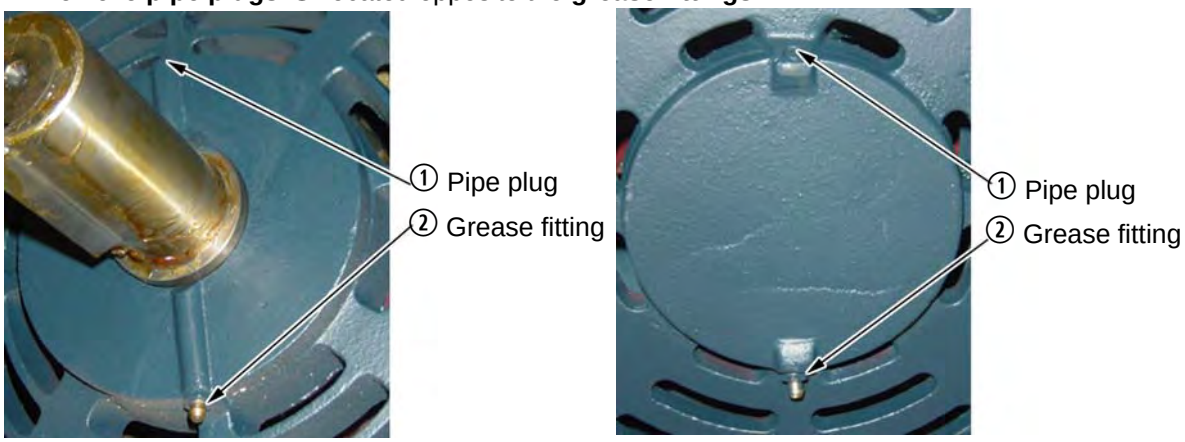


Figure 4-5

5. Wipe the tip of each **grease fitting** and the grease gun clean and connect the grease gun to the **grease fitting**.
6. Apply 2-3 full strokes from the grease gun to each **grease fitting**.
7. Wipe up any grease forced out the hole.
8. Replace **belt guard components**.
9. Replace **pump cover**.
10. Run **motor** for 20 minutes before replacing the **pipe plugs** ①.

Caution: ***Keep the lubricant clean. Always lubricate at motor standstill. Always remove and replace the pipe plugs at motor standstill. Never mix petroleum lubricants and silicone lubricants in motor bearings.***

Change Crankcase Oil

Avoid excessive wear and damage to the crankcase bearings by changing the crankcase oil according to the intervals specified in the maintenance schedule. The oil must also be changed anytime it becomes contaminated with water or other debris.

WARNING! ***Always use SAE 30 - 35 (ISO 100) non-detergent motor oil. Other types of oil may shorten pump life. If temperature in the pump's physical environment exceeds 90° F (32° C), use SAE 40 (ISO 150) non-detergent motor oil.***

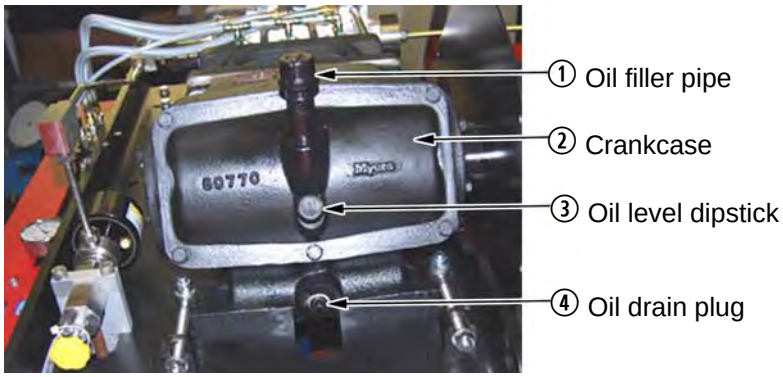
The crankcase requires 3 quarts (2.8 liters) of oil.

Operating Condition	Oil Required
Standard	SAE 30 - 35 non-detergent (ISO 100)
Operating at 90º F (+32º C)	SAE 40 non-detergent (ISO 150)

To change oil:

1. Disconnect **pump** AC power source.
2. Remove **pump cover**.
3. Place an oil drain pan below the **crankcase drain plug**.

4. Remove **crankcase drain plug** ④.



WARNING! ***Crankcase oil may be hot. Be careful when removing the plug to prevent hot oil from flowing out and burning your hand and fingers.***

5. Allow crankcase oil to drain completely.

Note: *To force out all remaining oil, inject a small amount of shop air into the hole in the oil filler pipe with the filler cap still in place.*

6. Replace **crankcase oil drain plug**.
7. Fill correct amount of oil through the **oil filler pipe** ①.
8. Check for the proper oil level using the **oil level dipstick** ③.

Note: *The oil level dipstick was designed to show FULL with 2 quarts (1.9 liters equivalent) of oil. When filling with 3 quarts of oil, the oil level should reach above the full line as shown below.*

Figure 4-6

9. When you replace the dipstick, verify the following:
   a. The **O-ring seal** on the **dipstick** is in place and in good condition.
   b. The **dipstick** is properly seated in the **gear case**.
   c. The **dipstick** is installed flat side up.

WARNING! ***If the dipstick is not installed with the flat side up, it could make contact with the crankcase rod bolt.***

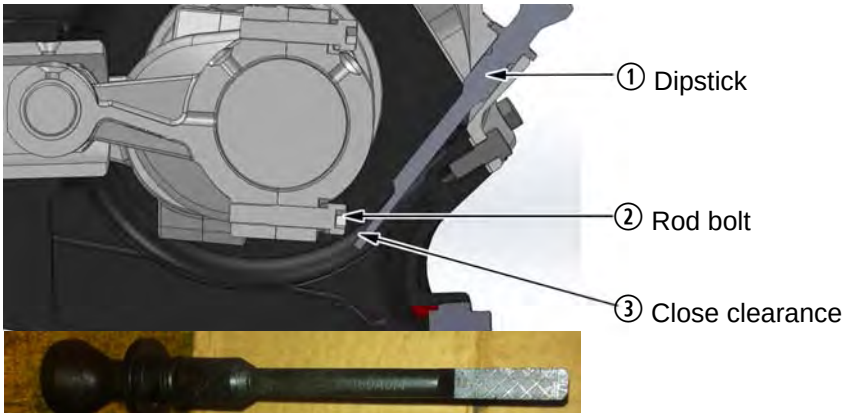


Figure 4-7

10. Replace **filler pipe cap**.
11. Replace **pump cover**.

Always dispose of discarded oil according to your local environmental regulations.

Charge Pump

The charge pump boosts incoming water pressure to a level required for high-pressure pump operation (≥80 psi for 20 and 30 hp pumps; ≥100 psi for 40 hp). This pump is also responsible for circulating water through the system cooling lines to cool wet end components before the high-pressure pump starts. This cooler water increases the life of the high-pressure pump seals. The charge pump must be running for the high-pressure pump to start.

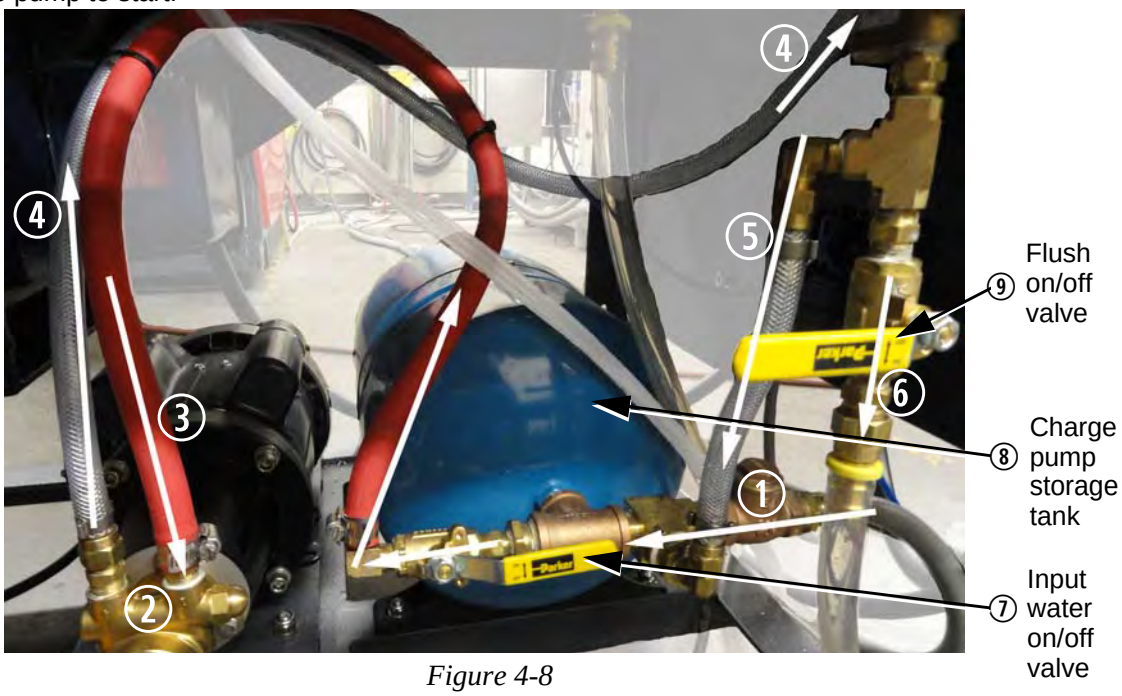


Figure 4-8

Water from the shop source enters the **charge pump storage tank** ⑧ through the **water input line** ①. Water from the **charge pump storage tank** is routed to the **charge pump** ②**.**

Caution: ***The last 6 in. (15.24 cm) of water line*** ③ ***to the pump must not be kinked for proper pump operation.***

Water from the **charge pump** is routed to the **filters ④.** Water from the **relief valve** returns to the **catcher tank**, through the **bypass valve** ⑤, or is routed through the **dump valve** to the **catcher tank or** drain ⑥. Water from the **charge pump storage tank** can be shut off at the **input water on/off valve** ⑦. (Filters removed in photo, for clarity.)

Water Filtration System Maintenance

Proper maintenance of the water filters in your low-pressure water system directly impacts the performance of your abrasive waterjet.

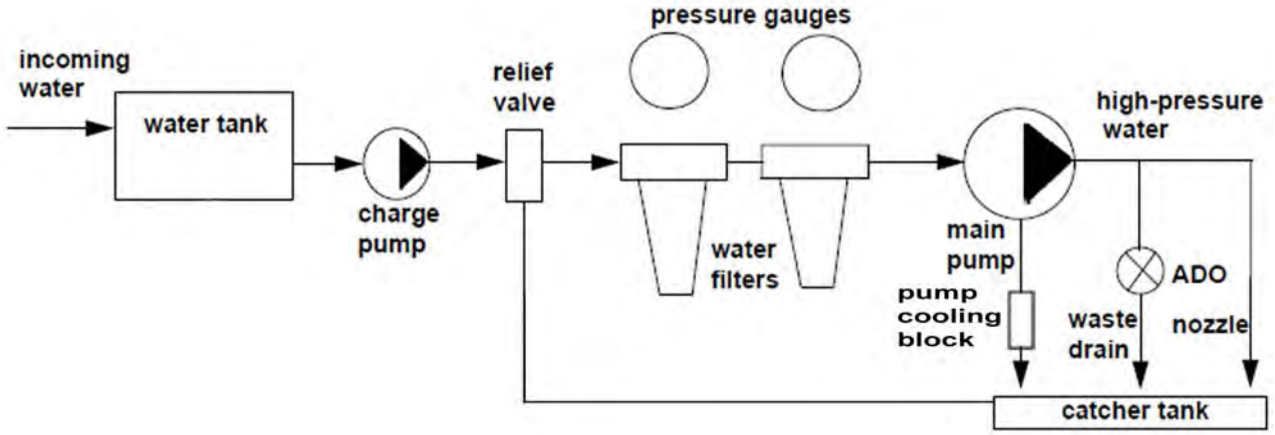
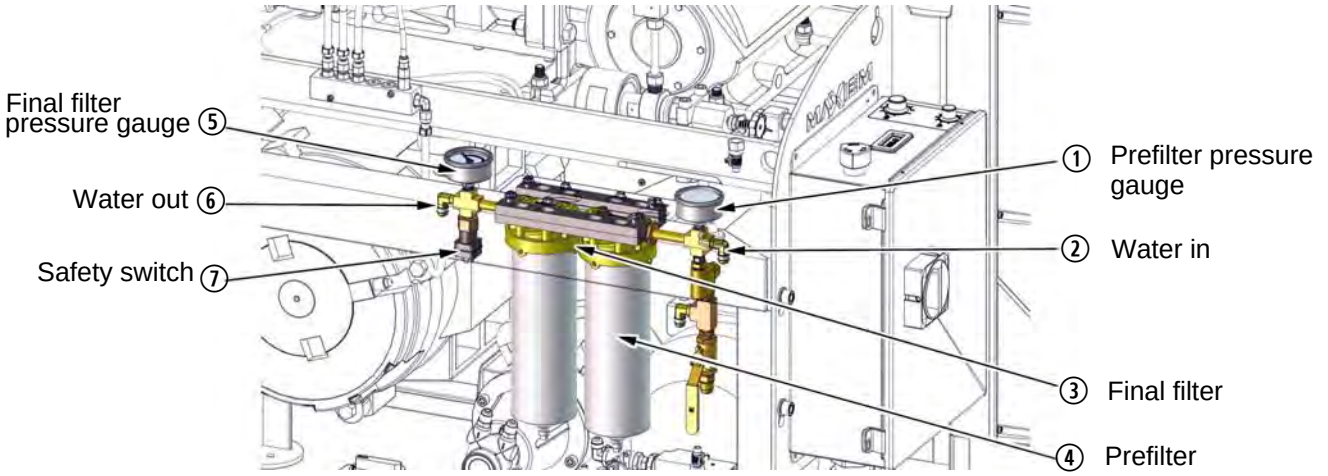


Figure 4-9

How the low-pressure water system filtration works:

1. Water from your local source is piped into your building and is plumbed to the **charge pump storage tank**.
2. When the **charge pump** is turned **ON**, water from the **charge pump storage tank** feeds water to the **final filter** ③.
3. The **prefilter** pressure should be set at:

Pump	Pressure
M20	125 psi
M30	125 psi
M40	150 psi



4. Water travels from the **charge pump** to the **prefilter** ④, through the **final filter** ③, and then to the **high-pressure pump**.

5. The **final filter pressure gauge** ⑤ reads the pressure after both **filters** have filtered the water.

Caution: ***When the low-pressure water system is not maintained properly and the charge pump is not able to develop sufficient water pressure, an internal low-pressure switch will be triggered (<80 psi for 20 and 30 hp pumps; <100 psi for 40 hp), causing the high-pressure pump to shut down.***

Note: *If problems with your water supply are suspected, contact OMAX Technical Support.*

Changing Water Filter Cartridges

Pressure difference between the gauges when the pump is running at high rpm determines filter status. When the pressure difference between the gauges is more than 20 psi with the pump running at a high rpm, filters are becoming clogged and should be replaced. Always change both filters. When filters are new, difference in pressure between the two gauges is close to zero.

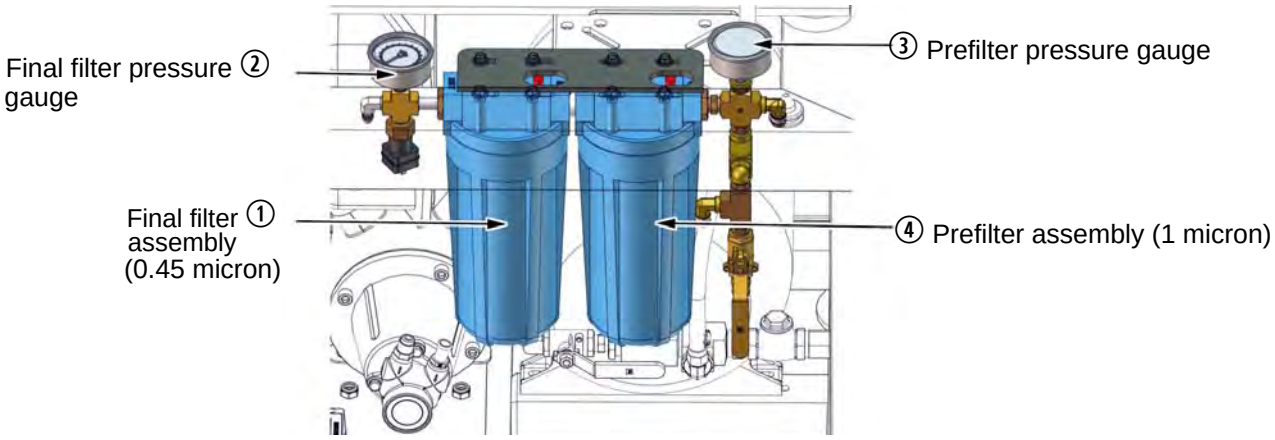


Figure 4-10

To replace the water filters:

1. Position abrasive waterjet **nozzle** in a safe location, or remove the **nozzle**.
2. Turn the **charge pump OFF**.
3. Turn water **OFF** at source.
4. Remove **pump cover**.
5. Unscrew each **filter housing**, using the removal tool provided.

Figure 4-11

6. Remove and discard the **filter elements**.
7. Wash and rinse the **filter housing** to remove all sediment and coatings from inside the **housing**.
8. Rub a thin coating of oil (Lubriplate or equivalent) on the ends of the coarser 1 micron **prefilter element** and install it. Reinstall the **prefilter housing**.
9. Rub a thin coating of oil (Lubriplate or equivalent) on the ends of the finer 0.45 micron **final filter element** and install it. Reinstall the **final filter housing**.

10. After replacing the two elements, turn **only** the **charge pump ON**.
11. For **M20** and **M30 pumps**, hold down the **red buttons** ① on top of the **filter housings** next to the **pressure gauges** to bleed air from the **filters**.

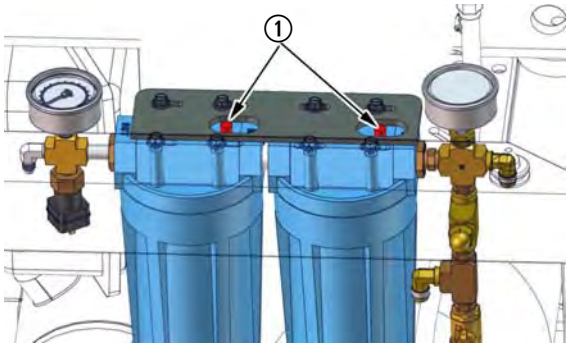


Figure 4-12

Note: *If all the air is not purged from the filters, the charge pump cannot develop sufficient pressure and the main pump will shut down.*

12. Turn the **charge pump OFF**.
13. Replace the **nozzle** if removed.
14. Replace **pump cover**.
15. Verify pressure differential at pump high rpm.

Flush Machine After Maintenance

Always flush the high-pressure plumbing system following maintenance of any high-pressure components.

1. Remove both the **nozzle assembly** and **final filter** from the **Z-axis**.
2. Position the **Z-axis** about 4-5 in. (10.15 - 12.7 cm) from the **table slats**.

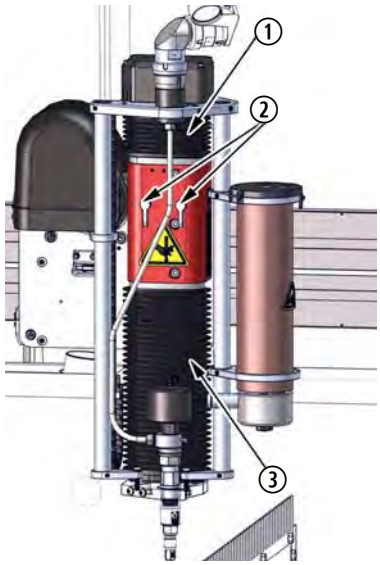
Note: *To minimize splashing, position it over jetbrick or place a piece of cardboard or rags over the slats beneath the Z-axis.*

3. Click the **Intelli-MAX Make Standard** icon on your desktop.
4. On the **File** menu, click **Open (Change Path Setup)**.
5. Under **Choose tool path for machining**, right-click in the white space.
6. Click **OMAX Sample files (for all users)**.
7. Click **Machine_Diagnostic_Files**.
8. Scroll down the list, click **CycleTest_NoAbrasive_100_Cycles.ord**, and click **OK**.
9. Click **Begin Machining,** and then click **Start**.
10. Inspect the system for leaks and repair as needed.
11. Conduct a water-only, low-pressure, and high-pressure test, again inspecting for leaks and repairing any found.

Table Maintenance

Lubricating the Z-axis

Both the lead screw and the two rail shafts in the Z-axis require periodic lubrication.



① Upper bellows
② Grease ports
③ Lower bellows

Figure 4-13

Lubricating the Rail Shafts

1. Position **Z-axis** up/down movement to size both top and bottom **bellows** approximately the same.
2. Clean **Z-axis assembly** and **bellows** to prevent garnet contamination when the **bellows** are opened.
3. Remove **dust covers** from both the left and right rail shaft **grease ports** ①.

① Grease ports

Figure 4-14

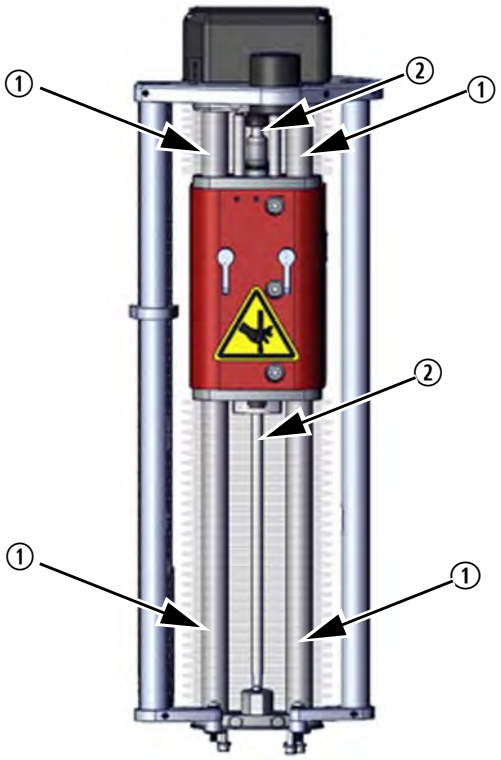
4. Wipe off the **zerk fittings** and the grease gun tip. Attach the grease gun filled with **Arctic Extreme Service Grease** to each of the **zerk fittings**, giving each at least two full pumps of grease.

Caution: ***The Arctic grease used for the two rail shafts is not the same as the grease required for lead screw lubrication (see* Lubricating the Lead Screw, *page 4-16). Do confuse the two types!***

5. Wipe off excess grease from the two **zerk fittings** and replace the **dust covers**.
6. Loosen the bottom **bellows clamps** for both **upper** and **lower bellows**.

Note: *It is recommended that only the bottom bellows clamps be loosened for lubrication access since replacing a top clamp is more difficult.*

7. Lift the bottom **bellows** and lightly apply a thin grease coating to the bottom 2-3 inches of each **rail shaft**, using **Arctic grease**.



① Rall shaft
② Lead screw

Figure 4-15

8. Lift **top bellows** allowing access to the top portion of both **rail shafts**. Apply a thin grease coating to the top 2-3 inches of **both rail shafts** using **Arctic grease**.
9. Move the **Z-axis** through the full up/down stroke to distribute the grease on the **rail shafts**.

Lubricating the Lead Screw

1. Lift **bottom bellows** and wipe off the old grease from the **lead screw**.
2. Apply a light coating of Jet-Lube Temp-Guard (Synthetic Molydisulfide) grease on the **lead screw threads** (Figure 4-15), ensuring that you work the grease deep into the thread grooves.

Caution: ***Grease required for lead screw lubrication is not the same as the Arctic grease used for the two rail shafts (see "*Lubricating the Rail Shafts*"). Do not confuse the two types!***

3. Lift **top bellows**, wipe off the old grease and apply a light coating of Jet-Lube Temp-Guard (Synthetic Molydisulfide) grease on the **lead screw threads**, ensuring that you work the grease deep into the thread grooves.
4. Pull both **bellows** down and tighten each **bellows clamp** securely to its **Z-axis mounting surface**, ensuring each **bellows** is fully mounted and unable to slip off during operation.
5. Move the **Z-axis** up and down over its full operating range a few times to distribute grease evenly along the **lead screw threads** and **rail shafts**.

Clean X-rails and Y-bridge Rails

Wipe down X and Y-bridge rails as needed to maintain uninterrupted operation.

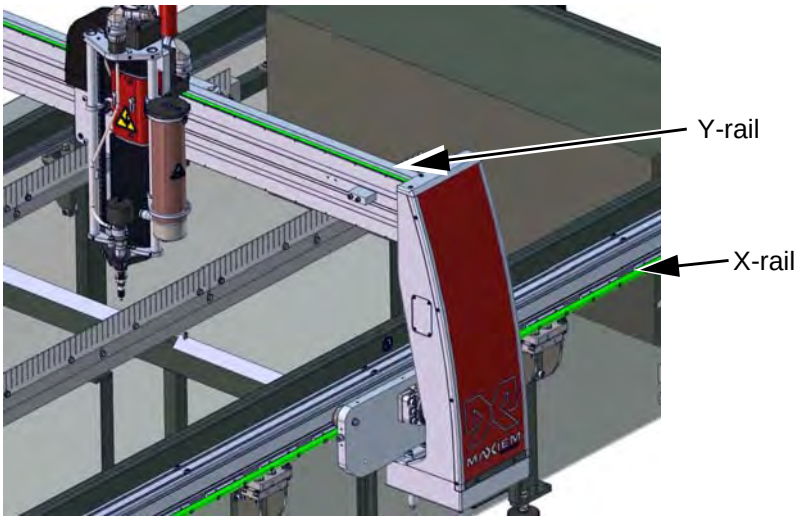


Figure 4-16

1. Apply mild soap and water to a clean rag (do not use any abrasive cleaners).

Caution: ***Do not spray cleaner directly onto the rails as the liquid may seep onto/under the magnetic encoder strip.***

2. Wipe down the **rails**.

Caution: ***Do not lubricate the rails as this will affect X and Y-axis motion.***

Clean Magnetic Encoder Strip

Clean the magnetic encoder strip on the X-rails and Y-bridge as needed to maintain uninterrupted operation.

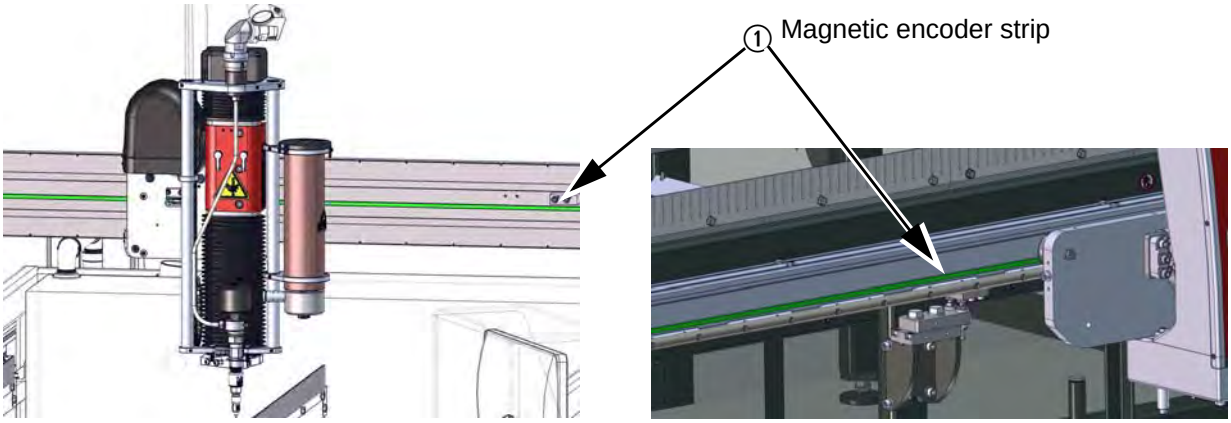


Figure 4-17

1. Apply cleaner to a clean rag. Use only mild soap and water (do not use any abrasive cleaners).

Caution: ***Do not spray cleaner directly onto the rails as the liquid may seep onto/under the magnetic encoder strip.***

2. Wipe off the **encoder strips** ①.

Abrasive Tubes

The abrasive tubes that run from the abrasive hopper to the nozzle wear with the flow of abrasive over time. Worn abrasive tubes can interrupt the flow of abrasive to the nozzle, affecting the quality of the part.

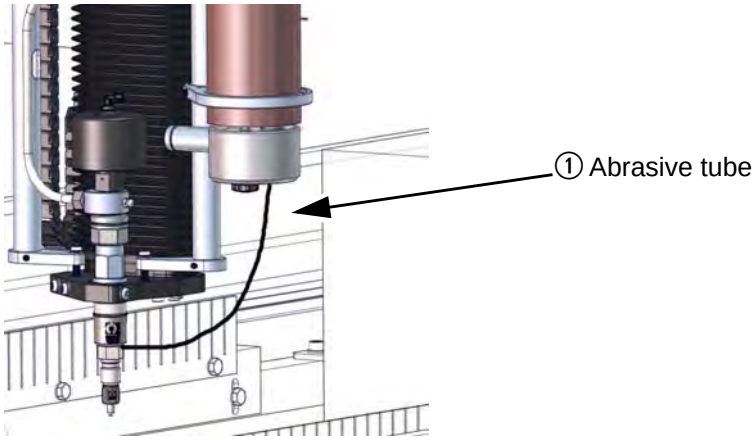


Figure 4-18

1. Inspect the **tubes** daily.
2. Replace as needed.

Note: *The length of replacement tube should be long enough to easily reach from the hopper to the nozzle, but not so long that it impairs the abrasive flow.*

Software Updates

Software updates are available from the OMAX Customer Support website.

Requires a user name and password, which you can obtain by registering on the OMAX website.

Caution: ***Run the installation program for the new software to install it. Do not manually uninstall the current version of your Intelli-MAX software; you may lose valuable history and settings files, causing your abrasive waterjet to make substandard parts.***

Chapter 5

Nozzle Care and Maintenance

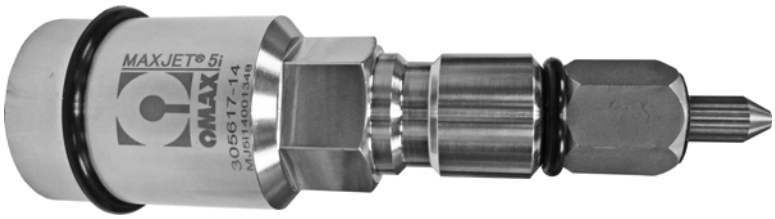


Figure 5-1

Introduction

The MAXJET 5i® Nozzle Assembly is guaranteed for 500 hours (prorated for use) if installed, operated, and maintained with proper procedures. The diamond orifice and carbide disc are intentionally fixed inside the nozzle body to ensure internal component alignment. The permanent component alignment produces an accurate jet stream whenever you cut.

Caution: ***The MAXJET 5i Nozzle Assembly contains an integrated nozzle body. The components in the integrated nozzle body (shown in the component diagram) are factory-assembled and should not be taken apart. Doing so will void the component warranty.***

Once the integrated nozzle body reaches or exceeds 500 operating hours and the performance degrades, replace the whole nozzle body. If you suspect premature nozzle degradation, contact Technical Support for assistance.

Removing the Nozzle Assembly

Note: *Refer to drawing, P/N 400565, MAXJET 5i Nozzle with Inlet Body for specific component identification.*

To remove the MAXJET 5i Nozzle Assembly from the machine, follow these steps:

1. Place a sheet of cardboard or similar under the **nozzle assembly** on the machine to prevent any components from falling into the **tank**.

Caution: ***Never remove the nozzle body without first removing the mixing tube, as it may put a large upward force on the parts and affect orifice retainment/alignment.***

2. Remove the **mixing tube nut**, **collet**, **O-ring**, and **mixing tube** from the **nozzle assembly** while the **nozzle** is still installed on the machine.
3. Remove the **integrated nozzle assembly** from the machine.
4. Clean the **nozzle inlet body**.
5. Replace the **nozzle filter seal assembly** in the **inlet body**.

Installing the MAXJET 5i

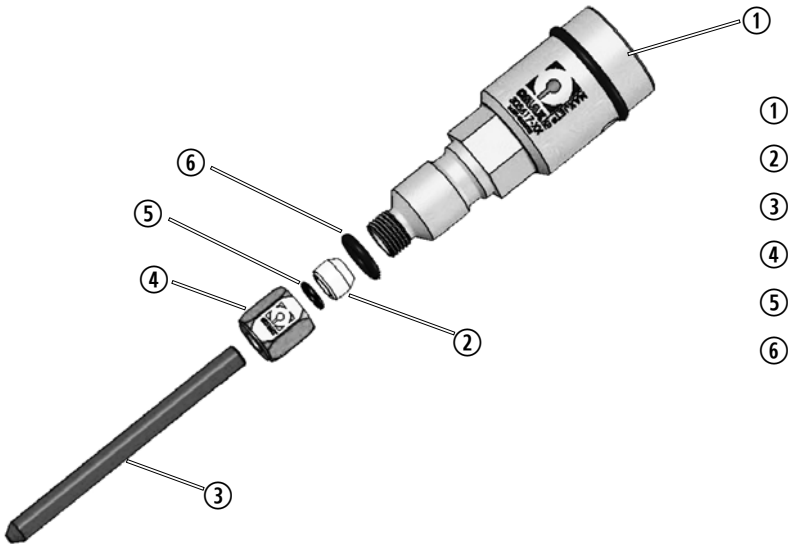
1. Apply a small amount (a light sheen) of Blue Goop on the threads of the **nozzle body**.
2. Attach the **nozzle body** to the **inlet body**.

3. Tighten the **nozzle body**.

≤ 25 ft-lb
34 N·m

Caution: ***Do not overtighten as this will damage the alignment of the orifice assembly inside the nozzle body. The plastic seals on the nozzle inlet filter accomplish the sealing without excessive tightening.***

4. Insert the **mixing tube** ③ so it sits firmly against the **mixing chamber** inside the **integrated nozzle body** ①.



① Integrated nozzle body
② Mixing tube collet
③ Mixing tube
④ Mixing tube nut
⑤ O-ring
⑥ O-ring

Figure 5-2

Caution: ***Never install and tighten the mixing tube, mixing tube nut, and collet on the nozzle body unless the nozzle body is installed on the machine. Doing so can put upward force on the integrated nozzle components moving them out of alignment.***

5. Hold the **mixing tube** ③ firmly in place and then attach the **collet** ②, **O-ring** ⑤, and **mixing tube nut** ④. Tighten until snug (tight enough so the **mixing tube** is firmly seated in the **nozzle body**).

Note: *If you have a leak, ensure all components are clean and free from dirt and abrasive, and then replace the filter and O-ring (apply a light film of Lubriplate to the O-ring on the filter). Overtightening will damage the sealing surfaces.*

Operating the MAXJET 5i

Caution: ***To avoid dead heading the pump, lower its rpm to minimum before activating the nozzle.***

1. Readjust the **adjustable dump orifice** to match operating characteristics of the **MAXJET 5i assembly**.
2. Calibrate the actual abrasive flow rate.

3. In **Make,** click **Setup,** and click **Pump and Nozzle settings**:

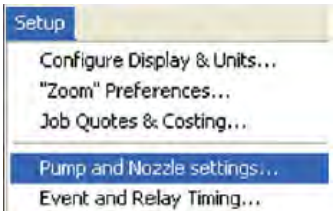


Figure 5-3

4. Correct any values being displayed that differ from those recorded when testing your machine. Change the **Abrasive Flow Rate** to the value you determined above. Set the **Jewel (orifice) Diameter** and the **Mixing Tube Diameter** to match the **orifice** size you are using, and the **Pressure at Nozzle in High Pressure Mode** to the value set for your **pump**:

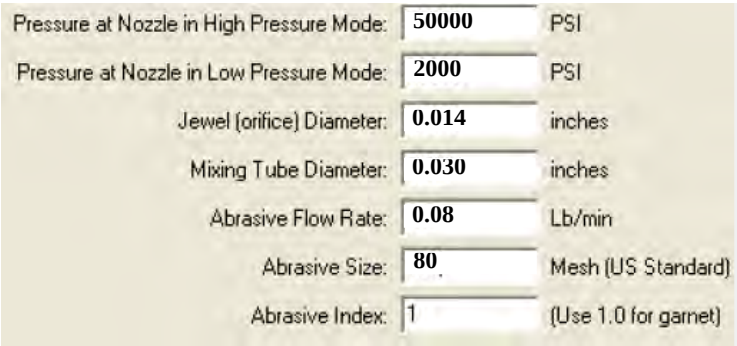


Figure 5-4

5. Click **OK** to save your changes.

Note: *The tool offset for the MAXJET 5i nozzle should be determined after some test cuts are completed. Use one half of the mixing tube diameter as a starting value.*

Nozzle Cleaning

The MAXJET 5i nozzle assembly should be cleaned once a week. To clean the integrated nozzle body, follow these steps:

1. Submerge the **integrated nozzle body** into an ultrasonic cleaner filled with white vinegar.
2. Run the ultrasonic cleaner for 3-5 minutes or until the **jewel orifice** is clean.
3. Rinse the **nozzle body** with clean water prior to installing.
4. Perform nozzle tests in the *Startup Checklist* after reinstalling the **nozzle**.

Filter Seal Assembly

Remove Nozzle Filter Seal Assembly

The **nozzle filter** is a consumable item that should be discarded and replaced weekly or as needed.

1. Screw the filter seal assembly/removal tool up into the **filter seal assembly**.

① Filter seal assembly

② Removal tool

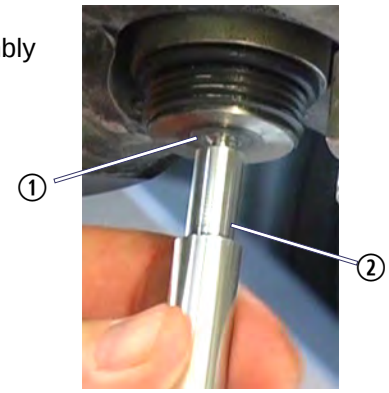


Figure 5-5

2. Pull the removal tool straight down to remove the **filter seal assembly** from the **inlet body**.
3. Unscrew the removed **filter seal assembly** from the removal tool and discard it. The **filter seal assembly** is a consumable item and will be replaced.

Install the Nozzle Filter Seal Assembly

1. Apply a light coating of Lubriplate to the **filter O-ring** ② and slide the lubricated **O-ring** onto the **filter** ①.

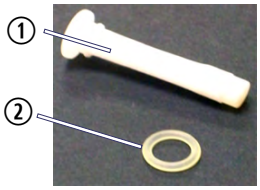


Figure 5-6

2. Push the **filter** with **O-ring** ① installed up into the **inlet body**.

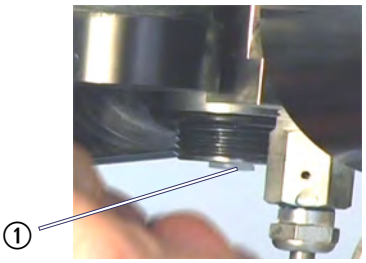


Figure 5-7

Note: *The nozzle filter seal assembly will be properly seated when the nozzle body is tightened.*

Caution: ***The nozzle body uses a soft filter, not a high-pressure, metal-to-metal seal. Do not over tighten! The ring seal and O-ring make the seal, not the torque of the body. Overtightening will not fix a leak and most likely creates additional repair issues. If you have a leak, inspect the sealing surfaces and replace the seal.***

Removing the Nozzle Body O-ring

O-rings should be removed for inspection and replaced when necessary.

1. Remove the **O-ring** ① from the **nozzle body** ②.

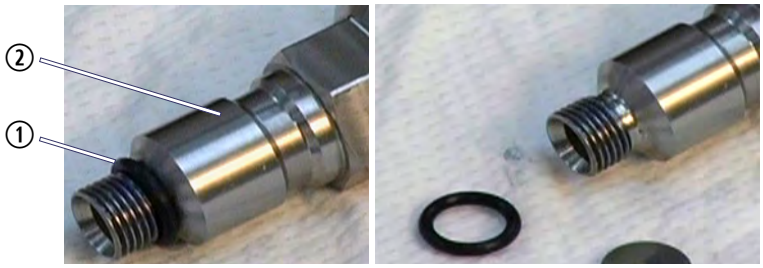


Figure 5-8

2. Inspect the **O-ring** and replaced when needed.

Cleaning and Inspecting Nozzle Components

Cleaning

Cleaning nozzle assembly components and maintaining cleanliness is critical. Any contamination, such as particles of garnet, metal chips, or small pieces of paper can negatively impact cutting.

1. Make sure your work space is kept clean and free of contamination and your hands are clean prior to handling clean **nozzle components**. In general, you should wash all parts using a non-abrasive, mild soap with water, or use an ultrasonic cleaner.

Note: *A small ultrasonic cleaner containing white vinegar is useful in cleaning nozzle parts and is recommended for removing material buildup in the orifice or jewel assembly.*

2. Ensure that dirt and grit are removed from all **nozzle** parts.
3. Rinse using clean water and carefully blow dry.

Figure 5-9

Caution: ***Use of any damaged or defective nozzle component will negatively impact performance of your abrasive waterjet.***

Orifice or Jewel Assembly

The MAXJET 5i body contains a diamond jewel that requires cleaning. If damaged, the whole integrated nozzle body needs replaced. The hole in the jewel is very small, approximately 0.014 in. (0.36 mm) in diameter for the MAXJET 5i orifice assembly. Water travelling through the orifice is accelerated to extremely high speeds. The jewel may have mineral buildup that is difficult to see with the naked eye. The jewel can also be plugged, worn, or become misaligned.

In Figure 5-10 note that in example A the edges are clean and sharp and the center hole is completely round. No damage appears in the area around the hole, and no deposits are plugging the hole as seen in example B.

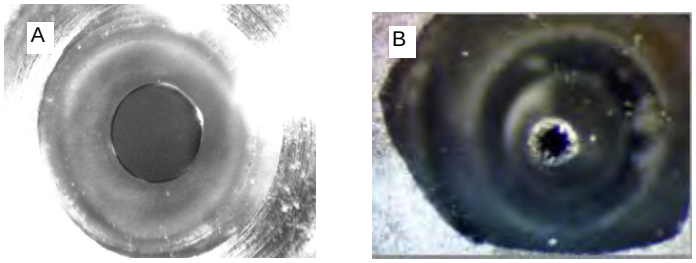


Figure 5-10

Variables including elevated water temperature and pH, plus the presence of scaling ions such as calcium, magnesium, or silicon can cause scale to build up in and around the internal diameter of the orifice. Mineral deposits, or scale, in the internal diameter of the orifice can form a hollow cone surrounding the small hole in the center of the jewel. Eventually, this buildup results in poor jet quality.

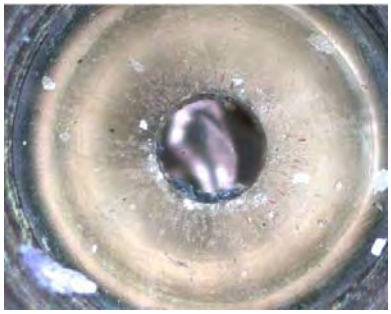


Figure 5-11

If in-line filters are not used, particles that are too large to pass through the orifice will plug (Figure 5-11) or damage it, causing the pump to fault. A fine particle filter, called the “last chance filter,” is installed just before the orifice to prevent particles upstream in the high-pressure system from entering the orifice.

If a jewel is damaged, misaligned, or not producing a well-formed jet, the life of the nozzle body assembly and the mixing tube will be dramatically reduced.

Mixing Tube

Although the mixing tube is made from an extremely hard material, over time, the flow of high-pressure water and abrasive will wear away the inside of the mixing tube. This results in a gradual, irregular widening of the internal diameter of the mixing tube, causing a less accurate stream of abrasive and water. Figure 5-12 provides some examples of worn mixing tubes. A cross section of these mixing tubes reveals the irregular wear of their internal diameter.

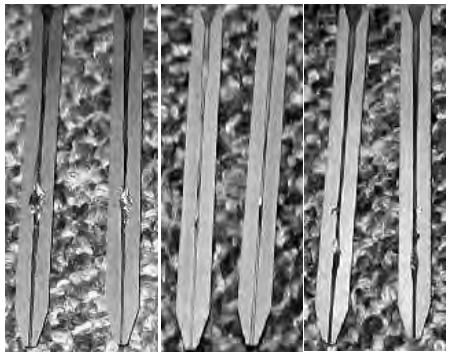


Figure 5-12

The mixing tube is also very brittle and easily broken if dropped or struck hard. The key to a long mixing tube life is maintaining a healthy orifice or jewel. Damage to mixing tubes caused by misaligned jets or a damaged jewel is not apparent when looking through the bore of the mixing tube. The size of the kerf and cutting performance are the best indicators of mixing tube wear. The kerf is the width of the cut made by the abrasive waterjet. With a 0.030 in. (0.762 mm) mixing tube, it can range from 0.015 in. (0.38 mm) to 0.060 in. (1.52 mm), depending on the nozzle, the thickness of the material being cut, and the amount of wear on the mixing tube.

A clogged mixing tube is most frequently caused by using contaminated abrasive. Because the opening in the mixing tube can be as small as 0.030 in. (0.76 mm) on a MAXJET 5i, even a small particle of dirt can clog it. Other potential causes of clogging include contaminated or wet abrasive. Metal chips from other shop operations and paper from the abrasive bag are two common sources of contamination. Clean the mixing tube and inspect its inlet and outlet ends to see if it needs to be replaced.

If the mixing tube is clogged, try to dislodge the blockage as follows:

1. In **Make**, click the **Test** button to display the **Test Pump and Nozzle** options:

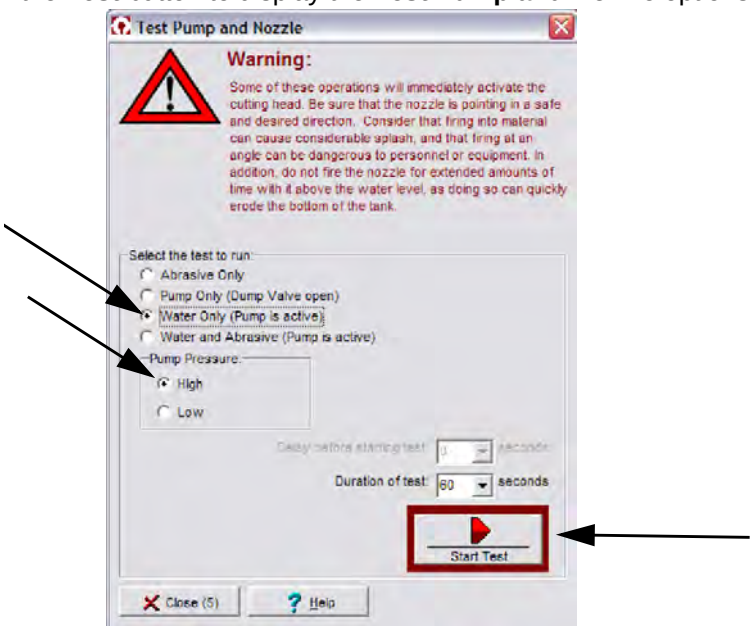
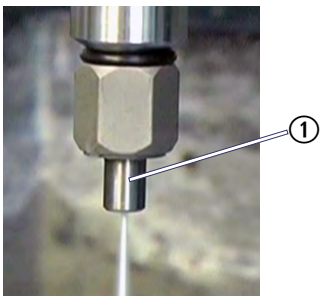


Figure 5-13

2. Select **High** under **Pump Pressure,** select **Water only (pump is active)**, then click **Start Test**.
3. Toggle the **Water Only** test **ON** and **OFF** a number of times in an attempt to dislodge the clog.
4. If that does not work, shut down the machine by following the *Shutdown Checklist*.
5. Remove the **mixing tube** from the **nozzle**, turn it upside down, and tighten it in the **nozzle body**.



① Mixing tube turned upside down

Figure 5-14

6. Start the machine.

7. Click **Start Test** and repeat the **Water Only** test to try and dislodge the clogged material.

Maximizing Nozzle Life

There are a number of things you can do to maximize the life of your nozzle components:

- Do not change the mixing tube simply because the jet stream looks wide.
- Cut test parts and do kerf checks on a regular basis to see when cutting performance begins to degrade.
- If the surface quality and accuracy are as expected, continue using the nozzle assembly.
- If the quality of the cut part is not as expected, prompt correction of the problem minimizes complications.
- Take advantage of features in **Make** that allow different tool offset values and mixing tube diameters to adjust for mixing tube wear.
- Maintain part tolerances and extend mixing tube life by entering the correct tool offset value in **Make**.

All nozzle components are negatively affected by contamination, dirt, or other materials present in high-pressure systems. In general, cleanliness is a key controllable factor in extending the life of nozzle components.

Some effective ways to maintain cleanliness include:

- Keep your work area clean.
- Store spare nozzle components and other parts in sealed, clean containers or bags until ready for use.
- Thoroughly clean all parts and high-pressure fittings prior to assembly or reassembly.
- Use an ultrasonic cleaner with white vinegar to remove mineral build-up in the orifice assembly.
- Prevent garnet contamination:
  - Do not store garnet in open bags or buckets – store in closed containers.
  - Use a sharp blade to open abrasive bags.
  - Always keep the top of the abrasive hopper covered to prevent water from entering.

Some best practices pertaining to parts and components will also lead to extended nozzle life:

- Do not use damaged parts. Visually inspect parts and all orifices prior to use.
- Always use pump manifold and last chance nozzle filters. Inspect and replace them on a regular basis.
- Depending on your application, and if speed and longer life are the primary concern, use a 0.042 in. (1.06 mm) mixing tube instead of the standard 0.030 in. (0.762 mm) mixing tube. Be aware that parts will have slightly more taper and a wider kerf.
- Use only high-quality abrasive as it contains less dust and a more uniform particle size.
- Use a Terrain Follower to help protect the mixing tube from damage during cutting.

Reduce nozzle maintenance downtime:

- Have a spare nozzle body built and ready to replace on the machine when needed.
- Have new consumable parts on hand and replace them when rebuilding the nozzle. Once the nozzle is installed and running, determine which parts can be reused as spares in the future.

Extend the life of the nozzle and its components:

- Use a nozzle splash guard and, whenever possible, cut under water to reduce splash-back. The splash-back contains water, garnet, and eroded material from the tank. This is preventable damage that will affect your warranty.
- After servicing the pump, nozzle, or replacing a piece of plumbing, always flush the system by performing a Water Only test for several minutes with both the orifice and last chance filter removed.
- Rotate the mixing tube 90 degrees following every eight hours of cutting. This distributes wear more evenly around the internal diameter of the mixing tube if the orifice is chipped or misaligned.

Rebuilding Dual On/off Valve

Use the following procedure to repair a faulty dual on/off valve:

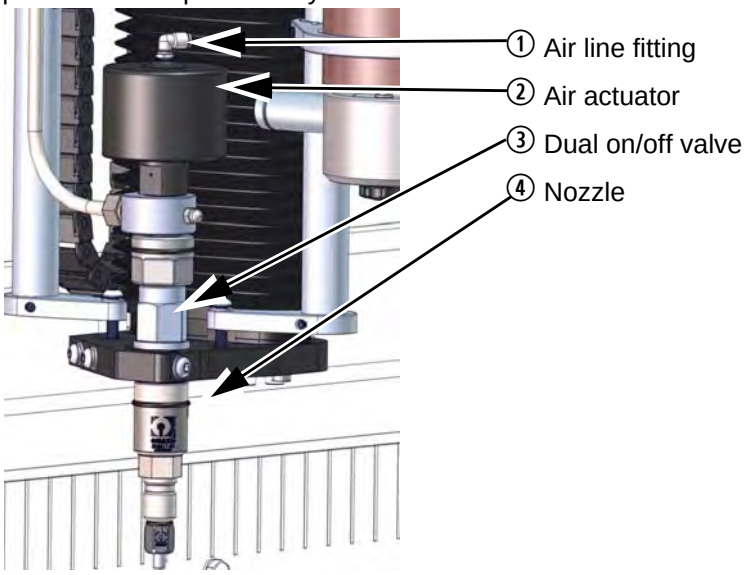


Figure 5-15

Remove the Dual On/off Valve

1. Switch **OFF** AC power for both **pump** and **table**. Disconnect main AC power breaker. Attach a lockout/tagout tag on this breaker and observe all applicable electrical safety procedures.
2. Bleed any residual air from the system by disconnecting the air source at the **pump** or by pressing the **air nozzle handle**.
3. Remove the **air line** from the **air line fitting** on top of the **air actuator assembly** and move it out of the way.

WARNING! ***Before removing the air line, you must first power OFF the pump! Once the air line controlling the on/off valve is removed, the nozzle becomes active.***

4. Remove **air actuator assembly** ② from the **valve body** ④.

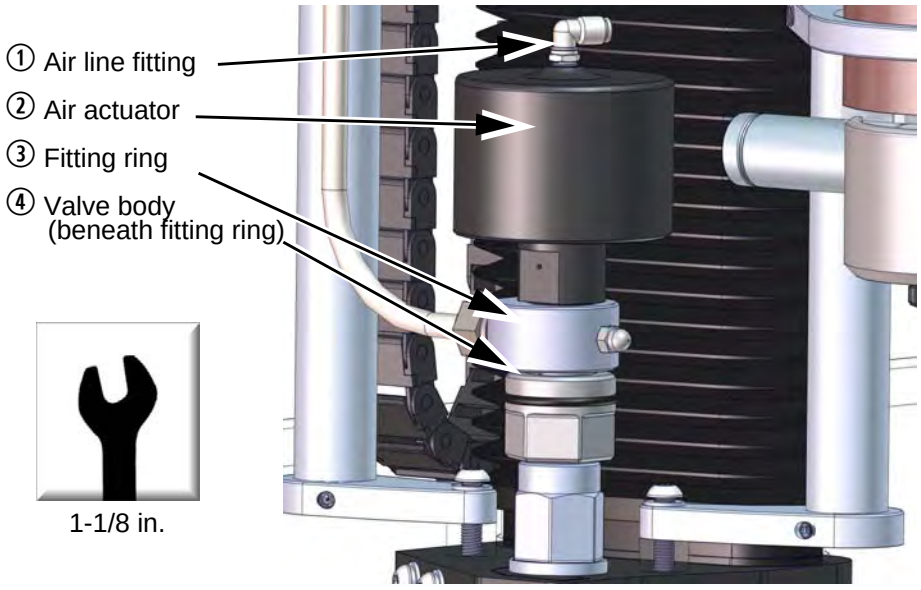


Figure 5-16

5. Remove **retaining screw** ① from **valve body** ②.

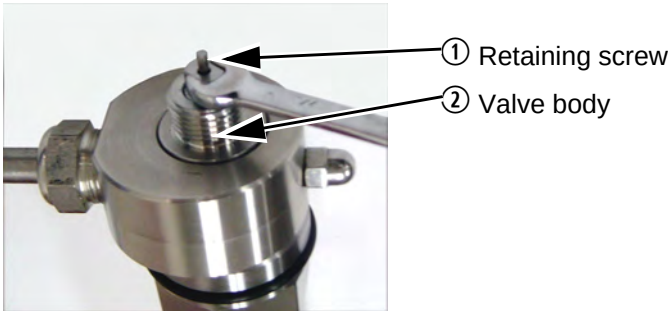


Figure 5-17

6. If possible, leave the **UHP tube** tightened in the **fitting ring** ① until the valve **gland nut** ② is loosened. After that, remove the **UHP tube** ③ from the **fitting ring**.

Caution: ***Always use two wrenches when removing a gland nut!***

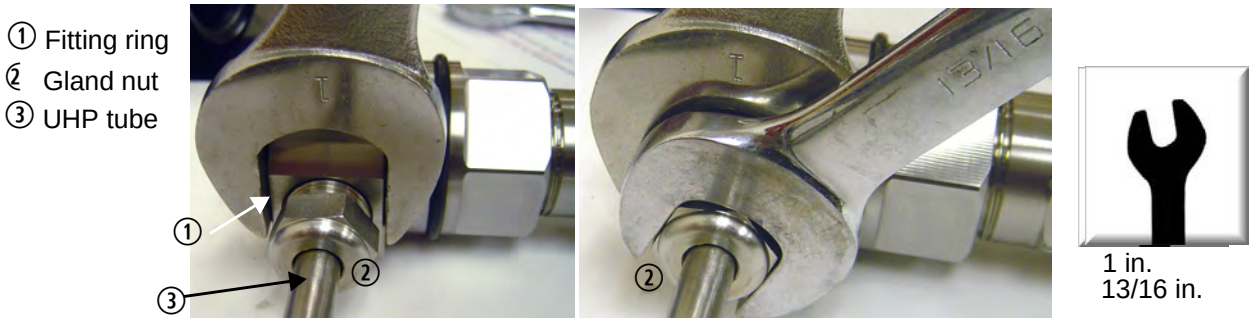


Figure 5-18

7. Loosen **valve gland nut** ② from **inlet body** ①**.**

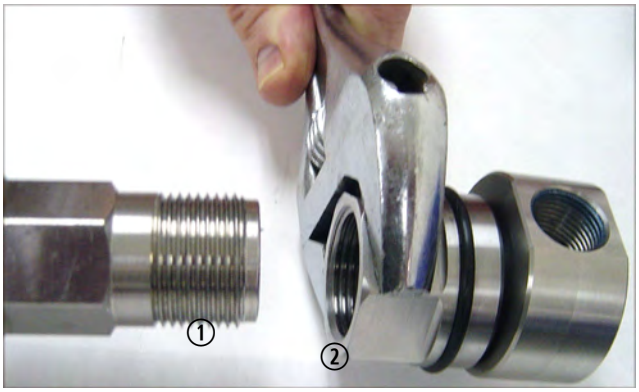


Figure 5-19

8. Rotate **on/off valve assembly** away from the **high-pressure nipple** and remove **valve gland nut**.
9. Remove **gland nut** from the **fitting ring** and carry the **dual on/off valve assembly** to a clean work area for rebuilding.

Caution: ***The on/off seat is not secured in the valve body at this point and may fall out when carried.***

Lubricate Air Actuator O-ring

Loss of lubrication on the O-ring can result in timing issues leading to fatigue in the high-pressure plumbing. Depending on daily machine use, inspect the seals and use Lubriplate on the O-rings regularly. Heavy machine use may require weekly inspection or lubrication; regular use may require monthly maintenance. Inspect both the actuator on the nozzle and the actuator at the pump.

1. Remove the **air actuator assembly** from the **on/off valve body**.

Figure 5-20

2. Remove the **snap ring** from the underside of the **actuator assembly**.

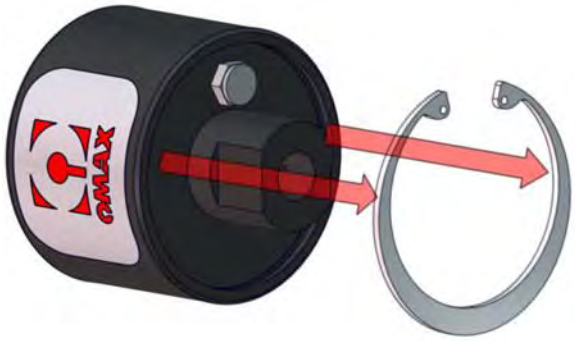


Figure 5-21

3. Slide the **actuator cylinder** off the **plunger assembly** and inspect the **actuator piston O-ring** ①.

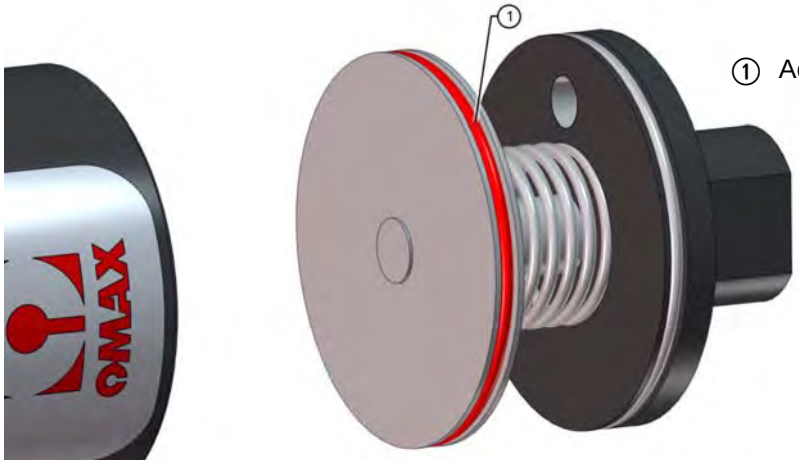


Figure 5-22

4. The **O-ring** on the **piston** (the top **O-ring)** receives the most wear; also inspect the second **O-ring** on the **plunger guide**. Apply a thin coat of Lubriplate on both O-rings to extend their life. If either **O-ring** shows signs of wear it should be replaced. The figure below shows an **O-ring** that needs to be replaced.

Figure 5-23

5. Reassemble the **actuator** by replacing the **actuator cylinder** on the **plunger assembly**, and then replacing the **snap ring**,
6. Apply Blue Goop to the **actuator plunger guide** and thread the **actuator assembly** onto the **on/off valve body**.

Disassembling Dual On/off Valve

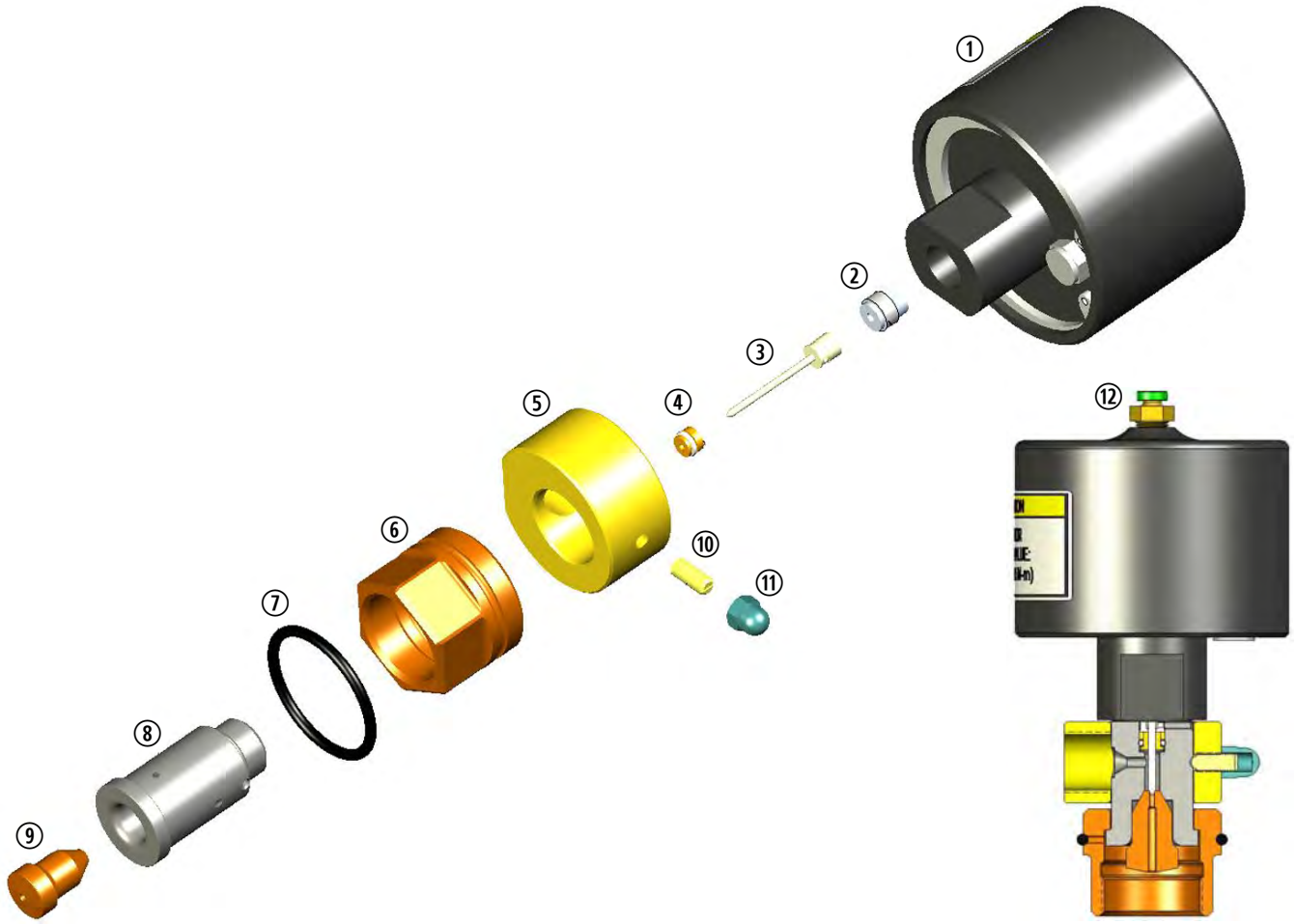


Figure 5-24

① Air actuator	⑤ Fitting ring	⑨ On/off seat
② Retaining screw	⑥ Valve gland nut	⑩ Set screw
③ Stem assembly	⑦ O-ring	⑪ Acorn nut
④ Seal with O-ring	⑧ Valve body	⑫ Air line fitting

1. Ensure working area for rebuilding is clean with all required tools and materials available (see page 4-1 for a list).
2. Pull **fitting ring** ④ and **valve gland nut** ② from the **valve body** ⑥.

① On/off seat
② Valve gland nut
③ O-ring
④ Fitting ring
⑤ Stem assembly
⑥ Valve body

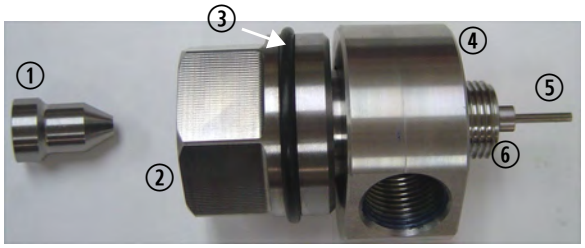


Figure 5-25

3. Remove the **stem assembly** ③ from the **valve body** ④.

① Seal assembly
② Fitting ring
③ Stem assembly
④ Valve body

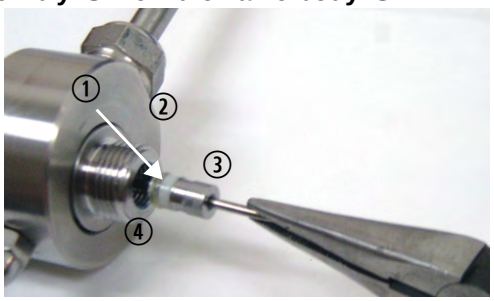


Figure 5-26

4. If the **seal assembly** remains in the **valve body** ②, use the end of an Allen wrench (or other long tool with approximately 3 mm diameter) to push the **seal assembly** out of the **valve body** being careful not to scratch the inside of the **valve body**.

① Push tool
② Valve body
③ Stem assembly

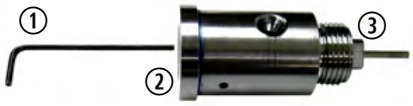
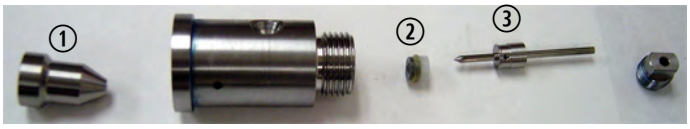


Figure 5-27

5. Clean all parts not being replaced in the repair kit. Discard used **on/off seat** ①, **seal assembly with O-ring** ② and **stem assembly** ③.



① On/off seat
② Seal assembly
③ Stem assembly

Figure 5-28

Note: *All items included in the dual on/off valve repair kit must be used. Do not reuse any parts that are provided in the repair kit. Reusing parts will decrease life of your rebuilt on/off valve assembly.*

6. Carefully inspect **valve body** for cracks and other defects. Cracked and damaged parts must be replaced.

Assembling the Dual On/off Valve

1. From the on/off valve repair kit, locate the **on/off seat**, **seal assembly with O-ring**, and **stem assembly**.
2. Slide **seal assembly** onto **stem assembly shaft** with **O-ring** facing towards **valve body.** Ensure the **seal assembly** slips over the **pointed end** of the **stem assembly**.
3. Lubricate both **seal assembly** ① **O-Ring** and **stem assembly** ② with Lubriplate grease.

① Seal assembly
② Stem assembly
③ O-ring towards valve body
④ Valve body

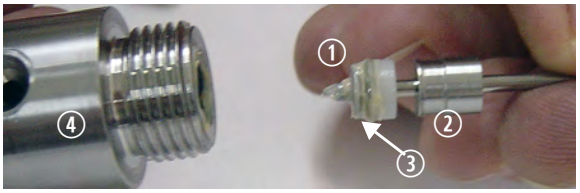


Figure 5-29

4. Lightly coat the **valve body bore** ① down past the threads to the internal lip with Lubriplate grease.

Figure 5-30

5. Tightly grasp the **stem assembly** ② with the **seal assembly** installed and gently push them down into the lubricated **valve body** ① bore.

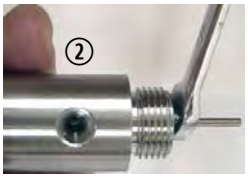
① Valve body

② Stem and seal

Figure 5-31

Note: *If the stem assembly body resists insertion into the valve body because of the seal assembly O-ring, push the stem assembly body in using the end of an Allen wrench (or equivalent long tool) until the internal threads of the valve body are exposed.*

6. Apply a light sheen of Blue Goop onto threads of the **retaining screw** ①, install in the **valve body** ②.



① Retaining screw

② Valve body

1/4 in.

Figure 5-32

7. Apply a light sheen of Blue Goop to each end of the **on/off seat** ① where it will contact the **valve body** ② and also where it will contact the **bulkhead adapter**. Insert into the **valve body** (or place in the **inlet body**).

① On/off seat

② Valve body

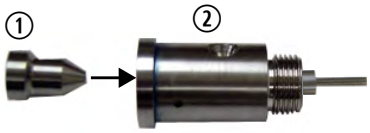
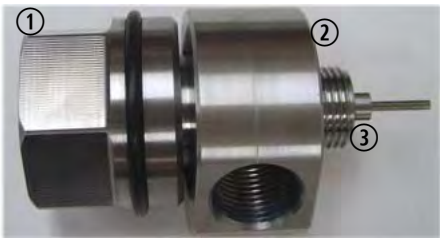


Figure 5-33

8. Slide **valve gland nut** ① and **fitting ring** ② onto the **valve body** ③.



① Valve gland nut

② Fitting ring

③ Valve body

Repair of the dual on/off valve is complete.

Install Dual On/off Valve

1. Verify the **on/off seat** remains in the **valve body** ①. Hand tighten the **valve gland nut** ③ onto the **nozzle inlet** after rotating the **valve body** so the **ultra high-pressure line** (UHP**)** is in alignment with the **opening** ④ in the **fitting ring** ②.

   ① Valve body

   ② Fitting ring

   ③ Valve gland nut

   ④ Opening

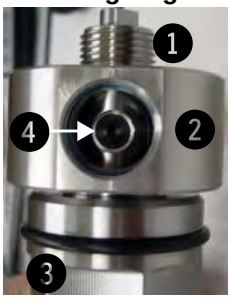
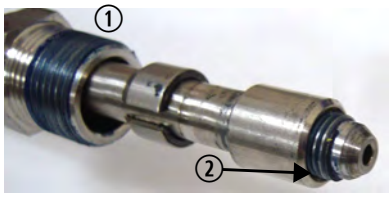


Figure 5-34

2. Insert the **UHP input line** into the **fitting ring**. Ensure threads on the **UHP input line** and the **gland nut** have had Blue Goop applied and **three threads** ② are showing.



① Gland nut

② Three threads visible

Figure 5-35

3. Tighten **gland nut** on the **UHP input line**.

13/16 in.
1 in.

50 ft-lb
67.8 N·m
< 75 ft-lb
< 102 N·m

4. Tighten **valve gland nut**, ensuring the **on/off valve** remains square to the **UHP line** to eliminate stress on the **UHP line**.
5. Apply a small amount of Blue Goop to **threads** ① of the **valve body**.

① Valve body threads

Figure 5-36

6. Install **air actuator assembly**.

1-1/8 in.

250 in-lb
28.2 N·m

7. Attach **air line** to the **air line fitting** on top of the **air actuator assembly**.
   Prior to use, remove the **nozzle body**. In **Make,** click **Test,** Select **High** Pump Pressure, **Water Only.** Flush system for at least 5 minutes.

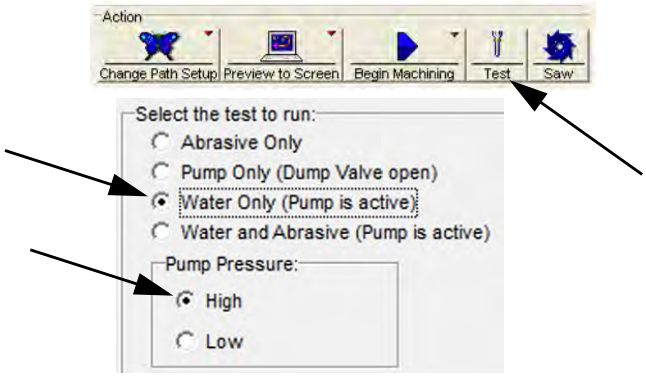


Figure 5-37

8. After five minutes of flushing, install **nozzle body**. Torque the **dual on/off assembly** to the **nozzle body**.

25 ft-lb
(33.9 N·m)

9. Following installation, test nozzle operation using **Low**, then **High Pump Pressure** and **Water Only** tests.

Note: *During a high-pressure condition, check for visible leaking from the weep holes. If water leaking is present, sealing is not complete between UHP fittings.*

Chapter 6

Pump Rebuild

Rebuilding the Pump Wet End Assembly

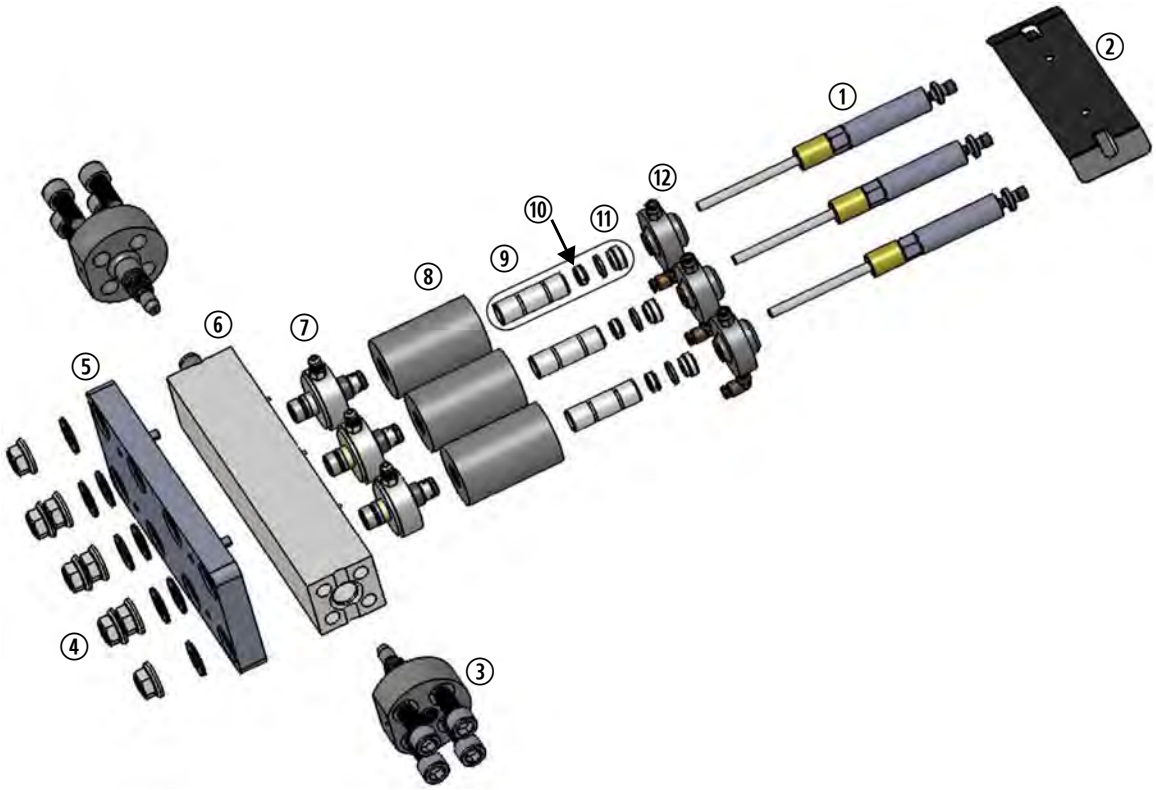


Figure 6-1

① Plunger assembly	⑤ Clamp plate	⑨ Displacer
② Cover plate	⑥ Pressure manifold	⑩ Dynamic seal
③ Port adapter assembly	⑦ Check valve	⑪ Backup ring assembly
④ Nut and washers	⑧ Cylinder	⑫ Coolant housing

Removing the High-pressure Wet End Assembly

The high-pressure wet end assembly consists of pump parts bolted to the crankcase and are directly involved in providing high-pressure water to the cutting nozzle.

Note: *During disassembly, keep all parts together in related sets, noting the original position of each set.*

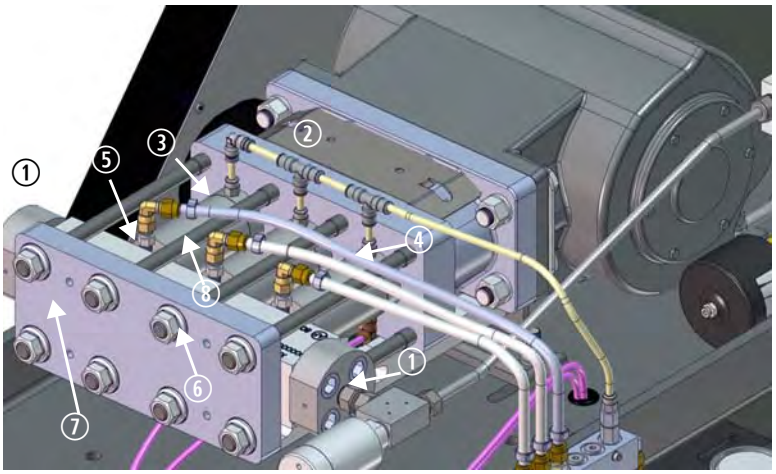
Caution: ***Never use a pipe wrench on any abrasive waterjet equipment!***
Do not disassemble the pump wet end unless a torque wrench capable of 175 ft-lb (235 N·m) is available for reassembly.

Remove High-pressure Wet End Assembly

1. Turn power to the high-pressure pump **OFF** at the main **AC disconnect**. Place a lockout/tagout tag on the power disconnect to alert others that maintenance is in progress.
2. Turn **charge pump** power **OFF**; turn the **air** and **water** sources **OFF** at the mains. Open the **air hose** until all residual air is drained from the system.
3. Disconnect the **plumbing** from the **port adapters**.

WARNING! ***Before disconnecting the plumbing, ensure the pump and charge pump are shut down, allowing the system to depressurize.***

1 in.
13/16 in.



① Port adapters
② Coolant housing water hoses
③ Coolant housing
④ Check valve water hoses
⑤ Check valve
⑥ Clamp plate nut and washer
⑦ Clamp plate
⑧ Stud

Figure 6-2

4. Remove **water hoses** ② from **housing assemblies** by pulling back on the green ring of the **push-in fittings**. Remove the three **water hoses** from the **check valve inlets**. Hold the **fitting** with the second wrench to avoid unscrewing it from the **check valve body**.

9/16 in.
1/2 in.

5. Remove the eight **clamp plate nuts** and **washers** ⑥ from the **clamp plate** ⑦, being careful to remove the load on the **studs** evenly. Break loose the **nuts** at the ends of the **clamp plate** first, then use a crisscross pattern when breaking the remaining four **nuts** loose. Using the same pattern, back each **nut** off ½ turn until the load is removed from the **studs**.

Caution: ***Remove the load on the studs evenly to prevent warping or damage to pump components.***

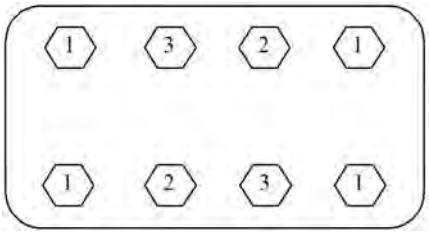
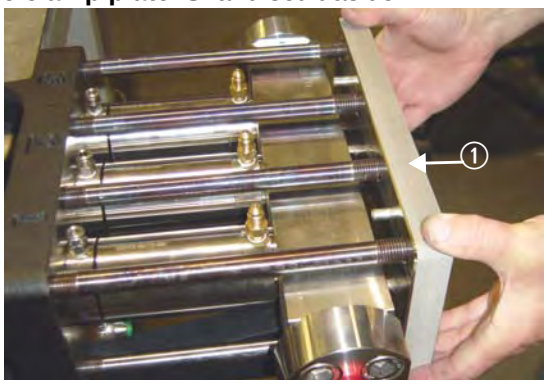


Figure 6-3

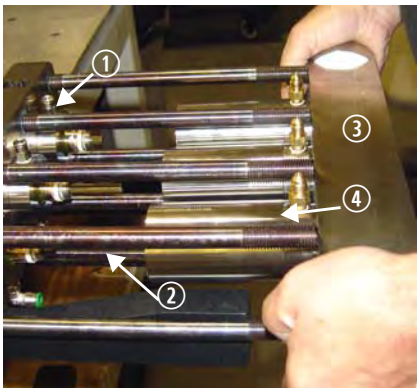
6. Remove **clamp plate** ① and set it aside:



① Clamp plate

Figure 6-4

7. Slide the **wet end assembly** away from the **coolant housings** ①. Keep the assembly level and square, being careful not to bind the internal **plunger rods** ②. All components typically stay in the **cylinder assemblies** ④ as the **wet end assembly** is removed.



① Coolant housing
② Plunger rod
③ Pressure manifold assembly
④ Cylinder assembly

Figure 6-5

8. If a **coolant housing** sticks to the **wet end assembly**, stop and disconnect the **hoses**, top and bottom, from each **coolant housing**. Proceed as in step 6, above.

Note: *If a coolant housing sticks to the cylinder and cannot be removed by hand, disconnect the coolant hoses and allow the coolant housing to remain attached to the cylinder.*

9. Set the **wet end assembly** on a workbench with the **manifold** side down and the **cylinders** standing upright.

Caution: ***Once the wet end assembly has been disassembled, all three cylinders must be removed and rebuilt using these procedures for disassembling and reassembling the high-pressure wet end. If the wet end was fully assembled, torque applied and then removed, the seals are not reusable and must be replaced.***

Disassembling the High-pressure Wet End Assembly

Refer to the component diagram for the most updated part numbers for this assembly.

1. Remove **cylinders** (3 ea.) and **check valve assemblies** (3 ea.) from the **manifold** using screwdrivers to lift the **check valve assembly** and **cylinders** out of the **pressure manifold**.

① Cylinder assembly
② Check valve assembly
③ Pressure manifold

Figure 6-6

Note: *If coolant housing assemblies remained fixed to cylinders when removing the wet end assembly, clamp the outside diameter of the coolant housing into the soft jaws of a vise and strike the side of the cylinder with a soft blow mallet to remove the coolant housings from the cylinders. The close tolerance fit of the coolant housing into the cylinder bore extends only into the bore of the cylinder approximately 0.050 in. (1.27 mm) and should remove easily.*

2. Insert the check valve removal tool ③ through the **backup ring assembly** of the first **cylinder** ① until it contacts the **check valve** ② **retainer nut** inside the cylinder:

① Cylinder
② Check valve
③ Removal tool

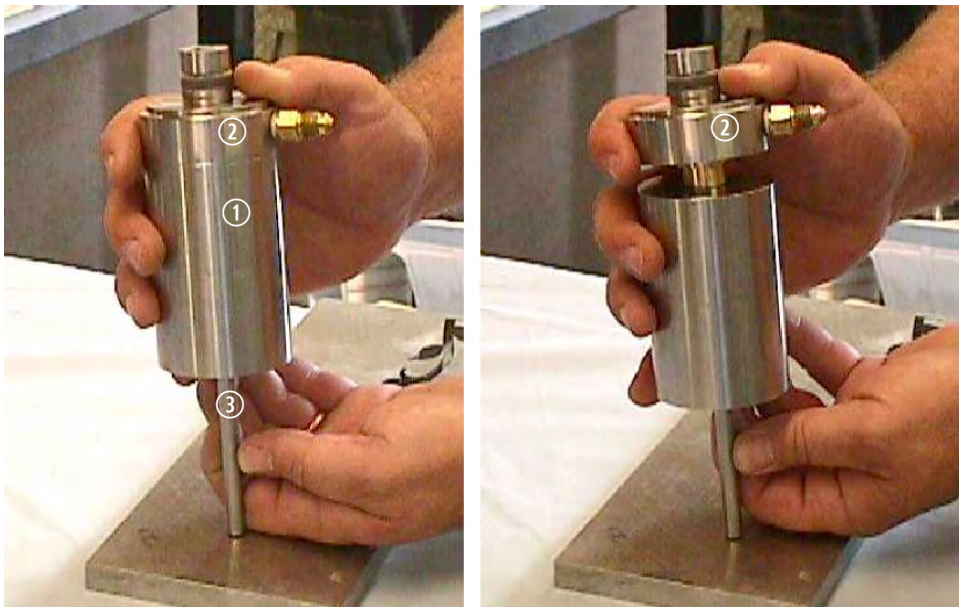


Figure 6-7

3. Strike the removal tool firmly against a solid surface to remove the **check valve assembly** from the **cylinder assembly**. Set the **check valve assembly** aside until later. Repeat for the remaining two **cylinders**.
4. Using the removal/installation tool, push the **sealing assembly** (**displacer**, **retainer** and **seal assembly**, **seal ring**, and **backup ring assembly**) out of the **cylinder** from the **check valve assembly** end toward the **coolant housing assembly** end using an Arbor press. Repeat for the remaining two **cylinders**.

Note: *The **ring seal** on the inlet side of the check valve assembly usually remains in the cylinder bore and can be removed by hand.*

① Removal tool
② Cylinder
③ Arbor press

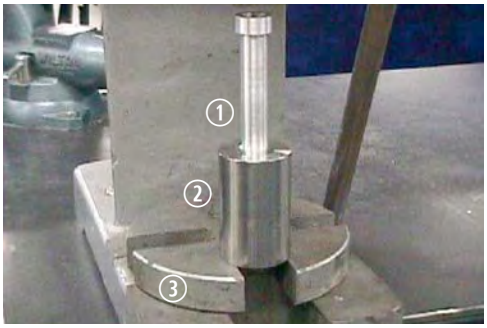
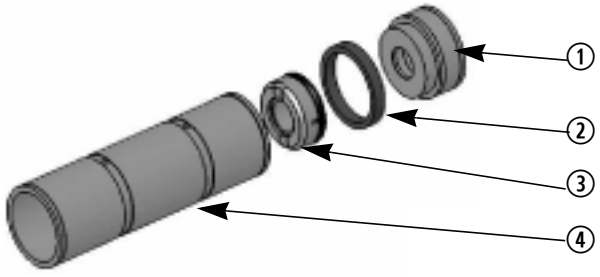


Figure 6-8



① Backup assembly
② Seal ring
③ Dynamic seal assembly
④ Liquid displacer

Figure 6-9

5. Separate the **backup ring assembly** ③ from the **liquid displacer** ② by placing the large end of the removal/installation tool ③ over the **backup ring assembly** and breaking the **seal ring** loose from the **displacer**.

① Removal installation tool
② Displacer
③ Backup ring assembly

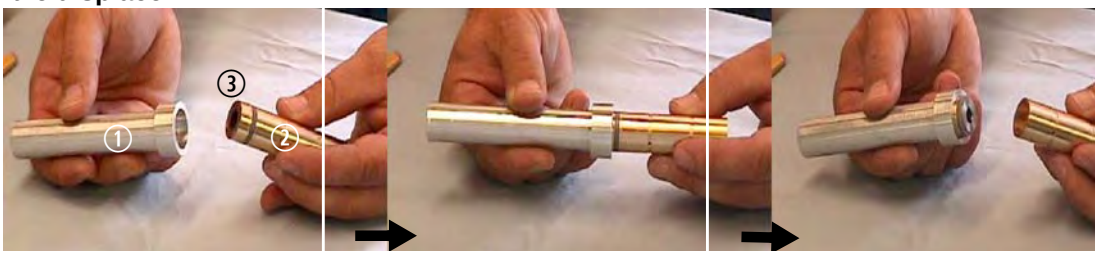
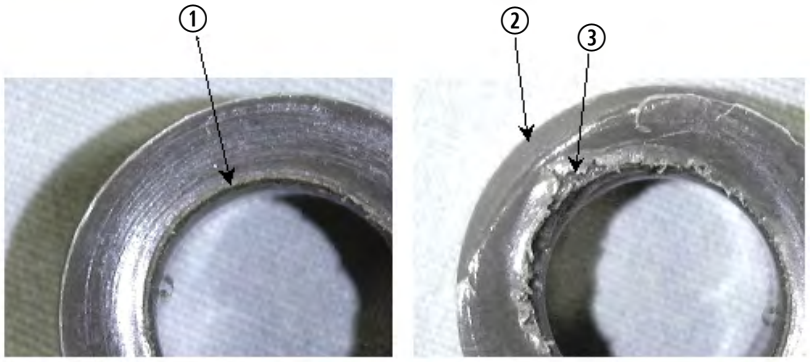


Figure 6-10

6. The **backup ring assembly** is machined together as one assembly. The outer **support ring** is pressed onto the inner **backup ring**. These parts should not be separated. Remove the **seal ring** from all three **backup ring assemblies**.
7. Before removing the **dynamic seal assembly** from the **liquid displacer**, inspect the **dynamic seal** for extrusion. Some extrusion of seal material around the edges of the bore in the **dynamic seal** is expected.

Caution: ***Uneven, excessive extrusion and/or missing material from one side across the face of the dynamic seal indicates a failed seal with possible plunger damage caused by the plunger rubbing on the bore of the backup ring. If uneven or excessive material is extruded or missing, then a close inspection of the backup-support ring assembly should be made for signs of rubbing.***



① Normal extrusion
② Material missing
③ Excessive extrusion

Normal wear - about 200 hours

Failed seal due to plunger rubbing backup ring, or possibly lack of cooling water flow

Figure 6-11

8. Remove **dynamic seal assembly** from inside end of the **liquid displacer**.
9. Remove **large O-ring** ① from outside the **dynamic seal** ②.
10. Separate components of the **dynamic seal assembly** by pushing the **dynamic seal** ② out of the **retainer** ④.
11. Remove **small O-ring** ③ from inside the **retainer** ④.

① Large O-ring
② Dynamic seal
③ Small O-ring
④ Retainer

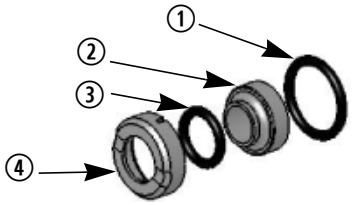


Figure 6-12

12. Repeat steps 4-8 for the remaining two **backup ring** and **liquid displacer assemblies**.
13. Discard **O-rings**, **plastic ring seals**, and **plastic dynamic seal** of the **dynamic seal assembly**. If not damaged, the metal **retainer** is reusable.

Inspect Backup Ring Assembly

If uneven dynamic seal extrusion or a dynamic seal failure occurred, the backup ring assembly should be examined in detail to determine if plunger rubbing has occurred and if the associated plunger assembly needs to be replaced.

1. Using magnification, examine the edges and interior of the metal lip in the bore of the **backup ring** adjacent to where the **dynamic seal** was positioned, especially if uneven or excessive extrusion of the **dynamic seal** was observed. The exterior edge of the **short lip** ① should be sharp and square with no nicks or gouges. There should be no evidence of rubbing on the **short lip**.

① Lip
② Bushing

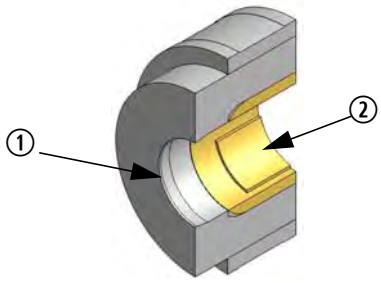


Figure 6-13

2. Figure 6-14 shows an undamaged and a severely damaged **backup ring**. The **short lip** should appear uniform in width all the way around. Any area where the width appears to be wider, or darker, or where machining marks are scraped away, indicates the lip has been rubbed by the **plunger**.

① Undamaged lip
② Undamaged lip
③ Damaged by plunger rubbing

Figure 6-14

Note: *Whenever plunger rubbing has occurred, the plunger assembly must be replaced along with the dynamic seal and backup ring assembly.*

Inspect Liquid Displacers

The small flanges on each end of the liquid displacer should be 0.8115 to 0.8125 in. (20.61 to 20.64 mm) in diameter. If these diameters are undersized, leakage between the coolant housing and the cylinder could result.

1. Clean **liquid displacers** and use micrometer to measure outside diameters of each **liquid displacer** end.
2. Any **displacer** with an **outer flange** ① that measures less than 0.8115 in. (20.61 mm) in diameter on either end should be replaced.

① Outer flange

Figure 6-15

3. Inspect **liquid displacer** edges on the ends to determine if the edges are sharp, free of any missing material, nicks, gouges, or burrs. Score marks from the **cylinder** bore are normal.

WARNING! ***Do not attempt to smooth score marks by sanding or using abrasive materials, as this makes the diameter undersized***

Disassemble and Inspect the Check Valve Assembly

It is important to inspect the seats and mating surface of the check valve body. Worn or damaged seats must be replaced. Inspection is best performed with the aid of a magnifying glass. Water leaking past check valves can form jets that damage the check valve body.

Caution: ***Do not run the pump if the output pressure begins to drop by more than 4-6 kpsi from the original rpm. If the check valve seats are worn, continued pump operation can damage the check valve body.***

Note: *Replacing check valve seats in all three cylinders at the same time is a good practice. Once one check valve seat has worn to the point of replacement, the others are quick to follow.*

To reduce overall downtime, replace the high-pressure seals and the check valve seats whenever the wet end is disassembled.

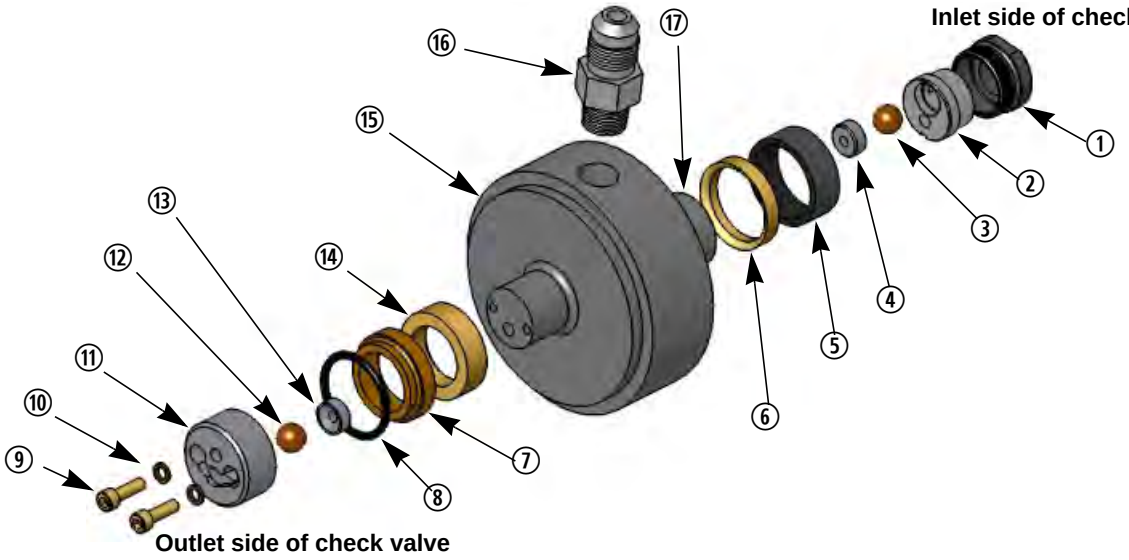


Figure 6-16

①	Inlet retainer nut	⑤	Ring seal	⑨	Screw	⑬	Outlet check valve seat
②	Inlet check valve retainer	⑥	Support ring	⑩	Flat washer	⑭	Static backup ring
③	Inlet check valve ball	⑦	Static seal	⑪	Outlet check valve retainer	⑮	Check valve body
④	Inlet check valve seat	⑧	O-ring	⑫	Outlet check valve ball	⑯	Water inlet fitting
						⑰	Check valve body stem

Disassemble Inlet Side Check Valve

1. Begin disassembly of **check valve assembly** from the inlet (**cylinder**) side. Clamp **check valve body** ② into soft-jaws of a vise. Remove the **inlet retainer nut** ①.

① Inlet retainer nut

② Check valve body

5/8 in.

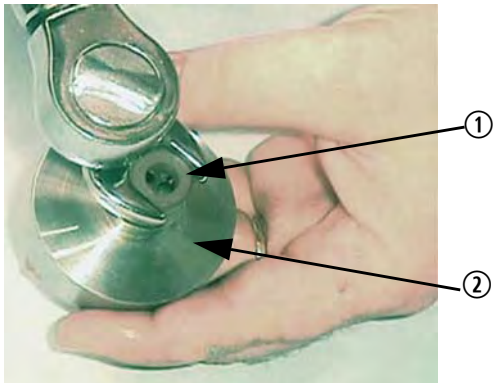


Figure 6-17

2. Remove **inlet check valve retainer** ①, **inlet check valve ball** ②, and **inlet check valve seat**. Needle nose pliers can be helpful when removing the **inlet check valve retainer**.

① Inlet check valve retainer

② Inlet check valve ball

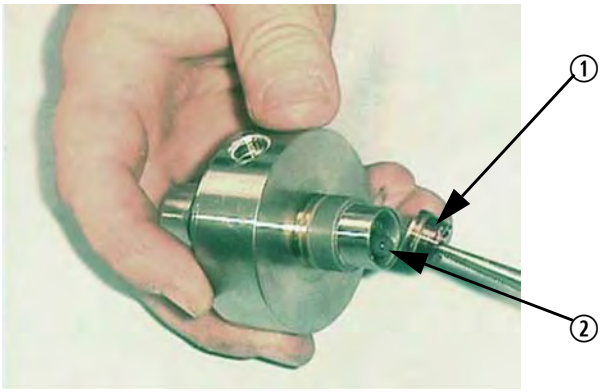


Figure 6-18

3. If the **ring seal** did not remain in the end of the **cylinder**, remove it from the **check valve body stem** and discard it.
4. Inspect **support ring** for cracks, chips or damage, particularly in the area around the center where it contacts the edge of the **cylinder**. If no damage is found, there is no need to remove it, except at the recommended rebuild intervals. Minor scoring marks are permitted.

Caution: ***Never attempt to remove scoring marks by sanding or use of abrasive material.***

5. If the **support ring** does not pass inspection or has reached its recommended replacement time, proceed to step 6, otherwise go to step 7.
6. A small amount of the **ring seal** material may have extruded under the **support ring**, locking it to the **check valve body stem**. To remove the **support ring** from the **check valve body stem**, use a propane torch to heat it slightly (20-30 seconds). This softens plastic between the **check valve body stem** and **support ring**, allowing it to be removed by hand using a rag or a pair of channel lock pliers.

Caution: ***Once the support ring has been heated, do not reuse it; the material softens and can no longer support ring seal compression. Take care not to scratch the check valve body stem surface with pliers during this process.***

Figure 6-19

7. Inspect the outer diameter of the **check valve body stem** for indications of erosion.
8. Inspect for erosion on the surface that was against the **inlet check valve seat**. This may indicate leakage between the flat side of the **inlet check valve seat** and **check valve body stem**, or leakage between the **inlet check valve ball** and **inlet check valve seat**.
9. Using magnification, inspect the **inlet check valve ball** for pitting or chipping. If pits, chips, or frosted spots are observed on the **ball** surface, replace it.

10. Inspect the **inlet check valve seat** ① for erosion or damage. Inspect the **inlet check valve ball** and the flat sealing surface that contacts the **check valve body stem**. If erosion or damage is observed, replace **seat**.

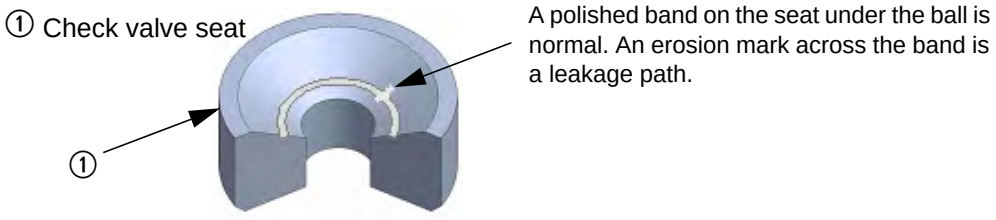


Figure 6-20

Disassemble Outlet Side Check Valve

11. Turn the **check valve body** over and remove the **screws**. Remove the **flat washers** and the **outlet check valve retainer**. The **screws** and **washers** should be replaced according to the maintenance schedule.

3/32 in.

12. Perform the same inspection of the **outlet check valve ball** and **outlet check valve seat** (see steps 7-10 above).
13. Carefully inspect the **check valve body stem** for indications of erosion on the surface contacting the **outlet check valve seat**. This may indicate leakage between the flat side of the **outlet check valve seat** and **check valve body stem**, or leakage between the **outlet check valve ball** and **outlet check valve seat**.
14. Remove and discard **O-ring** and **static seal**. Inspect the **static backup ring**, ensuring edges are sharp and square with no nicks or gouges. Also, see if it is cracked near the notch and replace whenever damage is apparent.
15. Clean the **check valve body stem** and radius at its base.
16. If leaking was observed between either the **check valve body** or the **pressure manifold** and **cylinder**, check the radius at the base of the **check valve body stems** for fine cracks using a magnifying glass.

Note: *Be careful not to confuse lines of discoloration with actual cracks. If a pressure loss occurred without any external leakage, but the high-pressure cylinder runs very hot, the check valve body is cracked internally, requiring replacement.*

17. Always discard any damaged or eroded parts and replace them with new ones.
18. Repeat this procedure for the two remaining **check valve assemblies**.

Assemble the Check Valve Assembly

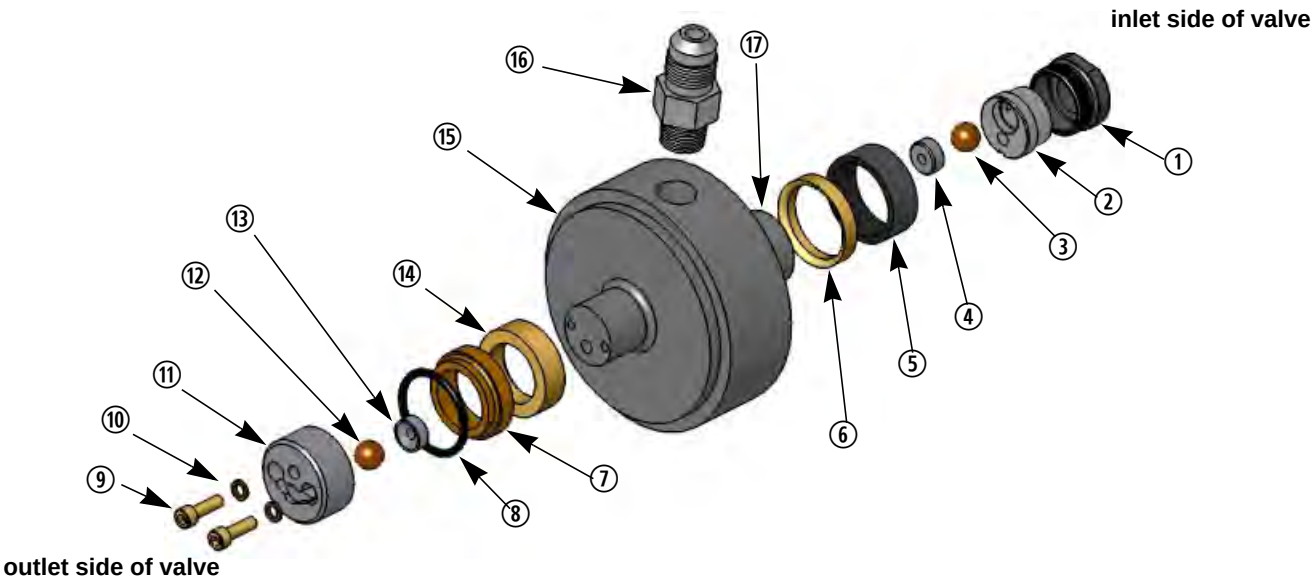


Figure 6-21

① Inlet retainer nut	⑤ Ring seal	⑨ Screw	⑬ Outlet check valve seat
② Inlet check valve retainer	⑥ Support ring	⑩ Flat washer	⑭ Static backup ring
③ Inlet check valve ball	⑦ Static seal	⑪ Outlet check valve retainer	⑮ Check valve body
④ Inlet check valve seat	⑧ O-ring	⑫ Outlet check valve ball	⑯ Water inlet fitting
			⑰ Check valve body stem

Assemble the Outlet Side Check Valve

1. Assemble the outlet side of the **check valve assembly** first.
2. Apply Lubriplate to the **O-ring**. Place the **static backup ring**, the **static seal**, and then the **O-ring** onto the outlet side of the **check valve body**.

Note: *The outlet side of the check valve body has three holes in the end of the stem (Figure 6-21). The notch and chamfer on one side of the static backup ring faces toward the check valve body.*

3. Apply a small amount of anti-seize lubricant to threads of the two **screws**. Install **flat washers** and the two **screws** through the **outlet check valve retainer**.

① Outlet check valve retainer
② Screws
③ Flat washer

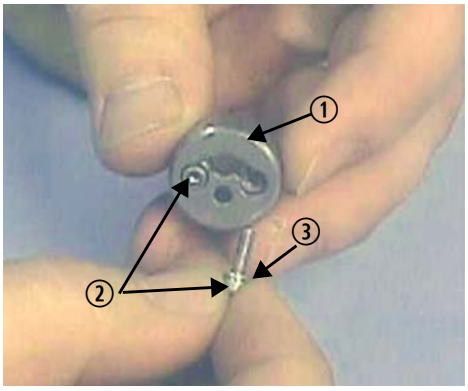


Figure 6-22

4. Place the **outlet check valve ball** ① followed by the **outlet check valve seat** ② in the **outlet check valve retainer**. Be sure the flat side of the **check valve seat** faces away from the **ball**. The **check valve seat** should be flush, or no more than 0.001 in. (0.0254 mm) above, the surface of the **check valve retainer**.

① Outlet check valve ball
② Outlet check valve seat

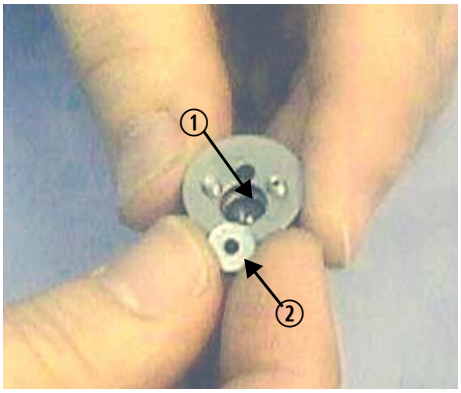


Figure 6-23

5. Place assembled **outlet check valve retainer** ② on the outlet end of the **check valve body stem** ③ with the **outlet check valve seat** up against the end of the **stem**. Place **ball** and **seat** over the hole in the **check valve body stem**.

① Outlet check valve ball
② Outlet check valve retainer
③ Check valve body stem

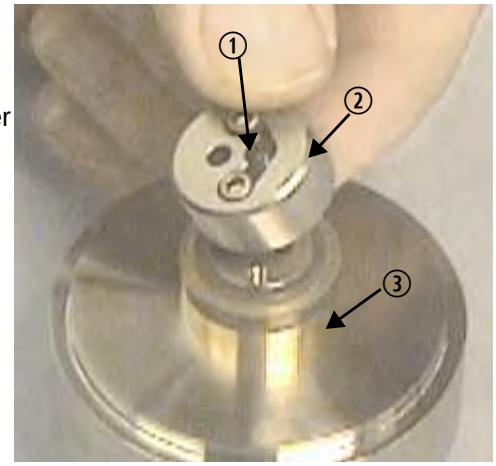


Figure 6-24

WARNING! ***Always ensure that the hole through the outlet check valve seat lines up with the hole in the outlet check valve body stem. The outlet retainer can inadvertently be installed 180 degrees out of its required position.***

6. Tighten the two **screws** from 3 to 5 in-lb (0.34 to 0.57 N·m). Holding the allen wrench as shown in Figure 6-25 prevents over tightening the screws.

3/32 in.

Figure 6-25

7. Repeat steps 1 through 6 for remaining **check valve body assemblies.**

Assemble the Inlet Side Check Valve

8. Begin assembling the **inlet side** of the **check valve body assembly**. This is the side with the threaded pocket and two holes (Figure 6-26).
9. Install **support ring** ①, with the small notch facing down, over outside of the **check valve body stem** ② on the inlet side.
10. Install **ring seal** ③ over outside of the **stem**.

① Support ring
② Check valve body stem
③ Ring seal

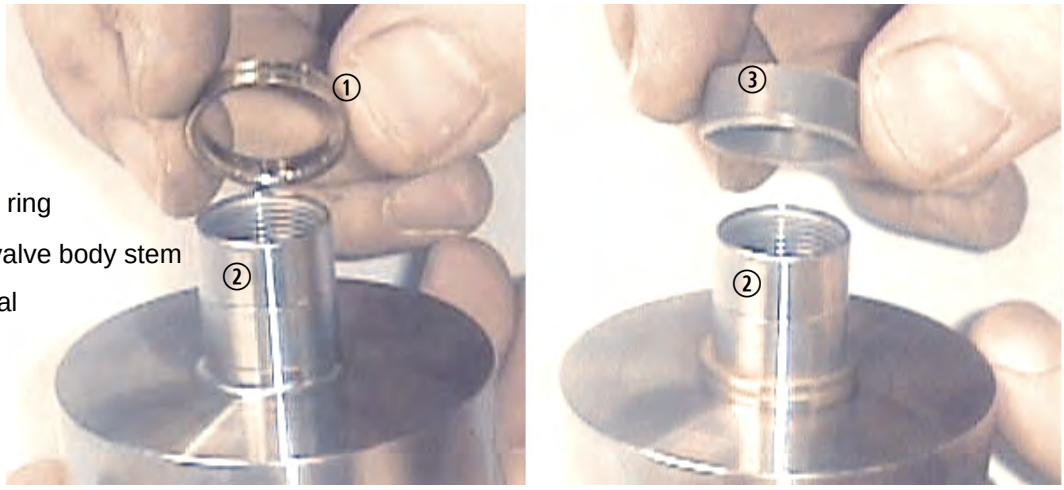


Figure 6-26

11. Next, insert the **inlet check valve ball** ① followed by the **check valve seat** ③ into the **check valve retainer** ②. Be sure the flat side of the **seat** faces away from the **ball**.

Note: *The inlet check valve seat normally protrudes well above the face of the ball retainer.*

12. Hold the **check valve body** so its **stem** ④ is facing down to enable insertion of the assembled **check valve retainer** ②.

Note: *An alignment pin inside the pocket of the check valve body is designed to fit into a slot machined on the outside of the retainer. Be sure to engage the alignment pin into this slot. Do not turn the assembly over until the retainer is fully engaged into the slot. When correctly installed, the inlet ball retainer will be almost flush with the end of the check valve body stem.*

① Check valve ball
② Check valve retainer
③ Check valve seat
④ Check valve body stem

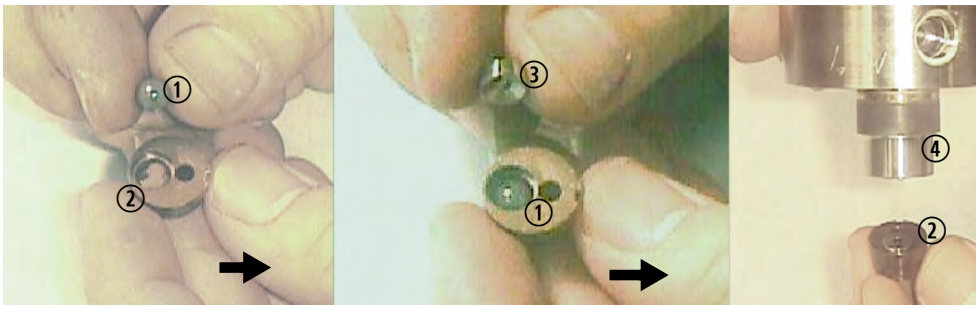
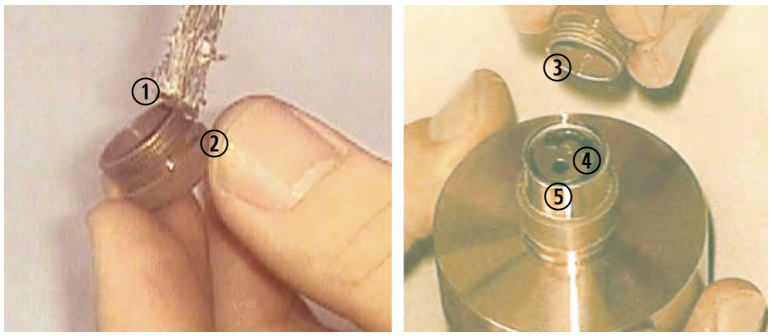


Figure 6-27

13. Apply a small amount of **anti-seize compound** ① to threads of the **retainer nut** ② and bottom lip of the **retainer nut** that contacts the **inlet ball retainer** ④.



① Anti-seize on threads
② Retainer nut
③ Anti-seize on bottom lip only
④ Inlet ball retainer
⑤ Check valve body stem

Figure 6-28

14. Screw the **retainer nut** over the **inlet ball retainer** and into the threaded **inlet check valve body stem**. Hand tighten.

15. Apply a light coat of Lubriplate to the 0.124" (3.15 mm) diameter **anti-rotation pin** ① and insert it through the outlet port of the **check valve retainer** and into the **check valve body** ②. Clamp the outside diameter of the **check valve body** in the soft-jaws of a vise.

① Anti-rotation pin

② Check valve body

③ Retainer nut

5/8 in. (16mm)
200 in-lb (22.6 N·m)

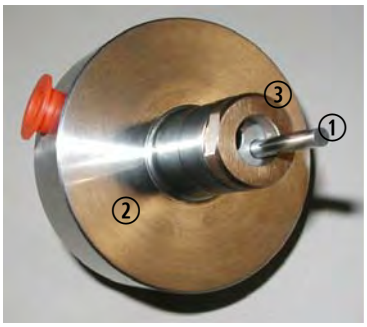


Figure 6-29

16. Remove the **anti-rotation pin**.

Note: *This may require clamping the pin in a vise and pulling on the check valve body.*

17. Repeat above assembly procedures for the remaining two **check valve assemblies**.

Replace High-pressure Port Adapter Seals and Filter

The high-pressure port adapter seals should be replaced at each pump rebuild, or at any time excessive leakage occurs between the manifold and port adapters. The pump in-line filter provides additional protection for the orifice assembly in the nozzle and dump valve. This filter should be replaced at every pump rebuild.

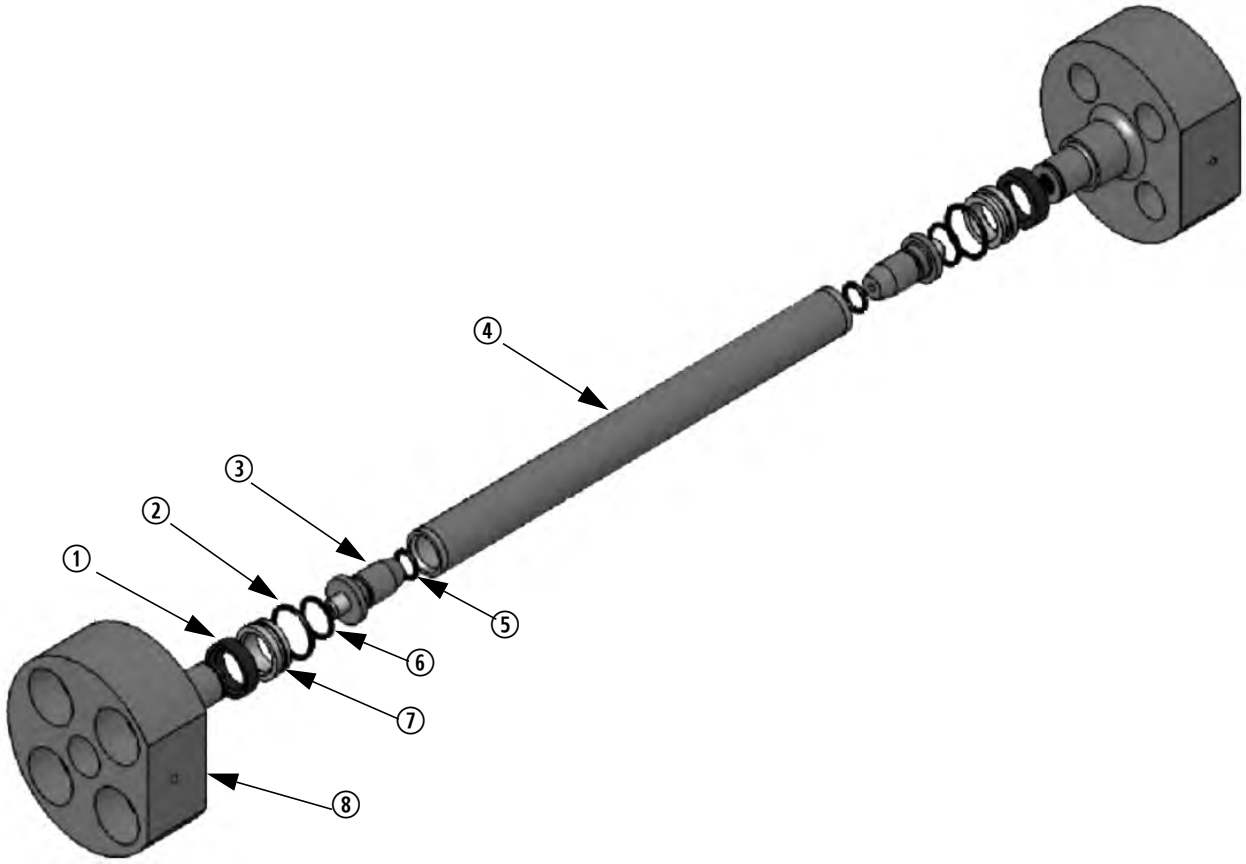
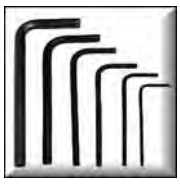


Figure 6-30

①	Backup ring	⑤	O-ring
②	O-ring	⑥	Snap ring retainer
③	Manifold filter adapter	⑦	High-pressure seal
④	Filter assembly	⑧	Port adapter body

Replace the High-pressure Port Adapter Seals and Filter

1. Place **pressure manifold body** into a vise.
2. Remove the four **screws** from both **port adapters**.



14 mm

3. With a soft-blow mallet, strike the **port adapter** on each side until a gap opens between the **pressure manifold** and **port adapter**.

4. Pry the **port adapter** out of the **pressure manifold**. Follow the same procedure to remove the second **port adapter**.

2X

Caution: ***Avoid scoring the metal components or damaging the filter.***

5. Remove the **filter assembly**.
6. Remove the **filter adapters** from each **port adapter**.

5/8 in. (16mm)

7. Remove the **retaining ring** from end of the **port adapter stem**. Slide the **static seal**, **O-ring**, and **static ring** off the **stem** of the **port adapter body**. Discard the **static seal** and **O-ring**.
8. Clean **static ring** and **port adapter**. Examine edges of the **static ring** to determine if edges are square and sharp. Check **static ring** for cracks near the notch. Replace **static ring** whenever problems are apparent.
9. Install the **static ring** onto the stem of the **port adapter** with chamfer on the inside of the **static ring** facing toward the **port adapter body**.
10. Place a small amount of Lubriplate on new **O-ring** and install it on a new **static seal**. Slide the **static seal** onto the stem of the **port adapter body** such that the large diameter portion of the **static seal** is next to the **static ring**.
11. Install the **snap ring retainer**.
12. Place a small amount of Lubriplate on the **O-ring** and install it into the O-ring groove on the **manifold filter adapter**. Thread the **filter adapter** into the stem of the **port adapter body**. Tighten until just snug.

5/8 in. (16mm)

13. Repeat above rebuild procedure for remaining **port adapter assembly**.
14. Install **filter assembly** on one of the **port adapters** by sliding it over the end of the **manifold filter adapter** until the **filter assembly** rests against **filter adapter shoulder**.
15. Apply a small amount of Lubriplate into **manifold bores.**
16. Position the **port adapter** with its flat side of the body facing away from the direction of the **cylinders**.

Note: *Either port adapter can be installed first. As the second one is being installed, ensure it engages into the filter assembly properly without being forced and causing damage. Tapping the end of the port adapter lightly with a soft-blow mallet may be required to seat it completely into the pressure manifold.*

17. Place **manifold assembly** onto a flat surface with the **check valve ports** facing up. Apply a small amount of anti-seize lubricant to threads of the four **screws** and tighten them sufficiently to hold the **port adapters** in place.
18. Secure the **manifold assembly** into a vise.

100 in-lb (136 N·m)

Assembly of the High-pressure Wet End Assembly

Caution: ***This section provides procedures for complete reassembly of the pump wet end. It is very important that all parts are kept clean. In general, all wet end parts for the pump may be cleaned by simply wiping them with a clean lint-free rag and blowing them off with shop air. Any dirt left in the pump can pass through the nozzle, possibly damaging it. Clean all parts and assemble pump components in a clean environment.***

Whenever the pump wet end has been disassembled:

- Always inspect all parts and replace the high-pressure seals as a set.
- Carefully wipe each part clean with a lint-free rag and blow them out with compressed air.
- Never tighten or loosen plumbing while under pressure.

Assemble the Wet End Assembly

1. Apply a light coat of Lubriplate to the interior of the holes on the **pressure manifold** and **check valve body** outlet side **O-ring** and **static seal**.
2. Install all three assembled **check valve bodies** into the **pressure manifold**.

Note: *Because of pins in the pressure manifold, check valve bodies can be installed in only one position.*

3. Place the **liquid displacer** ① over the **inlet check valve retainer** ② until it contacts the **seal ring** ③. Repeat this for all three **check valve assemblies**.

① Liquid displacer
② Ring seal
③ Check valve assembly

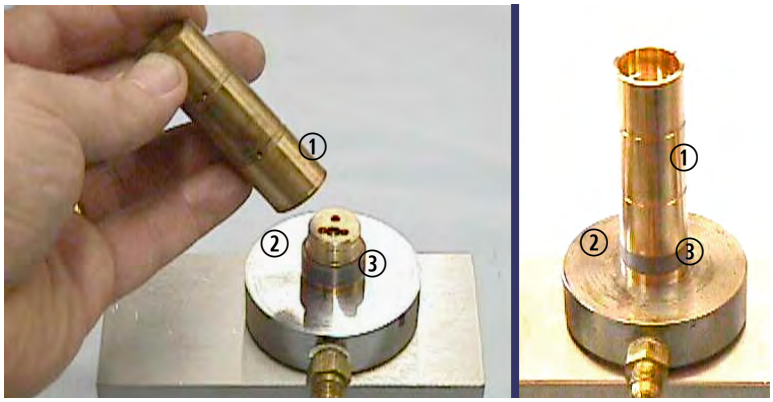


Figure 6-31

Caution: ***If the wrong end of the liquid displacer is installed on the check valve assembly, a large gap appears between the displacer and seal ring. See Figure 6-32. The end of the displacer must make contact with the seal ring.***

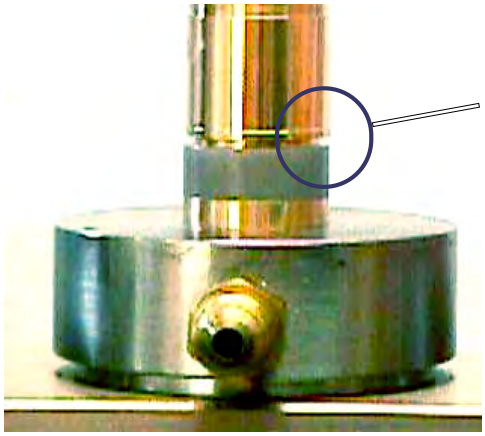


Figure 6-32

4. Apply a light coat of Lubriplate just inside the bore and on the end of the **cylinder** ① without the large chamfer. Slide the cylinder over the **liquid displacer** ②, **ring seal**, and **support ring** until it comes in contact with the **check valve assembly** ③.
5. Verify the end of the **cylinder** WITHOUT the large chamfer is against the **check valve assembly**.

Caution: ***The liquid displacer provides a close tolerance fit inside the bore of the cylinders; however, the cylinder should slide easily over the displacer if the cylinder is kept square with the displacer. It may be necessary to press firmly on the cylinder to push it over the ring seal. If the support ring was not removed during maintenance, the cylinder may not slide over it by hand. In this situation, place a rag over the open end of the cylinder and tap it into place with a soft mallet.***

① Cylinder
② Liquid displacer
③ Check valve assembly
④ Pressure manifold
⑤ Chamfer end of cylinder

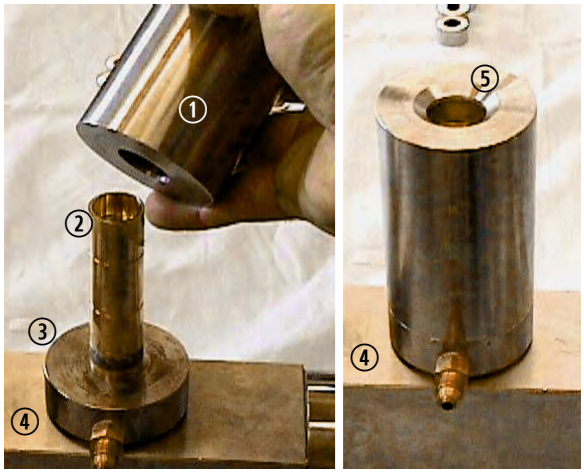


Figure 6-33

6. Repeat steps 3 through 5 for remaining **cylinders**.
7. Set **wet end assembly** aside until it is time to install onto the **pump**.

Replace Water Coolant Housing Seal

The low-pressure seal in the coolant bushing housing should be replaced at every pump rebuild.

① Bushing housing
② U-cup seal
③ Seal retainer sleeve
④ Snap ring

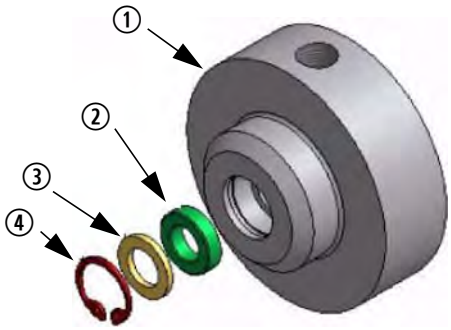


Figure 6-34

1. Remove **coolant housing assemblies** ① by sliding them forward until they clear the end of the **plungers** ②. The **coolant housing** fits snugly to the bore in the **adapter block** ⑤ and may be difficult to remove. Use the two **fittings**, **top** ③ and **bottom** ④, of the **coolant housing** to rotate the assembly while removing it. During removal, keep it aligned with the bore.

① Coolant housing assembly
② Plunger
③ Push-in inlet hose fitting
④ Push-in outlet hose fitting
⑤ Adapter block

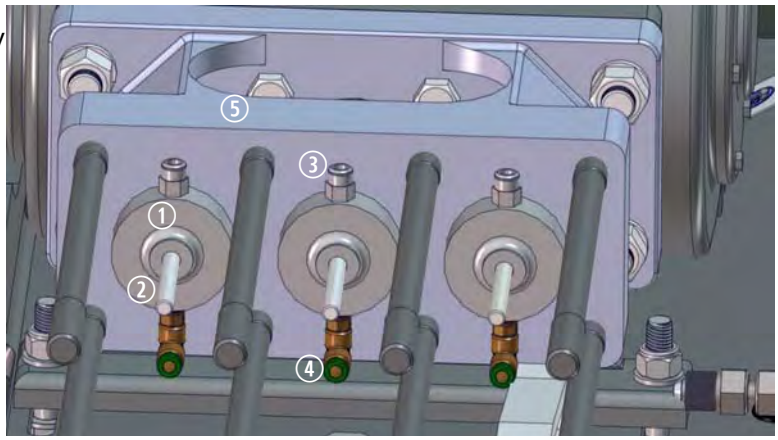


Figure 6-35

2. Pull coolant **hoses** out of the **push-in fittings** by pulling back on the outer ring of the **fitting** to release the locking device within the fitting while pulling on the **cooling line**.
3. After removing **coolant housing assembly**, remove **water hoses** from **housing assemblies** by pulling back on the green ring of the **push-in fittings**.
4. Remove the **snap ring**. Lift the **seal retainer sleeve** out of housing bore. Remove the **seal** in the same fashion.

5. Apply a small amount of Lubriplate to the lip of the **U-cup seal** and install it with the pressure lip, or cup, facing into the **coolant housing**, followed by the **seal retainer sleeve** and the **snap ring**.

Caution: ***The snap ring must be fully engaged in the snap ring groove. If not fully engaged, it can contact the plunger, damaging its surface.***

6. Set **coolant housing assemblies** aside for later pump assembly.

Removing Plunger Assemblies

Removal and inspection of the pump plungers is necessary only if plunger rubbing of the backup ring occurred. Rubbing may be expected if the dynamic seal indicates the plunger was out of alignment, or if the backup ring indicates plunger rubbing.

Caution: ***Damaged plungers ALWAYS cause premature dynamic seal failure and must be replaced.***

Plunger damage can be seen with the naked eye, or with low-power magnification. It is usually caused by the plunger rubbing on the backup ring or by foreign material in the pump. Whenever a plunger rubs the backup ring, metal adheres to the plunger surface. With extreme rubbing, a rough area showing discoloration of the plunger surface develops.

Note: *Once plunger rubbing has occurred, the plunger assembly must be replaced along with the dynamic seal and backup ring. If material is missing from the plunger surface, the plunger assembly, backup ring and coolant housing U-cup seal must also be replaced along with the dynamic seal.*

1. Remove **coolant housings**, if not already removed.
2. Access to the **wrench flats** ③ on **plunger assemblies** ④ is through an opening in the top of the **adapter block** ②. Remove metal **cover plate** on top of the **adapter block** and set it aside.

① Pony rod
② Adapter block
③ Wrench flats
④ Plunger assembly

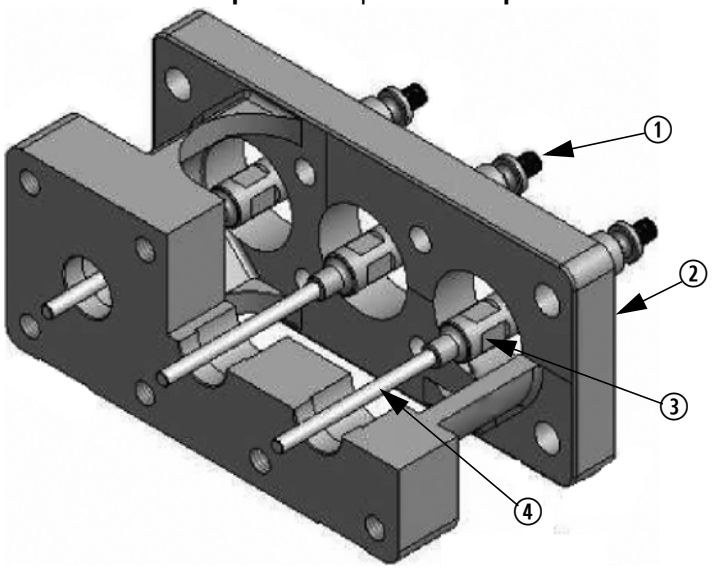


Figure 6-36

3. Remove **rubber cover** from the belt **access hole** ① on the **belt guard** ②.

① Access hole
② Belt guard

Figure 6-37

4. Use the **belt** to rotate the **pump crankshaft** by hand until the **plunger** being removed is positioned at bottom dead-center (fully retracted). Only two of the plunger assemblies are accessible at a time.

5. With a steady pull, loosen the **plunger assembly**. Avoid jamming the wrench and permanently bending the **plunger assembly**.

3/4 in.

3/8 drive breaker bar

Install Plunger Assemblies

1. Ensure threads on **plunger assemblies** and the face and threads of the **pistons** in the **crankcase** are clean.
2. Apply anti-seize lubricant to the mounting face and threads of the **pony rods**.
3. Install **plunger assemblies** into the **crankcase** and hand tighten.
4. Rotate the **pump crankshaft** so the **plunger** is at bottom dead-center.

Caution: ***The plunger must be at bottom dead-center (fully retracted) when being tightened to avoid bending the plunger assembly.***

5. Tighten each **plunger assembly**.

3/4 in.

225 in-lb
25 N·m

Assemble Dynamic Seal Assembly

The high-pressure dynamic seal assembly is assembled as follows.

1. Apply a small amount of Lubriplate to the outside of the **small O-ring** ③**.**
2. Place **small O-ring** ③ on the extended lip of the **dynamic seal** ②.
3. Snap the metal **seal retainer** ④ over the **small O-ring** ③ onto the **dynamic seal** ②. The **retainer** must be held square and may require some force to snap into place. An Arbor press may be used to lightly press the **retainer** onto the **dynamic seal**.

Caution: ***If using a tool to press the assembly together, ensure tool surfaces are clean to avoid dynamic seal contamination.***

4. Place the **large O-ring** ① over the outside of the back of the **dynamic seal assembly**.

① Large O-ring
② Dynamic seal
③ Small O-ring
④ Seal retainer

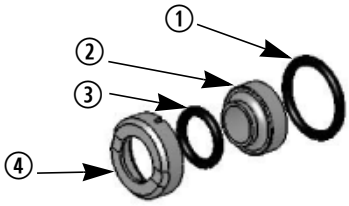


Figure 6-38

Assemble the Pump

WARNING! ***After the pump is assembled, the crankcase should be turned over by hand to verify all plungers reach full stroke without contacting check valve retainers. BE CAREFUL NOT TO CATCH ANY FINGERS BETWEEN THE DRIVE BELT AND SPROCKETS.***

1. For convenience, rotate the pump **crankshaft** until the center **plunger** is at top dead center (maximum extension). The ends of the other two **plungers** should be even and extend out far enough for assembly of the **wet end** without further rotation of the **crankshaft**.
2. Apply a light coat of extreme pressure lube (or Blue Goop) to the area of the **coolant housing assembly** that engages into the **cylinder** bore.

3. Slide the **coolant housing assembly** ① over the **plunger** ② until it is fully engaged into the bore in the **adapter block** ③. Note the **plunger** is not rigidly held and can be moved slightly for alignment with the **coolant housing assembly.**

① Coolant housing assembly
② Plunger
③ Adapter block

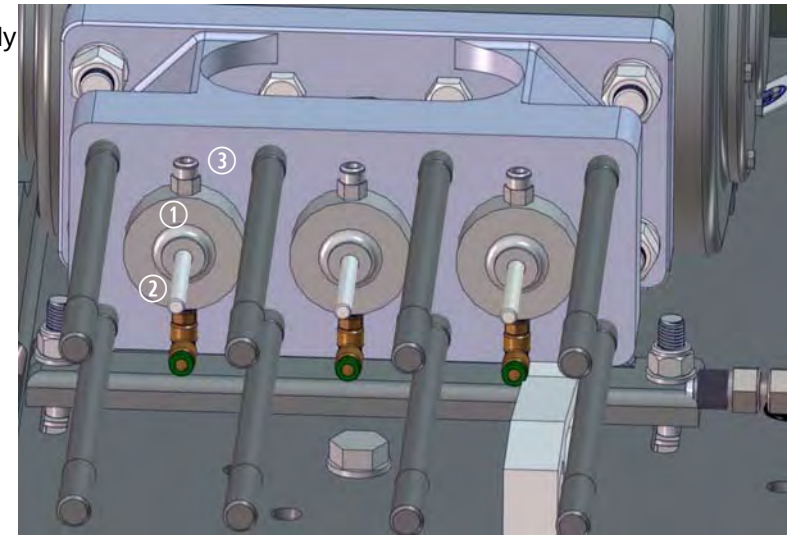


Figure 6-39

4. Trim ends of **low-pressure water supply** and **return hoses** ① square and back about ¼ in. Install into **push-in fitting** ② on the **coolant housing assemblies**.

① Water supply hoses
② Push in fittings

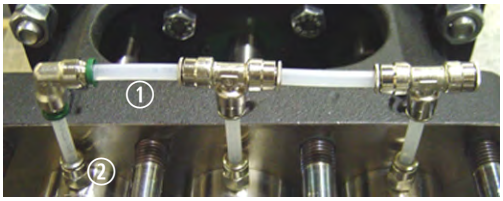


Figure 6-40

Note: *Hoses from the low-pressure supply manifold block should be connected to the upper fittings on the coolant housings. The hoses connected to the lower fittings should return water to the water tank.*

5. Slide **seal ring** ② onto the **backup ring assembly** ① and up against the **backup ring**.

① Backup ring assembly
② Seal ring

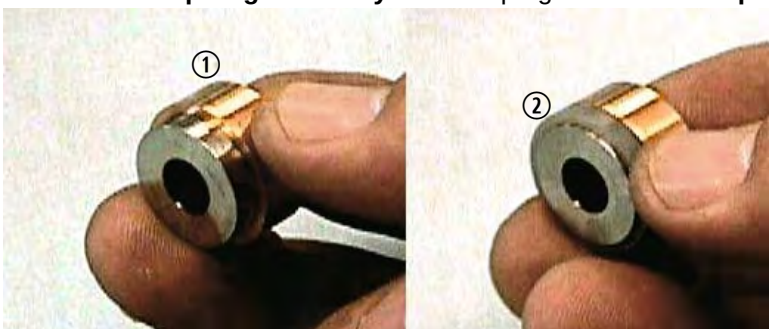


Figure 6-41

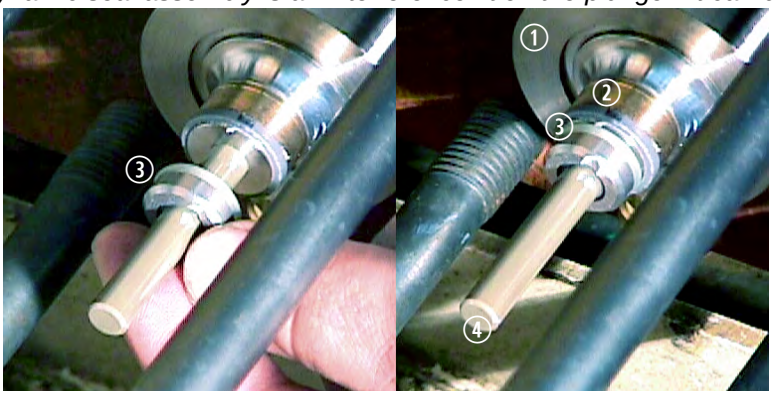
6. Slide **backup ring assemblies** ② onto the **plungers** ③ with the **black bushing** inside the **backup rings** toward the **coolant housing assembly** ①. Push the **backup ring assembly** down the **plunger** until it rests against the **coolant housing assembly**.

① Coolant housing assembly
② Backup ring assembly
③ Plunger

Figure 6-42

7. Slide assembled **dynamic seal assembly** ③ onto the **plunger** ④ until it rests against the **backup ring assembly** ②. The flat end of the **dynamic seal assembly** must be against the **backup ring assembly**, and the **metal retainer** must be on the side away from the **backup ring assembly**.

Note: *The dynamic seal assembly is an interference fit on the plunger. It can be difficult to install at times.*



① Coolant housing assembly
② Backup ring assembly
③ Dynamic seal assembly
④ Plunger

Figure 6-43

8. Apply a light coating of Lubriplate to the exterior surface of the outer ring on the **backup ring assemblies**.
9. Slide the **wet end assembly** ③ over the **plungers** ②. After starting to slide the **wet end assembly** into position, do not pull the **wet end assembly** back or cock it as this could cause internal components to dislodge from their assembled position. As **cylinders** ① begin to slide over the **seal rings**, they may, or may not go on all the way by hand. The small gap ④ that occurs between the end of the **cylinders** and the **coolant housing assemblies** closes when the **wet end assembly** is correctly torqued.

Caution: ***Use care not to damage plungers when sliding the wet end assembly over the plungers.***

① Cylinder
② Plunger
③ Wet end assembly
④ Pre-torque gap

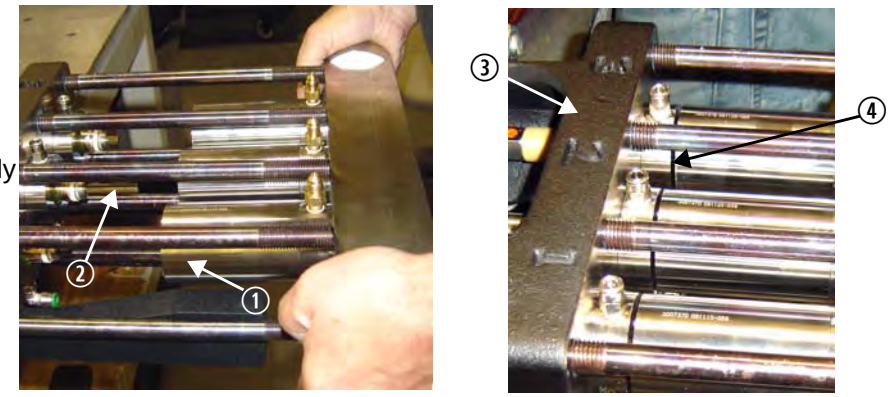
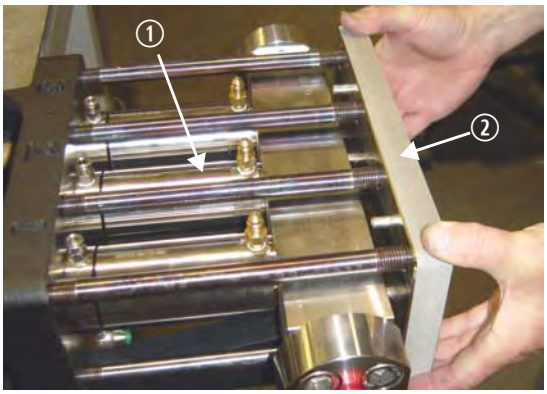


Figure 6-44

10. Install the **clamp plate** ②.



① Cylinder
② Clamp plate

Figure 6-45

11. Using a generous amount of anti-seize, lubricate the **stud threads**, **washers** (side that will face the **clamp plate**, and **stud nuts** (side that will face the **clamp plate**).
12. Install two sets of the lubricated **washers** and **nuts** onto **studs** labeled **1** and **2** in, with the lubricated side of the washers touching the **clamp plate**. Then add the **nuts** to the **studs**. Tighten these two **nuts** until they are just snug. An even gap of approximately 0.070 in. (1.78 mm) should remain between the end of the **cylinders** and the **coolant housing** assemblies.
13. Install remaining lubricated **washers** and **nuts** and hand tighten.

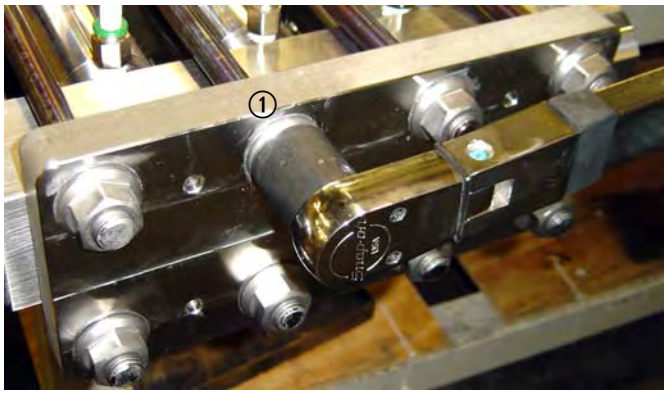
Caution: ***It is extremely important sufficient anti-seize compound be used to lubricate threads and surfaces between the nut and clamp plate so the torque applied properly loads the soft seals and studs.***

① Anti-seize compound

Figure 6-46

14. To ensure an evenly distributed load is developed on the **clamp plate** and **cylinders**, tighten each **nut** one-half turn in succession, following the tightening sequence specified below, until a torque of 175 ft-lb (237 N·m) is achieved on each **nut**.

175 ft-lb
(237 N·m)



① First stud nut in tightening sequence

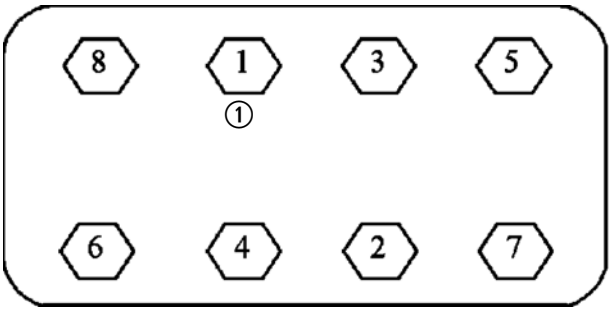


Figure 6-47

Caution: ***Verify all nuts are tightened evenly in the order specified in Figure 6-47 to avoid internal component damage and to achieve an even loading of seals and studs.***

15. Rotate the pump **crankshaft** by hand until each **plunger** crosses top dead center to ensure **plungers** clear **inlet retainers** and no binding exists in the **wet end assembly** that prevents a smooth rotation.
16. Install **access cover** onto the **belt guard**.
17. Install **plunger cover** over the **plungers**.
18. Complete **pump** assembly by connecting outlet **high-pressure tubing** and **low-pressure inlet hoses**.

Caution: ***Prior to starting the pump, always remove the nozzle assembly from the plumbing to prevent debris from damaging or plugging the orifice. Run the pump for ten minutes without the nozzle to clear out any debris after reassembly.***

Chapter 7
Rebuilding the Adjustable Dump Orifice

This chapter explains how to replace wear items in an Adjustable Dump Orifice (ADO). Refer to the ADO Component diagram for part numbers.

Caution: ***The Adjustable Dump Orifice was not designed to close completely as a "needle valve" would. NEVER screw the adjustment knob all the way in clockwise and force the tapered stem into the tapered seat. Doing so may jam the stem into the seat, requiring the ADO be disassembled to unjam the stem.***

Kit Contents

Following components are included in the ADO rebuild kit:

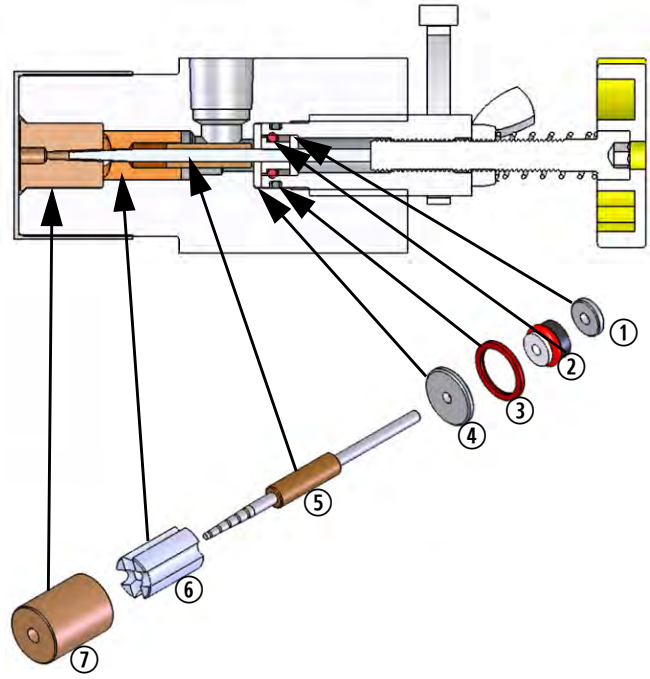


Figure 7-1

① Backup seal
② Seal assembly
③ O-ring
④ Seal guard
⑤ Stem assembly
⑥ Erosion shield
⑦ Tapered seat

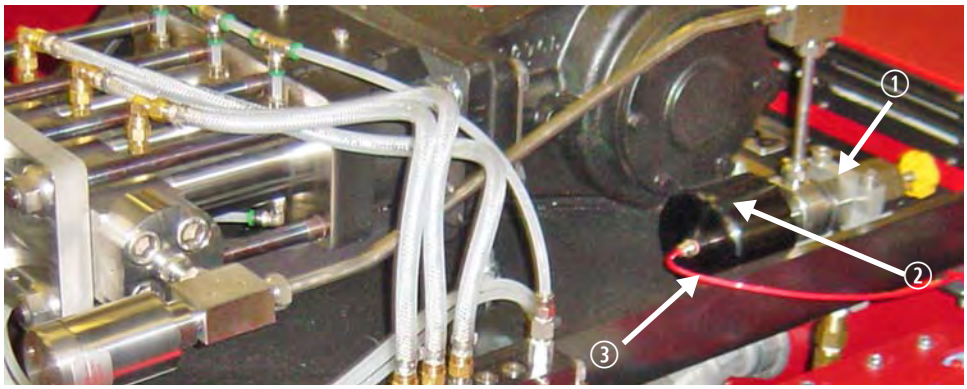
Tools and Additional Items Required

Refer to *Tools Required for Pump and Table Maintenance*.

Removing the ADO

Replacing wear items requires the ADO first be removed from the pump. Follow these procedures to complete the rebuild successfully.

1. Power down the **abrasive waterjet**, **high-pressure pump**, and **charge pump** using approved lockout/tagout procedures.
2. Shut down the main air and water supply.
3. Bleed residual air from the system by disconnecting the **air line** at the **air pressure valve** or by depressing the **air hose** until all air pressure is relieved.
4. Disconnect any **air lines** in the **pump** air supply system allowing all air pressure to vent.
5. Remove the upper **pump cover**.

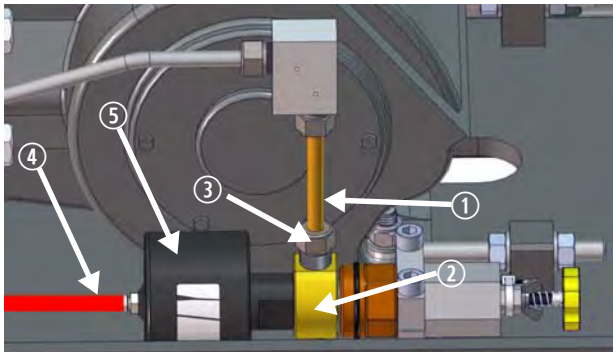


① ADO
② Air actuator
③ Air line

Figure 7-2

6. Remove **air line** ④ from the top of the **on/off valve air actuator** ⑤.
7. Disconnect the **nipple** from the **dump valve** ② by unscrewing the **gland nut** ③ on the **high-pressure tubing** ①

13/16 in.

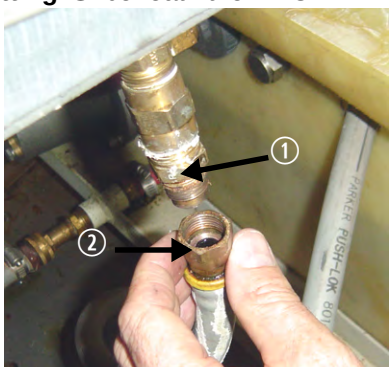


① High-pressure tubing
② Dump valve
③ Gland nut
④ Air line
⑤ Air actuator

Figure 7-3

8. Remove **drain hose fitting** ② beneath the **ADO**.

7/8 in.



① Adapter fitting

② Drain hose fitting

Figure 7-4

9. Remove two **mounting clamp screws** ② that secure the **ADO** to the **pump chassis**.

① Top mounting clamp

② Mounting clamp screws

8 mm

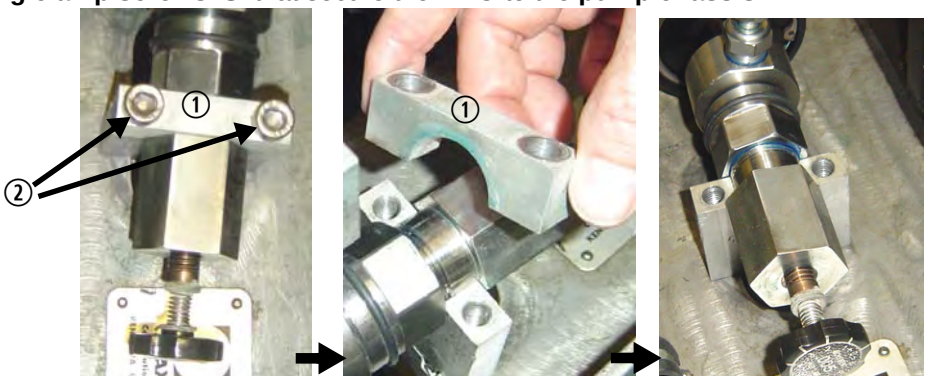


Figure 7-5

10. Lift **ADO** from the **mount** and place on a workbench for disassembly.

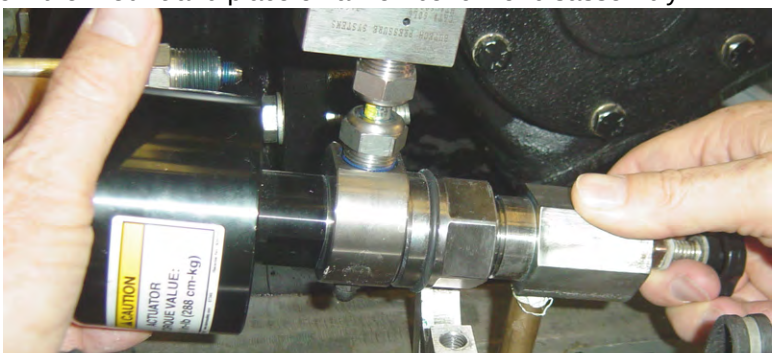
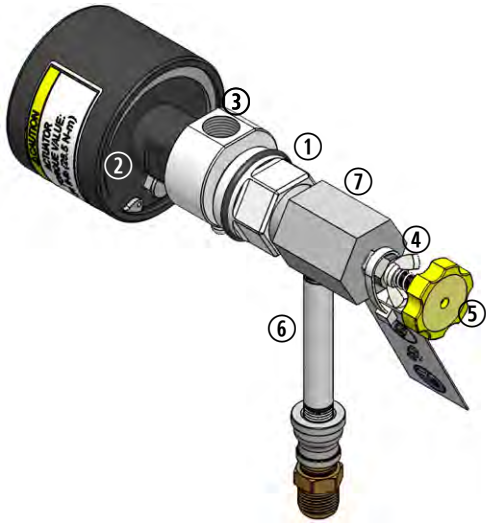


Figure 7-6

Disassembling the ADO

Once the ADO has been removed from the pump, use the following procedure to install components from the rebuild kit.

Note: *ADO disassembly involves disconnecting the on/off valve with the air actuator attached and removing all internal components of the body assembly that are being replaced in the rebuild kit.*



① On/off valve
② Air actuator assembly
③ High-pressure water inlet
④ Wing nut
⑤ Pressure adjustment knob
⑥ Low-pressure water drain
⑦ ADO body

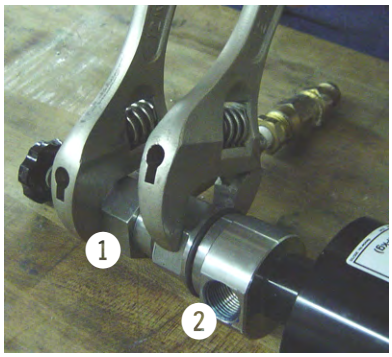
Figure 7-7

Caution: ***Ensure all garnet and other contaminates are cleaned from the ADO assembly prior to rebuild.***

1. With the **ADO assembly** on a workbench, remove the **ADO body assembly** ①.

① ADO body assembly
② On/off valve
③ ADO body removed

1-1/2 in.



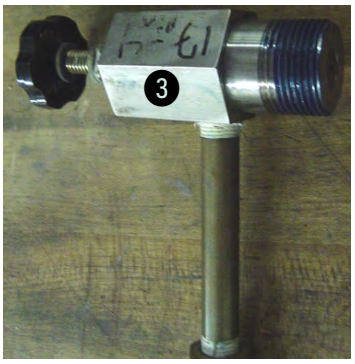
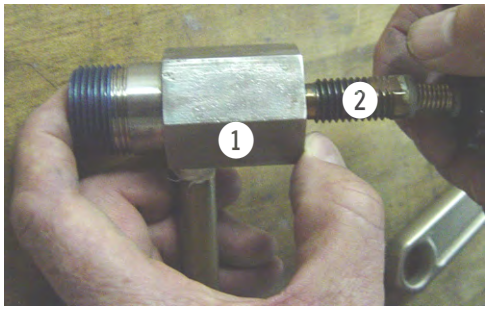


Figure 7-8

2. Unscrew the **stem adjuster** ② from the **ADO body assembly** ①.

1/2 in.



① ADO body assembly
② Stem adjuster

Figure 7-9

3. Pull the **stem adjuster** from the **ADO body assembly** along with the **stem assemby** and attached **seals**.
4. Using a thin diameter tool such as a small allen wrench, push out the **tapered seat** ② and **erosion shield** from the **ADO body assembly** ①.

① ADO body assembly
② Tapered seat
③ Stem assembly and seals
④ Thin push tool

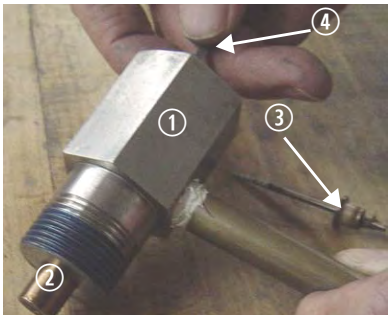


Figure 7-10

5. Remove and discard each component identified below (R), replacing them with parts provided in the ADO rebuild kit.

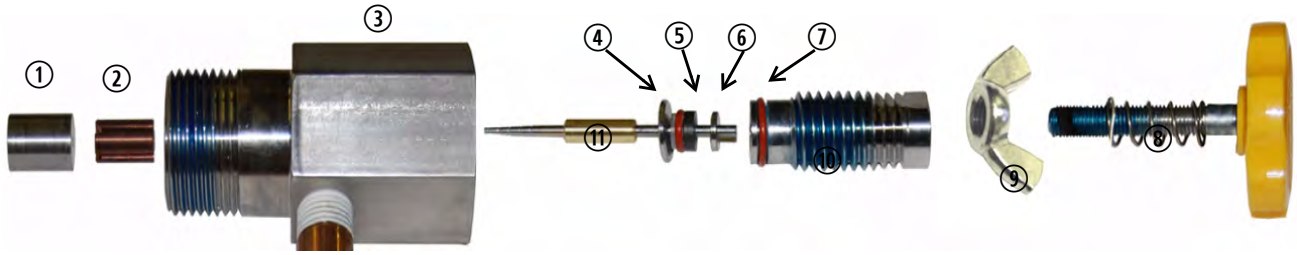
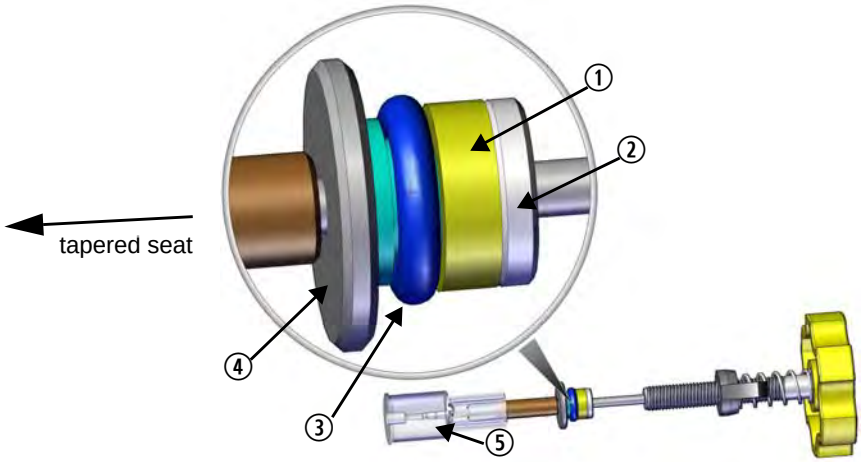


Figure 7-11

① Tapered seat (R)
② Erosion shield (R)
③ ADO body
④ Seal guard (R)
⑤ Seal assembly (R)
⑥ Backup seal (R)
⑦ O-ring (R)
⑧ Pressure adjustment knob
⑨ Wing nut
⑩ Stem adjuster
⑪ Stem assembly (R)

Caution: ***Correct orientation of the seal assembly must be observed during assembly. The O-ring on the seal assembly must face toward the tapered seat.***

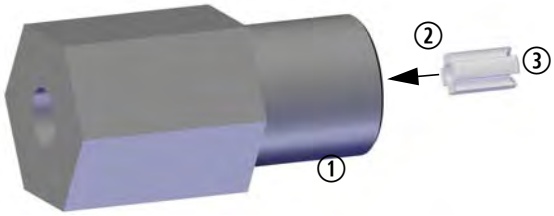


① Seal assembly
② Backup seal
③ O-ring
④ Seal guard
⑤ Tapered seat

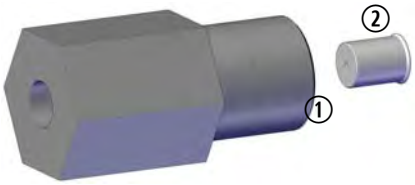
Figure 7-12

6. Install the new **erosion shield** ③ into the **ADO body** ①, inserting the **large diameter bore end** ② in first.

① ADO body
② Large diameter bore end
③ Erosion shield



7. Apply a thin film of Extreme Pressure Lube to the outside diameter of the **tapered seat** ②.
8. Place **tapered seat** ② in the **ADO body assembly** ①.



① ADO body assembly
② Tapered seat

Figure 7-13

9. Place **seal guard** ② on **stem assembly** ①.
10. Apply a light film of Lubriplate on the **stem assembly** and carefully slide on the **seal assembly** ③ with the white end toward the **seal guard** ②.
11. Place **backup seal** ④ on the **stem assembly** ①.
12. Apply a thin film of Lubriplate on **seal assembly** ③.

① Stem assembly
② Seal guard
③ Seal assembly
④ Backup seal

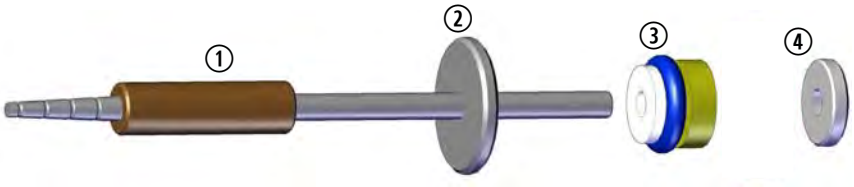
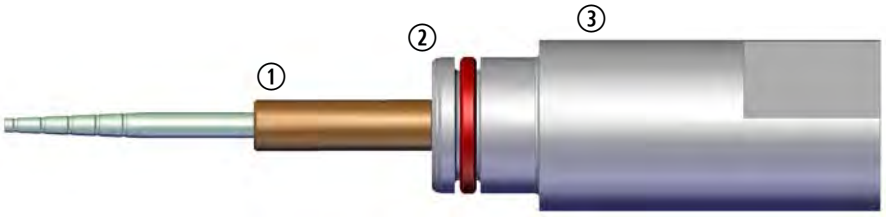


Figure 7-14

13. Carefully push **stem assembly** and components into the **stem adjuster** ③ until the **brass sleeve** ① of the **stem assembly** and **seal guard** ② contact the bottom of the **stem adjuster**.



① Brass sleeve
② Seal guard
③ Stem adjuster

Figure 7-15

14. Place **spring** and **wing nut** on **pressure adjustment knob** and screw **wing nut** on until the **spring** is half compressed.

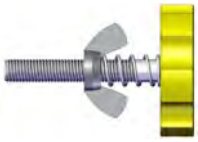


Figure 7-16

15. Apply a light film of anti-seize lubricant to threads of the **adjustment knob** and screw into **stem adjuster** ② until a 0.03 in. (0.762 mm) gap ③ opens between the **seal guard** ① and **stem adjuster** ②.

① Seal guard
② Stem adjuster
③ 0.03 in. gap

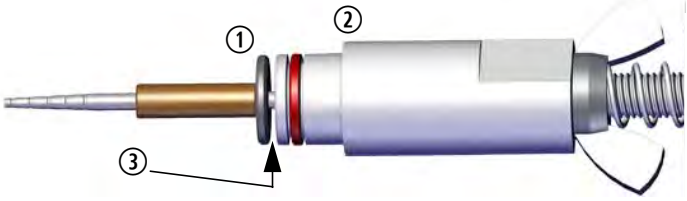


Figure 7-17

16. Holding the **pressure adjustment knob**, screw the **wing nut** down, to lock the **pressure adjustment knob** in position.

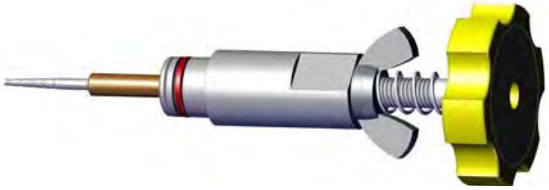
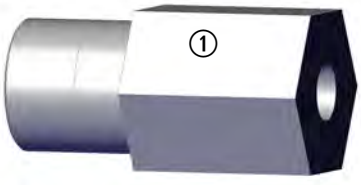
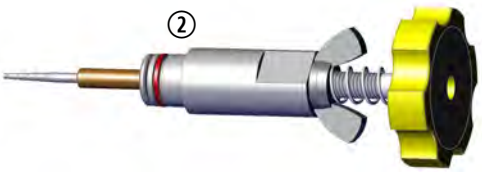


Figure 7-18

17. Apply a light film of Blue Goop to threads of the **stem adjuster** ② and screw into the **ADO body assembly** ①.

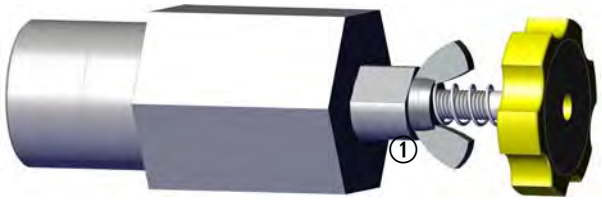




① ADO body assembly
② Stem adjuster

Figure 7-19

18. Lightly tighten **stem adjuster** ① to about 20 ft-lb (27.11 N·m)



① Stem adjuster

Figure 7-20

Caution: ***Never close the ADO completely prior to operating the pump or at any time during operation. This is not a shutoff valve! Doing so jams the stem into the tapered seat causing the pump to dead head and requires disassembly to correct.***

19. Attach **caution label** to **knob shaft** to remind operators to never screw the **stem** completely closed.

Installing the ADO

1. Prepare **on/off valve** for attachment to the **ADO body assembly**.

Note: *Before tightening the on/off valve to the ADO body assembly, rotate the fitting ring and on/off valve assembly to align threads of the fitting ring with the high-pressure water inlet hole in the on/off valve assembly (Figure 7-21). The water inlet hole aligned with the gland nut threads must be positioned to point up, 180 degrees from the side with the brass nipple pointing down. This alignment enables later installation of the nipple ring (Figure 7-26).*

① On/off valve
② Fitting ring
③ High-pressure water inlet
④ Gland nut threads

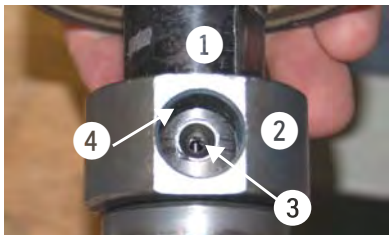


Figure 7-21

2. Once **water inlet hole** and **fitting ring** are aligned 180 degrees opposite the body assembly's **brass nipple**, place the **ADO body assembly** in a soft-jawed vice and tighten the **on/off valve assembly** to the **ADO body assembly**.

Caution: ***Ensure the water inlet hole and fitting ring remain aligned while tightening.***

3. Place the **ADO body assembly** ② back onto the **mounting clamp** ① with **on/off valve** pointing towards the **safety valve** and the **brass nipple** inserted into the **chassis hole**.

① Bottom mounting clamp
② ADO body assembly

Figure 7-22

4. Place the **top mounting clamp** ① over the **ADO body assembly** ②**,** insert the two **M10 screws** ③**,** and hand tighten both securely.

① Top mounting clamp

② ADO body assembly

③ M10 screws

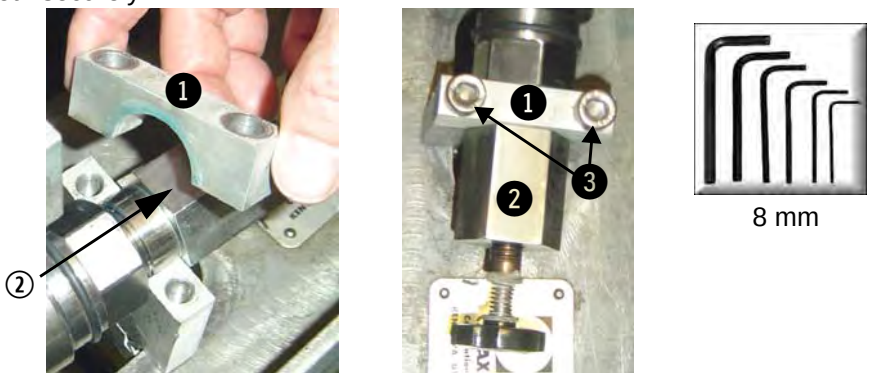


Figure 7-23

5. Insert and align the **nipple assembly** and **gland nut** ② into the **fitting ring** ③ in the **on/off valve** ④. Finger tighten only at this time
6. Insert and align the other end of **nipple assembly** and **gland nut** ② into **safety valve** ⑥ **Tee fitting** ⑤.

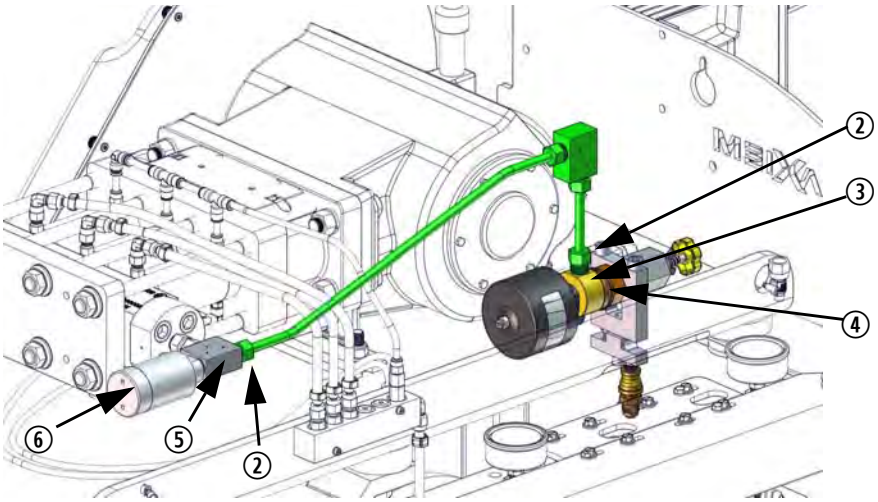


Figure 7-24

① Nipple assembly (green items)	④ On/off valve assembly
② Gland nut	⑤ Safety valve Tee fitting
③ On/off valve fitting ring	⑥ Safety valve

Note: *It may be necessary to rotate the on/off valve assembly until the gland nut can be threaded into the fitting ring.*

7. Tighten the **gland nut** on the **fitting** by placing a wrench on the **gland nut** and on the **fitting**.

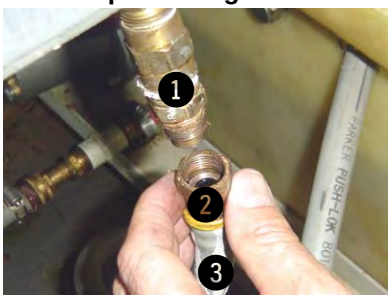
13/16 in.
1 in.

8. Tighten the two **ADO mounting screws**.

8 mm

9. Connect **air line** removed earlier to **air fitting** located on top of the **air actuator.**
10. Connect 1/2 in. **water hose** ③ to the **adapter fitting** ① beneath the **ADO**.

❶ Adapter fitting
❷ Hose fitting
❸ Water hose



7/8 in.

Figure 7-25

11. Installation of the **ADO** is complete. Next, see *Adjusting ADO Pressure*.

Adjusting ADO Pressure

ADO pressure requires verification and/or adjusting anytime a different sized orifice is installed in the nozzle, or the jewel is replaced. See Chapter 3, *Adjustable Dump Orifice (ADO).*

Chapter 8

Abrasive Waterjet Troubleshooting

Troubleshooting

The following lists most problems that could be encountered with equipment operation. Possible causes for each problem are provided with the most likely causes listed first. If you continue having a problem after following these procedures, contact OMAX Technical Support.

Problems

Refer to Solutions on page 8-3 to match a corrective action number listed below with the steps suggested to correct a problem.

Condition and Possible Causes	Corrective Actions
High-pressure Pump Fails to Start or "Pump fault" on Keypad	
The charge pump is not powered ON.	**1**
Insufficient water pressure or flow to the charge pump.	**1, 2**
Water pressure from charge pump too low.	**2, 3**
E-stop is activated	**34, 35**
Abrasive Waterjet Nozzle Does Not Move	
A soft limit has been reached.	**7**
The nozzle collided with the cutting material and stalled.	**8, 15**
Fault Message on Controller	
The emergency stop switch was either activated, the nozzle collided with some object, or for some other reason the machine detected a fault.	**33**
Parts are Too Short or Flat Spots Appear on Curves	
The cutting material is not securely fixtured.	**9**
The nozzle has reached its hardware limits.	**10**
Home Position or Soft Limits are Lost	
The nozzle has reached its hardware limits.	**10**
Poor Surface Finish	
The values defined in **Make** are not consistent with the actual cutting requirements.	**11**
An abrasive other than the recommended garnet is being used.	**12**
Mixing tube is excessively worn and unable to form a perfect jet stream.	**13**
Jewel that forms the jet is chipped, dirty, or out-of-tolerance.	**14**
Abrasive flow stopped or has been reduced by the presence of dirt or wet abrasive.	**15**
Poor fixturing of the cutting material.	**9**
Holes are Too Large and Parts Undersized	
The tool offset is set incorrectly.	**16**
Tool offset is on the wrong side of the path.	**17**
Excessive Taper on Part Edges	

The cut was made with the quality value set too low.	**18**
The stand-off between the abrasive waterjet nozzle and the material is too high.	**19**
Setup values in **Make** are not consistent with actual physical requirements.	**11**
An abrasive other than the recommended garnet is being used.	**12**
The mixing tube is worn and unable to form a perfect jet stream.	**13**
The jewel that forms the jet is chipped, dirty or out of tolerance.	**14**
Holes are Not Round	
The cutting material is not securely fixtured.	**9**
The jet is elliptical rather than round due to wear in the mixing tube or a slightly imperfect orifice.	**20**
Abrasivejet Not Piercing Material	
Setup values entered in **Make** are not consistent with actual physical requirements.	**11**
An abrasive other than the recommended garnet is being used.	**12**
Stand-off between the abrasive waterjet nozzle and the material being cut is too high.	**19**
Abrasive flow stopped or has been reduced by the presence of dirt or wet abrasive, or worn mixing tube.	**15**
Mixing tube is worn and unable to form a perfect jet.	**13**
Jewel that forms the jet is chipped, dirty or out of tolerance.	**14**
Pump is not delivering the pressure specified.	**21**
Abrasivejet Quit Cutting	
Abrasive flow stopped or has been reduced by the presence of dirt, wet abrasive, or worn out abrasive tube that collapses or leaks air.	**15**
Mixing tube in the abrasive waterjet nozzle is plugged.	**22**
Jewel orifice is plugged with foreign material.	**23**
Pump is not delivering the pressure specified.	**21**
No High-pressure Water	
No water from source or pump pressure has fallen below 50 psi.	**2**
Charge pump is not turned on.	**1**
Keyboard or Mouse Does Not Work	
Wires or connections in the computer may have become loose.	**24**
Blue Screen Errors	
Loose USB cable. If the USB cable is unplugged while **Make** is running, the monitor will blue-screen.	**25**
Corrupt device driver	**26**
Low air pressure	**27**
Pause activated	**28**
Water Flows Up the Abrasive Tube	
On/off valve is leaking.	**29**
Mixing tube in the abrasive waterjet nozzle is plugged.	**22**
Stand-off distance is so narrow that the nozzle is plugged by the work piece before it starts cutting, and water is forced up the abrasive tube.	**19**
Pump is not delivering the pressure specified.	**21**

Charge pump is not turned on.	**1**
The Jet Looks Wide and Fuzzy	
Jewel that forms the jet is chipped, dirty or out-of-tolerance.	**14**
Mixing tube is worn and unable to form a perfect jet stream	**13**
No Abrasive Flow	
Abrasive flow stopped or has been reduced by the presence of dirt, wet abrasive, or worn out abrasive valve.	**15**
Stand-off distance is so narrow that the nozzle is plugged by the work piece before it starts cutting and water is forced up the abrasive tube.	**19**
Shop air pressure is insufficient to open the abrasive valve.	**27**
No Abrasive Flowing from the Abrasive Tube	
Abrasive flow stopped or has been reduced by the presence of dirt, wet abrasive, or worn out abrasive tube that collapses or leaks air.	**15**
Jewel orifice is plugged by foreign material.	**23**
Stand-off distance is so narrow that the nozzle is plugged by the work piece before it starts cutting and water is forced up the abrasive tube.	**19**
Water Sprays Out of the Tank	
Part is positioned on top of a slat, causing the jet stream to reflect upwards.	**30**
Abrasive Piles Up on the Work Piece	
Accumulation of abrasive silt at the bottom of the tank is excessive.	**31**
The Table Has an Unpleasant Odor	
Excessive bacteria growth in the tank.	**32**

Solutions

Refer to Problems page 8-1 for a list of problems encountered.

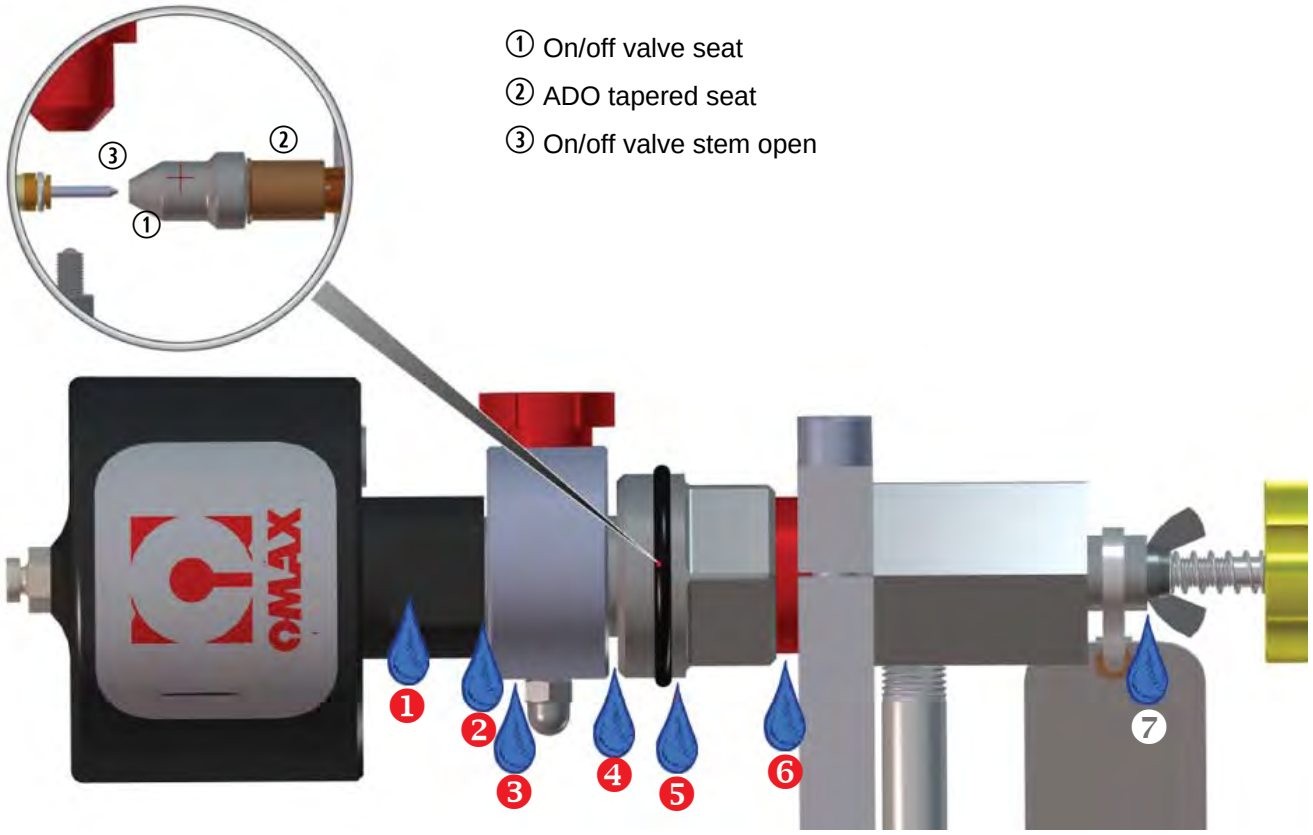
Corrective Action	Description
1	• Verify charge pump on/off switch is in the ON position. • Verify charge pump's AC power source is ON. • Verify pump power switch is ON.
2	Check water supply source and verify adequate flow and pressure. Replace charge pump water filters if they are restricting flow.
3	• The pump will not run when the water pressure drops below 50 psi. Check the two pressure gauges before and after the water filters. If the downstream gauge exceeds 50 psi, the pressure gauge may be defective. If the upstream gauge does not exceed 70 psi, the charge pump may be partially plugged or defective. • Check water filters are not plugged or damaged. If the pressure difference between the two pressure gauges is more than 20 psi, replace the filter cartridges.
7	Verify soft limits are enabled. Reset the soft limits if they are too small. **Note:** *Soft limits may have been corrupted by an abnormal stop such as a collision, power failure, or use of the emergency stop switch. If so, redefine values for the machine's soft limits and homes.*
8	• Cycle machine power OFF and then ON. • Verify material position and fixturing; remove any obstacles from nozzle path.
9	• The material was able to move during the cutting process due to drag of the nozzle or upwelling of the water below. Ensure material being cut is securely fixtured. This is the most common reason for scrapped parts. Improperly secured material will vibrate, causing a rough edge on the cut part. • Never fixture directly to slats. They can move during cutting. • Specify a higher cut quality such as 3 or 4.

10	Relocate work piece toward the table center. Set software limits to provide a warning before hardware limits can be reached.
11	Check values entered for the following parameters were correctly entered in **Make**: • Material Type and Material Thickness Verify parameters entered for the following **Pump and Nozzle Settings** are correct: • Water pressure • Abrasive index • Orifice diameter • Mixing tube diameter • Abrasive flow rate • Abrasive size
12	• Many abrasives do not cut as well as garnet, and the Abrasive Index should be reduced when using these abrasives. It may be necessary to experiment to determine the best settings. • Verify the settings for Abrasive Index are correct in the **Pump and Nozzle Settings**. **WARNING!** ***Never use silica sand as a cutting abrasive. Fine silica dust produced by the cutting process can lead to silicosis, a serious lung disease.***
13	Mixing tube wear occurs first at the inlet, then a conical wear zone grows toward the exit end of the mixing tube. Check the tube bore at both ends using a drill or gage pin. When the outlet has increased in size by 0.005 in. (0.13 mm), the mixing tube is near the end of its useful life for precise cutting.
14	Clean or replace the integrated diamond nozzle body.
15	Disassemble plugged items, blowing them clean and dry with an air hose. Replace nozzle abrasive tube if showing any signs of wear.
16	If not enough material is being removed (hole too small or part too large), decrease the tool offset by half the dimensional error observed. If too much material is being removed, increase the offset by half the dimensional error. By measuring parts as they are finished, you can monitor the wear of the mixing tube and periodically reset the tool offset to achieve more precise cutting. Refer to the kerf check part drawings included with the software.
17	Switch the lead in and lead out and then use the **Generate Tool Path** command in **Layout** to recreate the part. Check the tool offset using **Preview** in **Make**.
18	A quality of 1 will just barely pierce the material and usually has significant taper. Both taper and surface finish should improve as the quality value is raised (taking longer to make the part).
19	A stand-off of 0.040 in. (1.02 mm) to 0.060 in. (1.52 mm) is generally recommended. Typically, lower stand-off distances decrease the amount of taper, but a lower stand-off increases the likelihood of nozzle plugging. An 0.080 in. stand-off is required for the A-Jet.
20	If the jet remains elliptical, change the mixing tube. If that does not correct the issue, change the nozzle body assembly.
21	Measure the pressure to see if it is below specification. Follow pump troubleshooting procedures.
22	In an attempt to dislodge the plug, use **Make** to turn the high-pressure pump ON and OFF. If this fails, you may need to clean the nozzle or replace the mixing tube.
23	Remove the nozzle and flush the lines. Replace the integrated diamond nozzle assembly with a new one.
24	Verify the mouse and keyboard connections are firmly inserted.
25	Ensure the USB cables are plugged in firmly. Restart the table controller.
26	Reinstalling Intelli-MAX software can fix this. Be sure to fully power down the controller, wait 10 or more seconds, then turn it back ON for all driver related changes to refresh.
27	Verify system air pressure is 70 - 95 psi. Adjust as needed.
28	Deactivate Pause.
29	Tighten the nozzle body.
30	Contain the spray with a muff around the nozzle.
31	Remove the slats and clean out the abrasive from the tank bottom.

32	Use a floating device containing bacteria-killing chemicals. **Note:** Never use chlorine products if using the WRS (closed loop system) as it will reduce resin life.
33	Manually pull the emergency stop switch back to its original pre-activated position and press the controller's Reset button. The fault message should now be cleared. If the fault was caused by a nozzle collision or other machine fault, pressing the Reset button in for 2 seconds will clear it once the original fault condition has been corrected.
34	Verify ADO pressure is lower than nozzle pressure (not to exceed 1-2 kpsi below nozzle pressure).
35	Manually pull the emergency stop switch back to its original pre-activated position. Restart the machine. For detailed steps, see *Stopping the High-pressure Pump.*

Troubleshooting Leaks

Correcting Water Leaks in the ADO Assembly



Troubleshooting Leaks in the ADO Assembly

Leak Point	Leak/Other Point Description	Suspected Causes	Recommended Action
1	air actuator weep hole	• leaky on/off valve seal; damaged stem/seat • cracked on/off valve body	• Verify air actuator torqued at 250 in-lb (28.2 N·m); on/off valve rebuild • check on/off valve body for cracks
2	leak between air actuator and fitting ring	• leaky on/off valve seal; damaged stem/seat • cracked on/off valve body	• on/off valve rebuild • check on/off valve body for cracks
3	leak between fitting ring and gland nut	• cracked on/off valve body • bad UHP tubing • loose gland nut	replace defective component; verify gland nut torqued at 60 ft-lb (68 N·m) on/off valve rebuild
4	leak from weep hole between collar and nut	• cracked body • loose gland nut • failed seat or seal	replace defective component; verify gland nut torqued at 60 ft-lb (68 N·m)
5	leak from weep hole located beneath the O-ring.	damaged metal-to-metal seal between the ADO and on/off seats	repair with repair kit for on/off valve first, or ADO kit if still leaks

Leak Point	Leak/Other Point Description	Suspected Causes	Recommended Action
6	if leaks between gland nut and ADO body, a low-pressure leak	normal wear leakage	rebuild with ADO kit at next scheduled maintenance
7	leak at ADO wing nut	normal wear leakage	rebuild with ADO kit at next scheduled maintenance

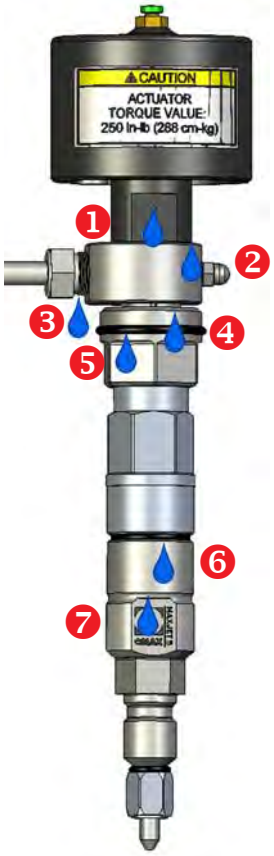
Note: *Diagram shows ADO and on/off valve. Troubleshoot each component separately.*

Troubleshooting Weep Hole Leaks in the ADO Assembly

If you see leaks at the weep hole between collar and nut (point 4, or point 5, Figure), troubleshoot with these tests.

1. In **Make**, click **Test**, then click **Pump Only (Dump valve open)**.
2. If leak occurs at point 4 or 5:
   a. **On/off valve seat** is defective, or
   b. **On/off valve body** is cracked.
3. In **Make**, click **Test**, then click **Water Only (Pump is active)**.
4. If leak occurs at point 4 or 5:
   a. Leak is between **on/off valve seat** and **ADO seat**.
   b. Repair with on/off valve repair kit first, then ADO repair kit if on/off repair kit does not fix the leak.

Correcting Water Leaks in the Nozzle Assembly



Troubleshooting Leaks in the Nozzle Assembly

Leak Point	Leak/Other Point Description	Suspected Causes	Recommended Action
1	air actuator weep hole	leaky seal	Verify air actuator torqued at 250 in-lb (28.2 N·m); replace seal
2	between air actuator and fitting ring	leaky seal	replace seal
3	between fitting ring and gland nut	cracked body, bad UHP tubing, loose gland nut	replace defective component; verify gland nut torqued at 60 ft-lb (68 N·m)
4	between fitting ring and valve gland nut	cracked body; loose nut	replace defective component; tighten nut
5	valve body	cracked inlet or valve body; loose nut	replace defective component; tighten nut
6	between nozzle body and inlet body	cracked inlet or nozzle body; leaky O-ring	replace defective component
7	weep hole on nozzle body	chipped jewel, cracked body, leaky seal	replace defective component

Correcting Water Leaks in the ON/OFF Valve

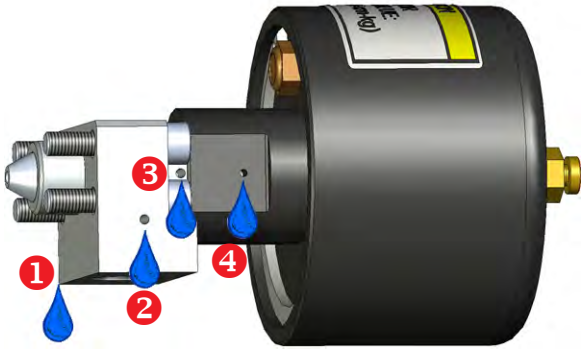


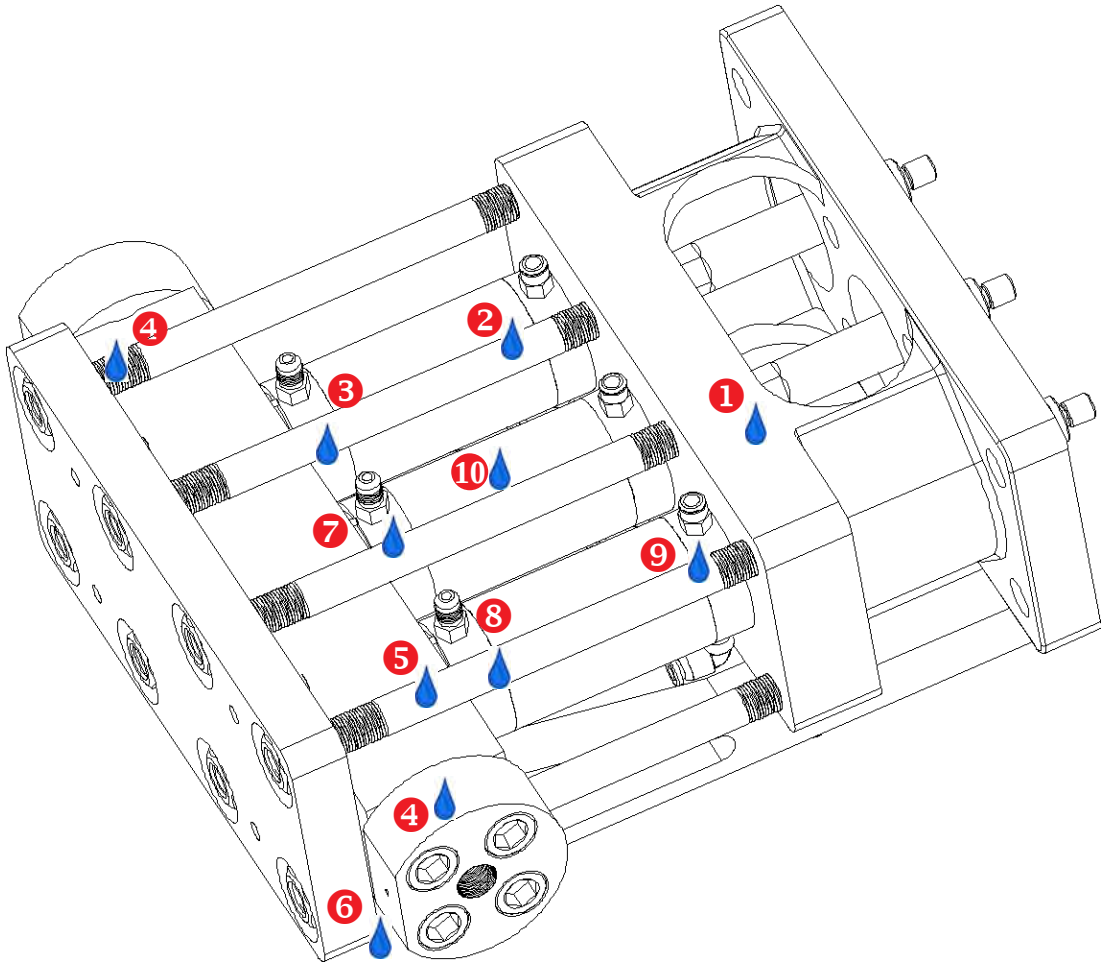
Figure 8-1

Troubleshooting Leaks in the ON/OFF Valve

Leak Point	Leak/Other Point Description	Suspected Causes	Recommended Action
1	Leaking around the plate and not from any weep hole	cracked inlet or valve body; loose bolts	replace defective component; tighten loose bolts
2	weep hole	UHP adapter to body leak; cracked body	replace defective component
3	weep hole	Cracked body or leaky seal	replace defective component
4	weep hole	leaky UHP seal	replace leaky seal

Correcting Water Leaks in the Wet End Assembly

This section identifies possible water leaks in the wet end assembly and suggests ways to correct them.



Troubleshooting Leaks in the Wet End Assembly

Leak Point	Leak/Other Point Description	Suspected Cause	Recommended Action
1	Leak from coolant housing seal	• Coolant housing seal failure	• Replace coolant housing seal at next rebuild (this is coolant water and will not affect output pressure or pump life)
2	Leak(s) between cylinder body and coolant housing and/or between cylinder body and check valve body (immediately after rebuild)	• Insufficient torque on clamp plate nuts • Insufficient anti-seize on clamp plate nuts	• Check torque on clamp plate nuts • Apply fresh anti-seize to face of clamp plate nuts and threads and tighten to 175 ft-lb
	Leak between the cylinder and coolant housing	• Cracked support ring • Damage to the support ring that supports the ring seal • Cracked cylinder	• Rebuild wet end assembly • Inspect support rings for damage
3	Leak between check valve body and cylinder body (immediately after rebuild)	• Liquid displacer installed upside down	• Rebuild wet end assembly • Inspect liquid displacer for damage and to ensure it is within tolerance before re-installing in the cylinder. If damaged, replace.
	Leak between the check valve body and cylinder	• Cracked check valve body • Cracked support ring • Damage to support ring that supports the ring seal • Cracked cylinder	• Rebuild wet end assembly • Inspect support rings for damage • Inspect check valve body for cracks and replace if cracked/damaged
4	Leak between port adapter and manifold	• Port adapter seal failure	• Replace port adapter seal
5	Leak between the check valve body and the manifold	• Cracked check valve body • Cracked manifold • Seal is loose fit to stem of the check valve • Damaged O-ring • Extrusion of static ring seal	• Rebuild wet end assembly • Inspect manifold and check valve body for damage/cracks • Inspect O-rings and seals for excessive extrusion, fit, and/or damage
6	Leak from weep hole on port adapter	• Possible damage to seal surface of the port adapter • Possible damage to tubing seat	• Replace port adapter and seal • Replace tubing
7	warm fitting on check valve	• Damaged check valve inlet seat or ball **Note:** There can be a damaged check valve inlet seat/ball with no noticeable heat.	• Rebuild wet end assembly • Inspect for damaged check valve inlet seat or ball/replace as needed
8	warm cylinder at check valve end	• Damaged check valve outlet seat or ball	• Rebuild wet end assembly • Inspect for damaged check valve outlet seat or ball/replace as needed

Leak Point	Leak/Other Point Description	Suspected Cause	Recommended Action
9	cylinder body warm at dynamic seal end only	NORMAL	NONE
10	Sudden loss of pressure and cylinder body very warm or hot.	• Cracked check valve body between the high- and low-pressure ports	• Rebuild wet end assembly • Inspect for cracks/damage in the check valve body (internal cracking – inspect viewing through the low-pressure port – may require magnification)