MAXIEM®
WATERJETS
A DIVISION OF OMAX

User's Guide

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Chapter 1

Safety

This chapter contains safety instructions to be followed when installing, operating or servicing the MAXIEM equipment. If ignored, physical injury, death, or equipment damage may occur. Read the safety instructions before you use your MAXIEM.

MAXIEM Safety Labels

The following safety labels may appear on your MAXIEM Waterjet.

Safety Label	Description
	**Wear Gloves** Since bacteria in the tank water can build up, even a seemingly minor break in the skin could 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.
	**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 present on circuits prior to maintenance activities, etc.
	**Lock Out Power** Never open or conduct maintenance on the MAXIEM equipment with the main power disconnect ON or unlocked, or while the pump unit is operating. Always follow standard lockout/tag-out procedures. Don't apply power to the equipment while maintenance work is in progress. Always lock the main power to the MAXIEM pump Off at its source.
	**Eye Protection** Always wear approved safety goggles whenever cutting. Regular glasses do not provide sufficient eye protection!
	**Ear Protection** Always wear hearing protection while in the vicinity of the MAXIEM. When cutting in air, noise levels can exceed 120 dB.
	**Flying Debris/Loud Noise** Eye and ear protection are required during operation.
	**Emergency Stop Switch (E-stop)** Pushing E-Stop in immediately shuts down operation of both the high-pressure pump and controller. The E-Stop is disengaged (reset) by manually turning and pulling it back to its original position. The pump cannot be restarted until the E-Stop is reset. The E-stop disables only pump and nozzle operation; the computer remains powered up.

Safety Precautions

Safety Label	Description
	Never operate the MAXIEM with any of its protective guards or covers removed or rendered inoperative. Never make unauthorized alterations to the equipment or components.
	Never operate the MAXIEM with any of its 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 a waterjet injury. Injuries caused by high pressure waterjets are serious. Do not delay!
	Never step, stand or walk on the support slats. They are weakened with continued cutting and may collapse under your weight.
	Never place your hands or fingers in areas where they are in danger of becoming pinched during equipment operation.

Always observe the following safety precautions while operating or servicing the MAXIEM. Carefully operated, the MAXIEM is a safe, productive tool. When operated carelessly, serious injury can result.

Table Safety Requirements

Do

- Be careful when handling materials in the tank. Fingers can be caught between heavy parts and the sharp edges of the support slats.
- Have an eyewash station located near the MAXIEM 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.
- Treat all injuries with caution. Because bacteria in the water can build up, even a seemingly minor break in the skin can introduce harmful bacteria into the wound. Any injury involving contact with the water should receive immediate attention. Use antibacterial chemicals in the tank water to reduce this hazard, and always wear protective gloves if you have cuts or open wounds on your hands.
- Seek immediate medical attention in the event of a waterjet injury. Injuries caused by high pressure waterjets are serious. Do not delay! Inform the physician of the cause of the injury, what type of waterjet project was being performed at the time of the accident, and the source of the water.
- Dispose of cutting wastes properly and in accordance with all local and federal regulations. The MAXIEM 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.

- Because of inevitable water spills, cover the floor around the operator area with a nonslip material such as a textured rubber mat or nonslip paint.
- Use only approved work platforms.
- Always use a splash guard on the abrasivejet nozzle. It helps keep the noise level low during machining and reduces splash and spray.
- Always use proper lifting techniques and equipment when handling heavy work materials.
- Keep a minimum of 16 inches (40 cm) from pressurized lines.

Do Not

- Operate the MAXIEM Waterjet without first being adequately trained to operate it correctly and safely.
- Allow nozzle movement while handling material in the tank. Stop the abrasivejet before making any adjustments. Nozzle movement can crush any hands or fingers caught between it and another object.
- Operate the MAXIEM with any of its protective guards or covers removed or rendered inoperative.
- Operate the MAXIEM in an explosive atmosphere. Machining titanium and certain other materials can produce sparks. Never allow explosive or flammable vapors to accumulate in the area of the MAXIEM.
- Allow unauthorized personnel access to the machining area without proper supervision.
- Switch tank chemicals for bacterial control without first reading the manufacturing warnings on the labels. Mixing different kinds of chemical pellets can create a hazardous situation.
- Use silica sand as a cutting abrasive. Fine silica dust produced by the cutting process can lead to silicosis, a serious lung disease.
- Operate the machine in close proximity to other machines as water can spray or splash out of the cutting table area.

Pump Safety Requirements

Do

- Operate the MAXIEM pump only after reading this manual and receiving instruction from qualified personnel.
- Stay in a location within easy reach of the emergency stop switch.
- Start the pump only when all protective covers are securely in place.
- Maintain all protective guards and shutdown devices around the MAXIEM pump.
- Immediately notify responsible repair personnel whenever leaks are detected in pump fittings or connections.
- Follow the manufacturer’s recommendations for servicing the equipment and use only original manufacturer replacement parts.
- Follow a periodic maintenance schedule that ensures proper equipment operation.
- Following maintenance activities, clear all tools and rags from around the MAXIEM pump before starting.

Do Not

- Start the MAXIEM pump unless you know how to stop it.
- Open or perform maintenance on the MAXIEM pump with the main AC disconnect ON or unlocked, or while the pump unit is operating. Always follow standard lock-out/tag-out procedures.
- Apply power to this pump while maintenance work is in progress. Always lock the main power to the MAXIEM pump Off at its source.
- Make unauthorized alterations to the equipment or components.

- Perform any electrical and maintenance work on this equipment unless you have received appropriate training and are qualified to service MAXIEM pumps.

Disposing of Waste Materials

In abrasivejet 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 a waterjet will produce sparks. Therefore, do not operate your 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 MAXIEM abrasivejet system.

Equipment Safety Features

The MAXIEM equipment provides several built-in safety features.

Emergency Stop Switch (E-Stop)

The MAXIEM pump, controller, and remote switches are all equipped with emergency stop switches. An E-Stop is engaged by pushing it in. Once engaged, it immediately shuts down the pump unit and abrasivejet. Refer to Figure 2-6 for an illustration of the E-Stop switch and its location on the controller front panel.

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 MAXIEM 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.

Electrical Disconnect

Electrical disconnect that cuts off and isolates the MAXIEM pump from its main electrical supply.

Access Control Circuit

The OMAX Access Control Circuit (ACC), if applicable, is designed to allow creation of a designated safety zone around a MAXIEM Waterjet cutting machine that protects operators from injury when using the equipment. 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 Waterjets

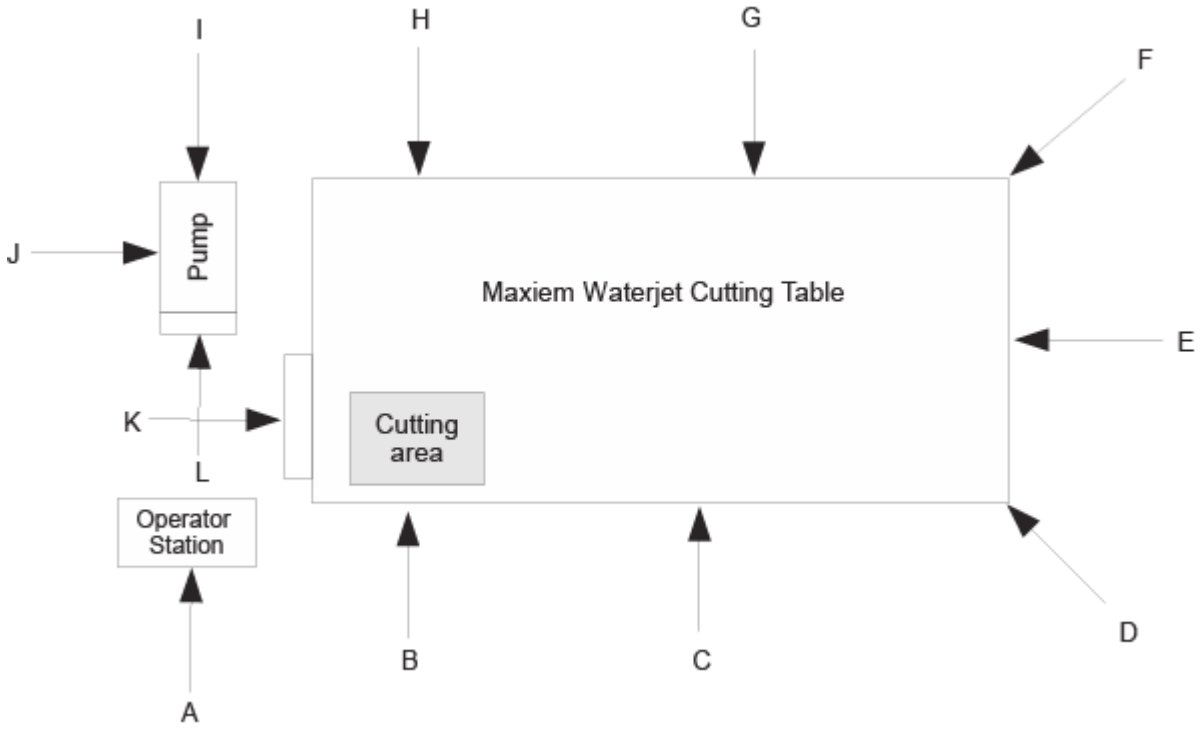


Figure 1-1: Airborne Noise Emission Sound Pressure Level (dB A)

** 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

MAXIEM Waterjets Safety Checklist

Safety Checklist Topics	
Safety Labels	
	Wear Gloves
	Electrical Hazard
	Lock Out Power
	Eye Protection
	Ear Protection
	Flying Debris/Loud Noise
	Danger – Watch your Hands and Fingers
	Warning – Keep hands away from jet
	Warning – Worn slats
	Warning – Pinch points
	Danger – 480 Volts
Safety Precautions (Do)	
	Material handling
	Hearing protection
	Approved Safety goggles/ Eyewash Station
	Treat injuries with caution – wear protective gloves
	WJTA Warning Card – medical attention for any waterjet injury
	Special handling of hazardous materials
	Prevent slipping
	Use only approved work platforms
	Use the splash guard (muff)
	Use proper lifting equipment
	Remove power from equipment when not in use
	Operate equipment after reading equipment manuals and receiving qualified instruction
	Be able to quickly access the emergency stop switch
	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.)
Safety Precautions (Don't)	
	Don't start equipment unless you know how to stop it
	Never open or perform maintenance on the equipment with the main power disconnect ON or while the pump is operating. Always follow proper lockout/tag-out procedures
	Don't make unauthorized alterations to the equipment or components
	Do not operate in an explosive atmosphere or near an ignition source
Equipment Safety Features	
	Emergency (E-Stop) Switch (Controller and Pump)
	Overpressure Protection safety valve and software shutdown
	Electrical Protection

Chapter 2

Introduction

MAXIEM Waterjets

Refer to the MAXIEM web site (http://www.maxiemwaterjets.com/) for machine sizes and specifications.

MAXIEM Components

Figure 2-1

- **MAXIEM Table**
  - X- Y- and Z-axis Motion System
  - Nozzle and Hopper Abrasive Delivery System
  - Catcher Tank with Table Cutting Surface
  - Table Controller with Keyboard, Mouse, and Monitor providing 2 USB ports
- **MAXIEM Pumps**
  - High-Pressure Pump
  - Charge Pump (not illustrated; see page 2-7)
- **Intelli-MAX® Standard Software**
  - Layout for drawing parts
  - Make for cutting parts
  - MAXIEM Help user reference
  - MAXIEM Parts Online

MAXIEM Cutting Table

X-, Y-, and Z-axis Motion System

Figure 2-2

Abrasive Delivery System

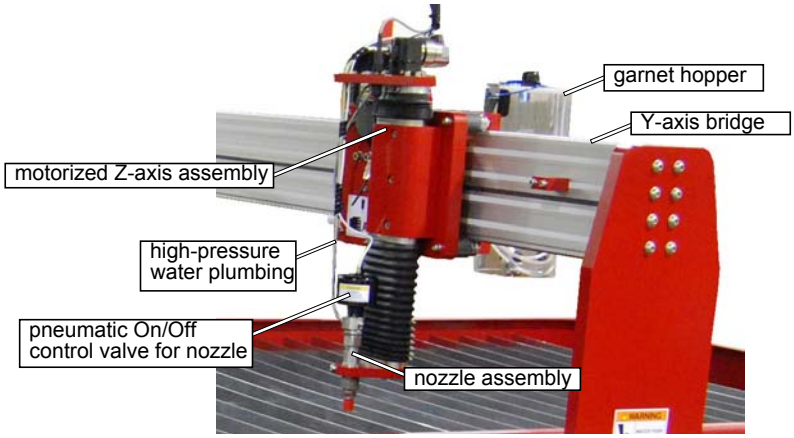


Figure 2-3

Catcher Tank

Figure 2-4

Table Controller

Figure 2-5

MAXIEM Operator Controls

A main **power disconnect** switch is available on the right side of the table controller (Figure 2-5). This switch shuts off all power to the table controller and can be locked to secure use.

The main **operator controls** for the MAXIEM table (Figure 2-6) are available in an environmentally sealed switch box with a magnetic backing that allows it to be easily attached to the tank or other metal objects at any location that facilitates operator access.

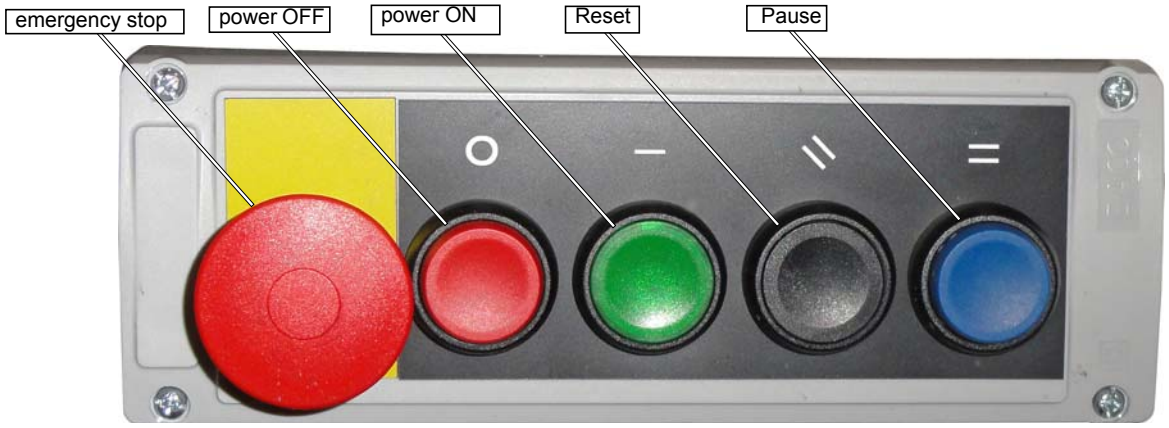


Figure 2-6

Emergency Stop
Immediately shuts down the high-pressure water pump and stops all abrasivejet operations, but the MAXIEM computer continues to run. Refer to Stopping the High-pressure Pump on page 3-22 for operational details.

Caution: ***The abrasive feed line must always be cleaned out after an E-stop!***

Power OFF Switch
Press to disable the axis drive motors.

Power ON Switch
Press to activate the MAXIEM X-, Y-, and Z-axis drive motors.

Reset Switch
Press to initiate a computer RESET following a fault condition.

Pause Switch
Press to stop machine motion and shut down the abrasivejet nozzle. Machining can be resumed following a “pause” without any loss of machine positioning information as occurs when using the Emergency Stop switch.

MAXIEM Pumps

High-pressure Pump

This pump provides the high-pressure water required by the MAXIEM 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 electronic VFD varies the electric motor speed and therefore the pump speed.

Refer to the MAXIEM website (http://www.maxiemwaterjets.com/) for additional information.

Pump Options

Three pump sizes are available for the MAXIEM Waterjet, the 20 horsepower M20, the 30 horsepower M30, and the 40 horsepower M40. For pump specifications, refer to the MAXIEM Waterjets website.

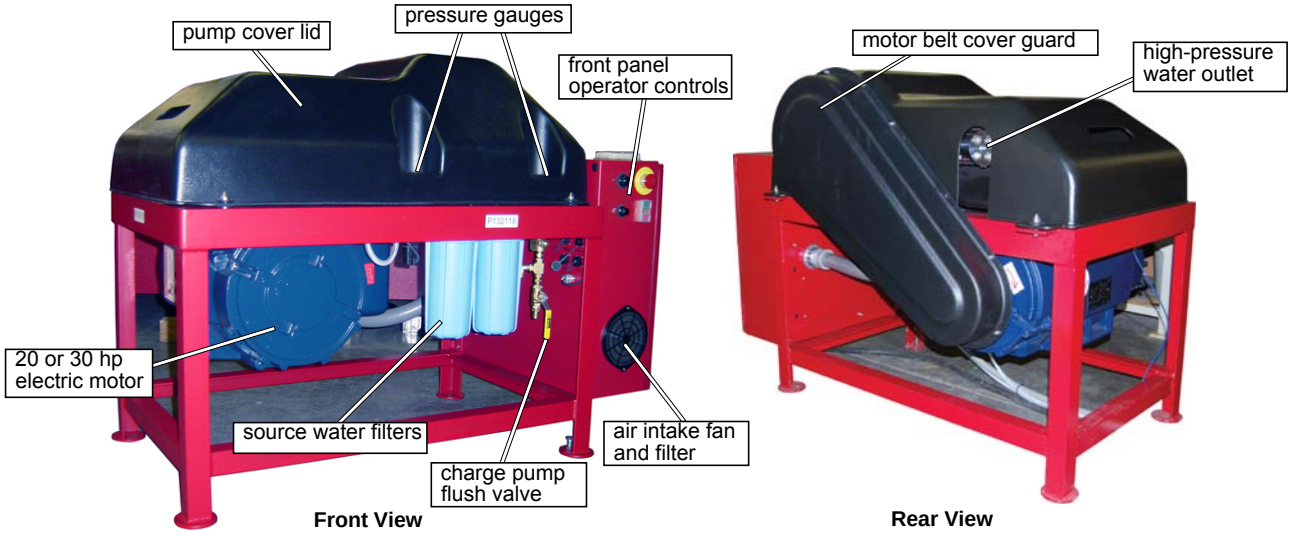


Figure 2-7

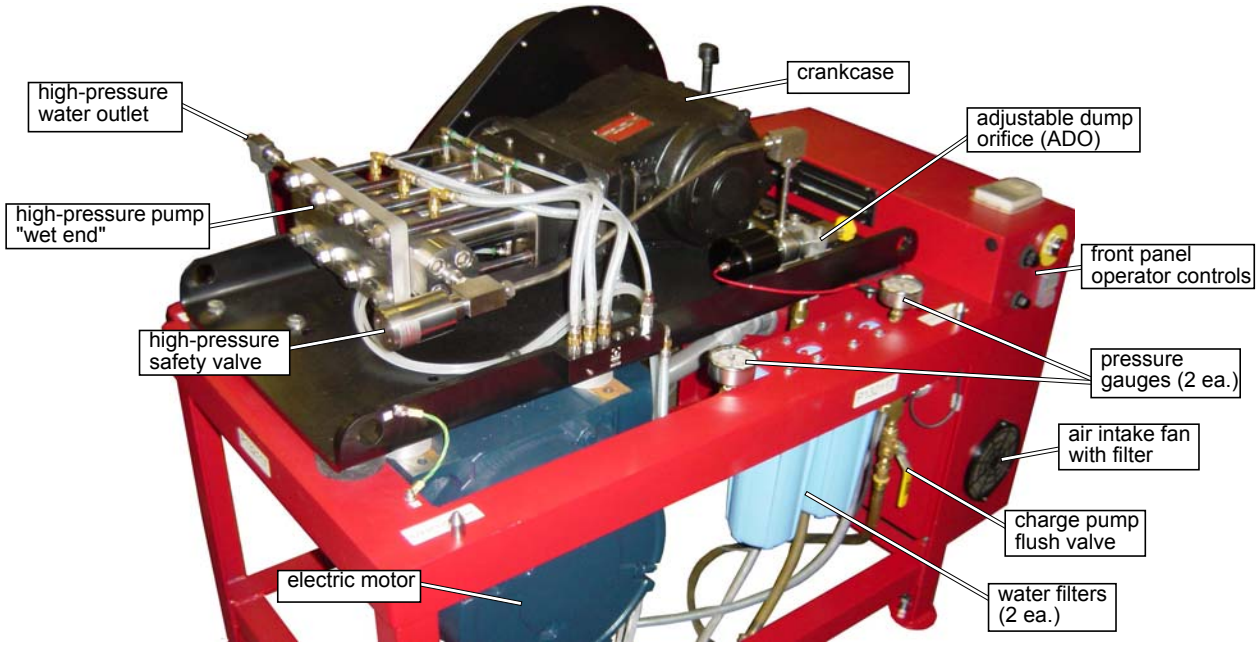


Figure 2-8

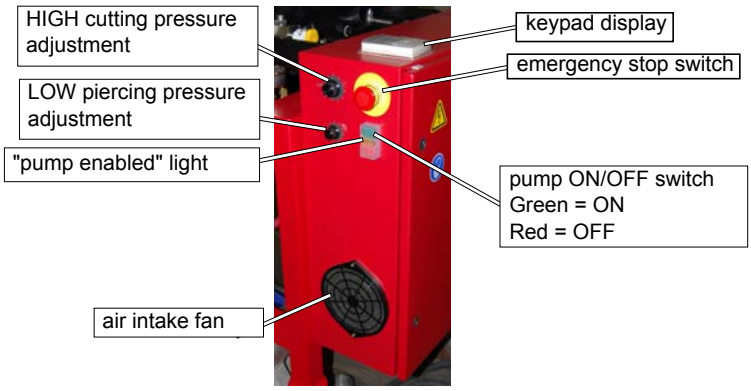


Figure 2-9

Emergency Stop
Immediately shuts down the high-pressure water pump and stops all abrasivejet operations. Computer remains ON. Refer to *Stopping the High-pressure Pump* on page 3-22 for operational details.

Caution: ***The abrasive feed line must always be cleaned out following an E-stop!***

Pump On/Off Switches with Pump Enabled light in center
Press **Green** to enable the pump for operation.
Press **Red** to stop the pump.

Note: A light between the red and green switches lights whenever the pump is enabled and ready for use.

High Cutting Pressure Adjustment (HP)
Adjusts cutting pressure by controlling motor RPM monitored in the keypad display (Figure 2-10). To increase RPM, adjust the knob clock-wise; adjust counter clockwise to decrease.

Low Piercing Pressure Adjustment (LP)
Adjusts piercing pressure by controlling motor RPM monitored in the keypad display (Figure 2-10). To increase RPM, adjust the knob clock-wise; adjust counter clockwise to decrease.

Caution: ***Motor RPM for piercing should be adjusted only when in Make's Nozzle Test Mode set at LOW for Abrasive/Pressure Flow Rate. See page 3-8 for procedure. Do not adjust this control in other modes.***

Keypad Display

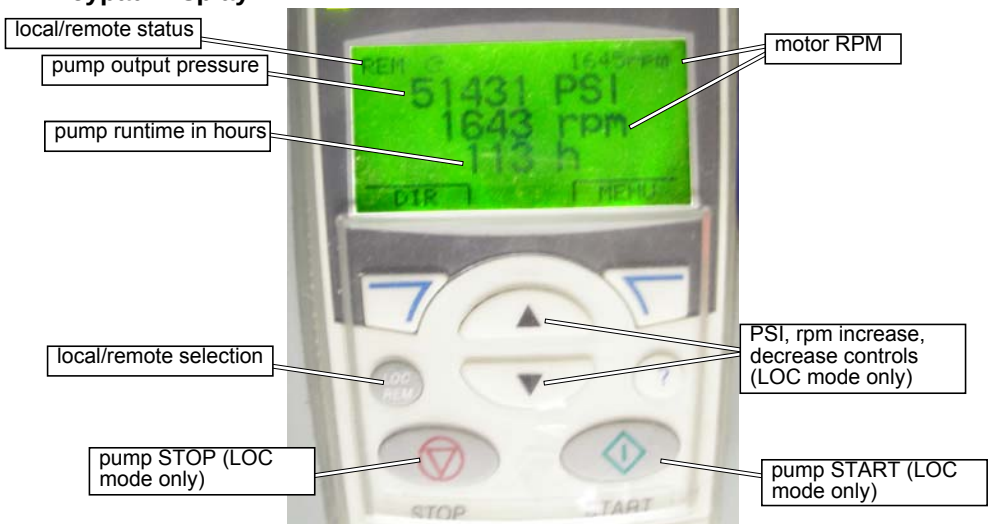


Figure 2-10

Local (LOC)/Remote (REM) Select Button
In LOC mode, the pump can be operated using the keypad;
In REM mode, the pump is operated using the Make software.
The pump has a “Low PreSet” RPM mode for low pressure operations. This is useful for piercing brittle materials or etching and scribing materials at reduced pressures.

START/STOP buttons
Turns the pump ON or OFF when in the LOC mode.

Arrow **Up** ▲
Arrow **Down** ▼
Used to adjust motor RPM when in the LOC mode.

Charge Pump

The charge pump boosts incoming water pressure to a level required for MAXIEM pump operation (≥120 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 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. The water storage tank requires a charge of 10-20 psi (0.70 - 1.40 Kg/cm) of air pressure for proper operation. The storage tank buffers temporary fluctuations in the incoming water supply. An ON/OFF power switch is provided for charge pump operation.

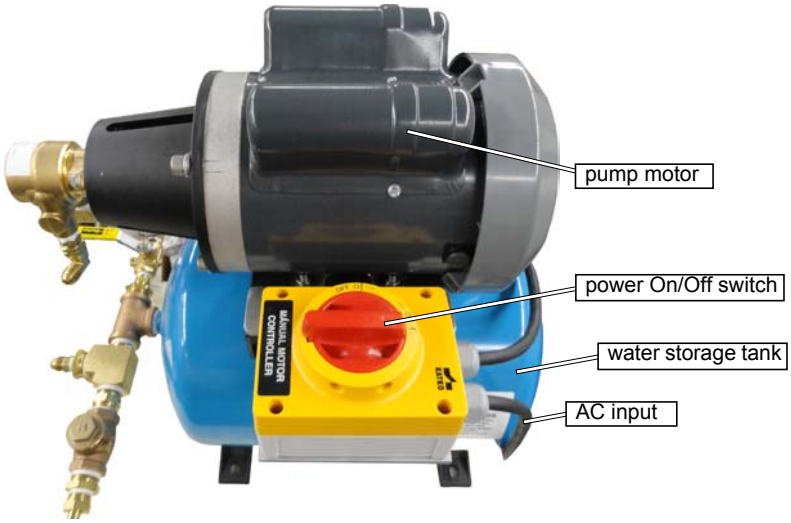


Figure 2-11

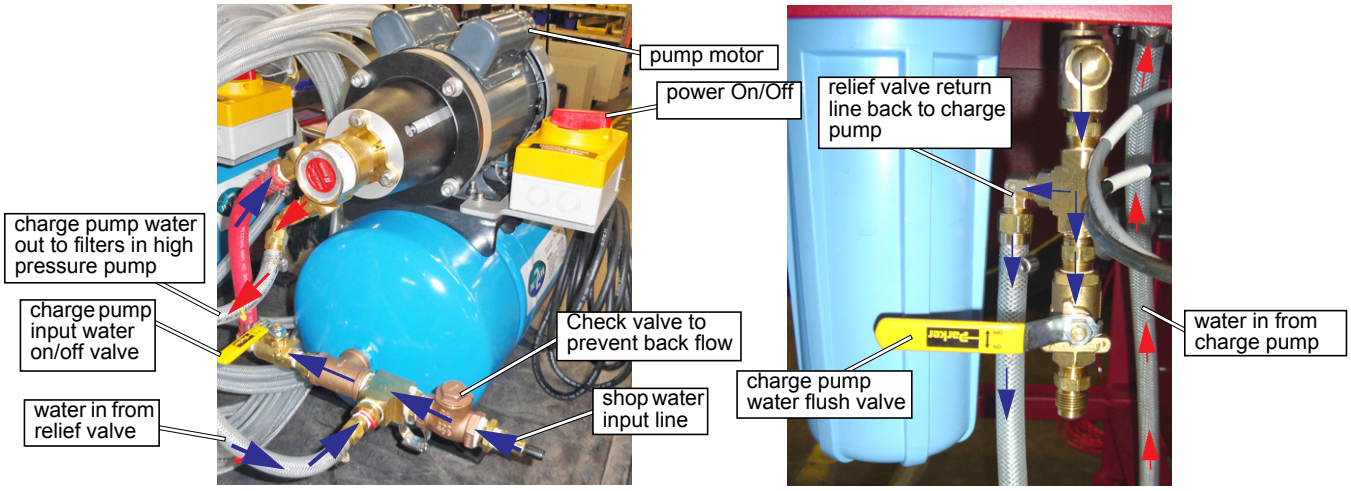


Figure 2-12

MAXIEM Software

The Intelli-MAX Standard software used by MAXIEM controls operation of the equipment. Intelli-MAX Standard **Layout** software creates the part drawings. Intelli-MAX Standard **Make** software cuts the part. In addition to Intelli-MAX Standard Layout and Make, **Help** files provide instructions and detailed information on use of this software. Refer to *MAXIEM Intelli-MAX Standard Software* on page 3-1 for additional information.

Chapter 3

MAXIEM Operation

This section provides general guidelines for operating the MAXIEM. Refer to **MAXIEM** Help for additional information.

MAXIEM Waterjet Overview

About Abrasivejet Machining

An abrasivejet 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 (see Figure 3-1). 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 to form the abrasivejet. 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.

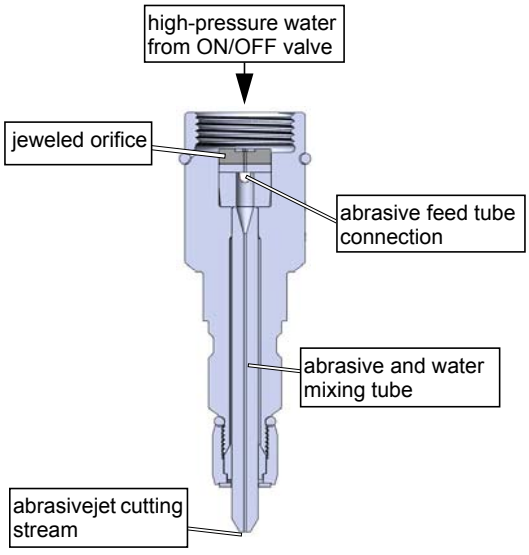


Figure 3-1

MAXIEM Intelli-MAX Standard Software

The Intelli-MAX Standard software creates part drawings (*Layout*) and then cuts the part (*Make*). This software completely controls the operation of the MAXIEM Waterjet.

Intelli-MAX Standard Layout Program

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

Intelli-MAX Standard Make Program

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

Intelli-MAX Standard Help Files

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

To access the help files:

1. Click the **Help** button when using a command. Many Layout and Make commands provide a Help button that opens the help files to the specific page describing that command.
2. Press the **F1** key while in either Layout or Make.
3. Click **Help** in the Layout or Make main menu.

Tutorial

Tutorial files are provided in Intelli-MAX Standard to help you learn about Make and Layout software. For access to these files, select the **Index** tab in the MAXIEM Help and type “tutorial”.

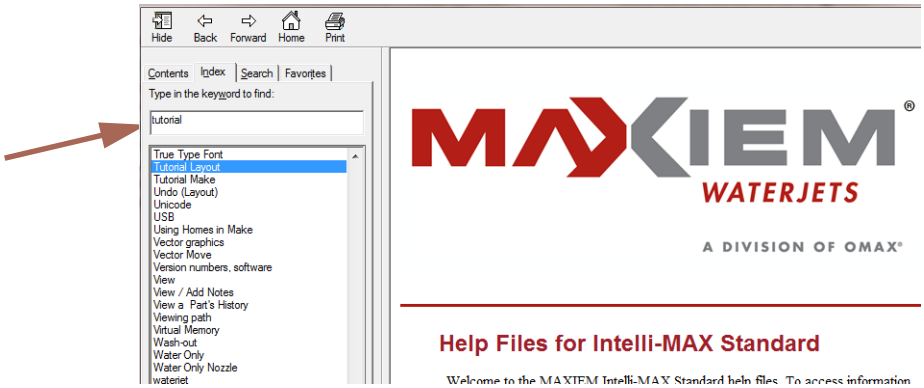


Figure 3-2

Drawing a Part Using Layout

The Layout software is a drawing program that creates parts 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 Layout’s tracing capabilities.

Determining Quality

Each entity in a drawing is assigned a quality value (1-5) which controls how quickly the abrasivejet nozzle moves when it cuts the piece. The slower the abrasivejet nozzle moves, the higher the quality of a cut.

Figure 3-3 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.

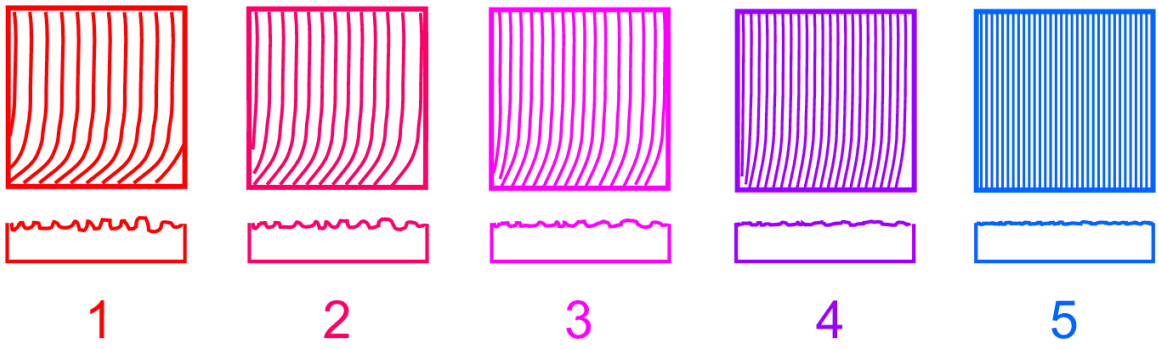


Figure 3-3

Setting the Tool Path

After a part drawing is created, Layout's **Generate Tool Path** command creates a tool path that defines how the part will be cut in an ORD (OMAX Routed Data) file.

Making the Part

Once the tool path is defined and the ORD file created, the Make software controls movement of the abrasivejet and the cutting of the part. Before beginning the machining operation, you can preview how the part will be made, how long it will take to make the part, and the amount of abrasive required.

Clamping and Positioning Materials for Cutting

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.

WARNING! ***Always be careful when handling material on the cutting table. During normal use, the abrasivejet cuts into the support slats and their edges can become extremely sharp. Avoid situations where your fingers can become pinched between the cutting material and a support slat. Wear protective gloves!***

A small downward force (about one pound or 4 newtons) is exerted on the material from the abrasivejet stream; however, a much larger upward force is exerted from all the air forced down with the abrasivejet 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 sway back and forth slightly, 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 or Waterjet Brick to hold small parts preventing them from slipping past the slats and down into the tank.*

Ensuring Clean and Quiet Machining

There are a number of techniques that promote clean and quiet machining with the MAXIEM.

Always place a splash guard on the abrasivejet nozzle when machining to reduce cutting noise and splash and protect the Z-axis assembly components. Included with the MAXIEM software is a file called "Muff" located in the `\SAMPLES\USEFUL_TOOLS` directory. This file contains a pattern used for making

additional splash guards. Use sponge material at least 1" (2.5 cm) thick for the splash guard. Muffs may also be ordered from MAXIEM.

Figure 3-4

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

Tips for Effective Cutting

- **Use an abrasivejet nozzle standoff between 0.040" (1.0 mm) and 0.060" (1.5 mm)**
  The closer the abrasivejet nozzle is to the material being cut, the less the taper. Increasing this standoff increases the taper. Smaller standoff distances increase the likelihood of plugging the nozzle during piercing.
- **Keep contaminants out of the abrasive**
  Contaminants in the abrasive material will clog the mixing tube. Contaminants include drops of water, bits of paper, metal shavings, dirt, etc.
- **Measure the tool offset regularly**
  The tool offset (half the width of the abrasivejet kerf) will gradually increase as the mixing tube in the abrasivejet 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, try to place the material so the abrasivejet is not cutting along a slat. Cutting along a slat also shortens its life.
- **Rotate slats regularly**
  Most parts are cut in the same area of the machine. Slats located in this area tend to wear out first. Rotating slat placement distributes their 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 (up and down). 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're 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**
  Wait until the MAXIEM reaches a rapid traverse before you stop machining and reposition weights.

This is easily done by right-clicking on the “pause” button in Make and choosing “Pause at Start of next traverse,” or “Pause at end of next traverse.”

- **Don’t 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.
- **Sandwich sensitive material between sacrificial material**
  When cutting parts that are sensitive to scratching, sandwich the part between pieces of a sacrificial material. The bottom of the part being machined is especially vulnerable to slat 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 can’t be pierced**
  Some materials cannot be easily pierced. For example, weak granites can be pierced, but may chip or crack apart. 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 abrasivejet stream and cause irregularities on the bottom of the part.
- **Don’t always make parts in the same location**
  Using the identical location wears out slats in the area more quickly and can cut through the tank. Make parts in different areas of the table to even slat wear.

Setting Machine Limits

There are two types of limits that restrict the area of nozzle movement on a table’s cutting surface: *absolute* limits (hard) designed into the machine’s hardware and user-defined *soft* limits.

Absolute 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 can 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 a nozzle movement is commanded that will exceed a defined soft limit, a window pop-up 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 the Machine

Auto Homing is the process of locating a table’s *Absolute Home*.

Note: *All homes are related to Absolute Home. Absolute home is the only home position that can be lost. Re-setting Absolute Home resets all other homes to their correct positions.*

All home positions and soft limits are points that are relative to the Absolute Home location. **It is important that Auto Home be run to re-zero Absolute Home at the beginning of each work day and whenever you shut down for maintenance or reboot the table controller, or when the machine has faulted.**

To Auto Home the MAXIEM:

1. Move the machining head so that it is 5 to 12 inches (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).

Caution: ***Prior to auto homing the machine, ensure that the Z-axis height is sufficient to prevent the nozzle from striking the table sides. Also ensure that the nozzle is within 1 foot (30.5 cm) of the home position.***

2. In Make, right-click the **Zero** button, select **Advanced** and then **Auto Home**:

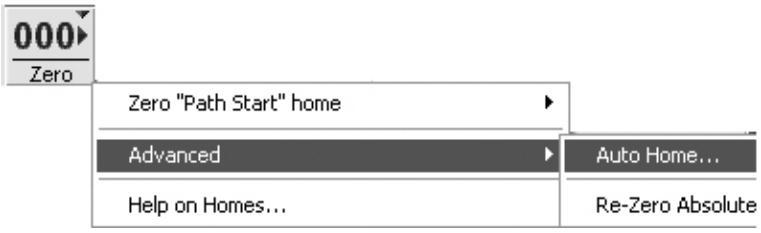


Figure 3-5

3. After reading the warning, click **OK** to start the automatic homing process. This will take a minute or so.
4. Make asks to zero the absolute home to this position. Choose **Yes**.

Note: *The machine will now move 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.*

The MAXIEM should now be accurately aligned and ready for use.

Summary for Creating a Drawing Using Layout

1. Import the part file (.DXF) into **Layout**, the Intelli-MAX Standard drawing tool.
2. Use the **Clean** command to remove any unnecessary dots, close any gaps, and remove any duplicate entities from the drawing.
3. Define the quality of the cut needed for each part entity:
   - **Quality 1** provides the lowest quality cut and cuts the fastest.
   - **Quality 5** provides the highest quality cut and cuts the slowest.
4. Add nozzle **lead-ins** and **lead-outs** to the cutting path.
   - Lead-ins are typically drawn longer; lead-outs are drawn shorter.
   - The side of the entity where you placed the lead-in/outs 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/lead-out to minimize witness marks or blemishes.
   - Path the part to avoid collisions.
5. Save the completed version of the DXF file.
6. Use the Layout **Path Tool** to specify the machine tool path and create the ORD file.
   - Configure the path either manually or automatically.
   - Run problem detection and make corrections for any found.

7. Save the final path drawing. Layout automatically saves it as an ORD file.

Summary for Cutting a Part Using Make

Setting Up the Hardware

1. Before powering up this equipment, ensure that you and other operators have access to the required protection devices (safety glasses, ear plugs, and gloves).
2. Switch the main power breaker ON for the MAXIEM equipment (Figure 2-5).
3. Turn the air supply valve ON.
4. Turn the water supply valve ON.
5. Power ON the charge pump.
6. Open the charge pump water flush valve (see Figure 2-12 on page 2-7) to purge warm water from the charge pump plumbing.
7. Run the charge pump for at least 15 minutes then measure the temperature of the water exiting the 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), you may experience a shorter life from pump seals. If the temperature is above 70° F (21.1° C), a chiller will be required. It is important to understand if the metal in the pump cylinders ever exceeds 80° F (26.7° C), the first 5 minutes of running could destroy a possible 100 hours of seal life. Continue doing this for 5 days in a row, and the pump seals will need rebuilding.***

8. When the charge pump exiting water goes below 70° F (21.1° C), close the charge pump water flush valve opened in step #8.

Note: *Steps # 6 through 8 should always be repeated whenever the pump and charge pump have both been shut down, especially following prolonged cutting. The cylinders, hot from cutting, will quickly heat up the non-flowing cooling water, allowing the seals to heat up and exceed their allowable operating temperature.*

9. Power ON the MAXIEM controller disconnect switch (Figure 2-5).
10. Press the Green MAXIEM ON switch (Figure 2-6).
11. Verify the operating system boots up without issues.

Note: *The Green ON button should be pressed **before** Windows fully boots. If not, press the black Reset button* (Figure 2-6) to activate the axis motors.

If the PC fails to start, open the MAXIEM controller door and verify that the PC power ON button is ON.

12. Power the high-pressure pump ON (ensure that it is in the REMOTE mode).
13. When applicable, also power ON any attached MAXIEM accessories.
14. Verify the nozzle mixing tube, orifice, and flow rate for the abrasive size are correctly matched to the size of the pump motor being used:

Pump Motor Size	Nozzle Orifice	Nozzle Mixing Tube	Abrasive Flow Rate
			80 Mesh
20 Hp	0.011" (0.279 mm)	0.030" (0.76 mm)	0.50 lbs/minute (.23 kg)
30 Hp	0.014" (0.356 mm)	0.030" (0.76 mm)	0.75 lbs/minute (.34 kg)

Pump Motor Size	Nozzle Orifice	Nozzle Mixing Tube	Abrasive Flow Rate
			80 Mesh
Dual 30 Hp	0.020" (0.508 mm)	0.042" (1.07 mm)	1.8 lbs/minute (.82 kg)
40 Hp	0.015" (0.38 mm)	0.042" (1.07 mm)	1.00 lbs/minute (.45 kg)
Dual 40 Hp	0.022" (0.559 mm)	0.042" (1.07 mm)	1.8 lbs/minute (.82 kg)

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 Set the Adjustable Dump Orifice pressure ensuring it is within 1-2 Ksi, but not above the nozzle cutting pressure. on page 3-11 for instructions.***

15. Ensure the mixing tube has been installed properly and has been pushed in all the way.
16. Pour the desired abrasive size (mesh) into the nozzle hopper. Ensure that the amount added will be sufficient to finish cutting the planned part.
17. Check the tank's water level. Add or drain tank water as needed.
18. In Windows, click the **Make** icon to launch the cutting software.
19. Auto Home the machine to ensure that the machine's zero (absolute home) position is set. Right-click the bottom **Zero** button, and select **Advance**/**Auto Home** (see Figure 3-5).
20. Verify soft limits are enabled (**Setup**/**Advanced**/**Soft Limits** - see Figure 3-6):

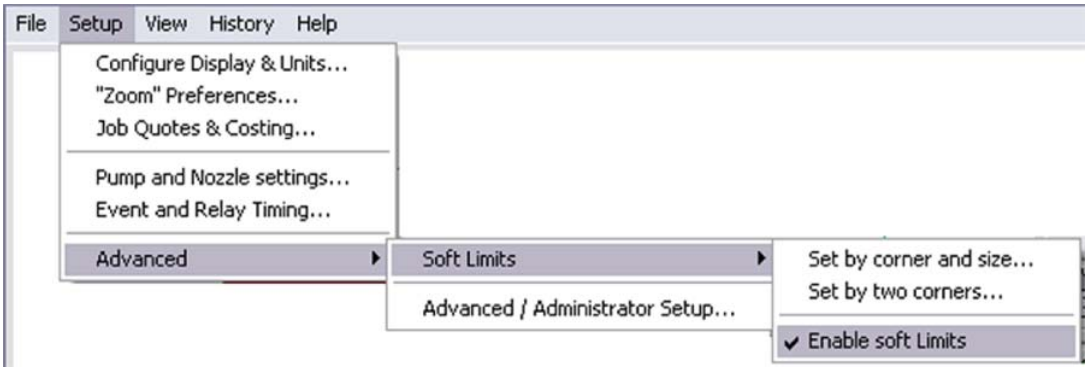


Figure 3-6

21. Position the nozzle between two table slats at 1 (.254 cm) to 1.5 inches (3.81 cm) above the water surface.

WARNING! ***Always use ear protection when operating the abrasivejet nozzle.***

22. Test operation of the nozzle at **Low Pressure**:
    a. Click the **Test** button to display the Test Pump and Nozzle options:

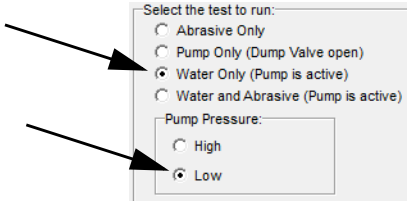


Figure 3-7

b. Select **Water Only** and **Low** pump pressure to begin the test (Figure 3-7).

c. When the jet stream begins, pinch the abrasive feed tube from the abrasive feed block on the abrasive valve (Figure 3-12) to block air flow through the feed tube. Then, examine the quality of the jet stream as illustrated below:

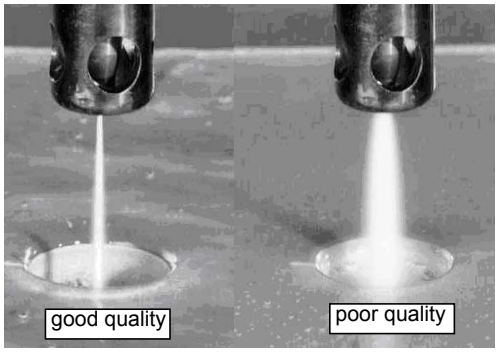


Figure 3-8

Note: *Always block the abrasive feed tube prior to visually inspecting the jet quality. Air from this tube interferes with the jet stream, making inspection difficult.*

d. Refer to Figure 3-9 to compare the effect that a damaged orifice and worn mixing tube have on the quality of a nozzle's jet stream.

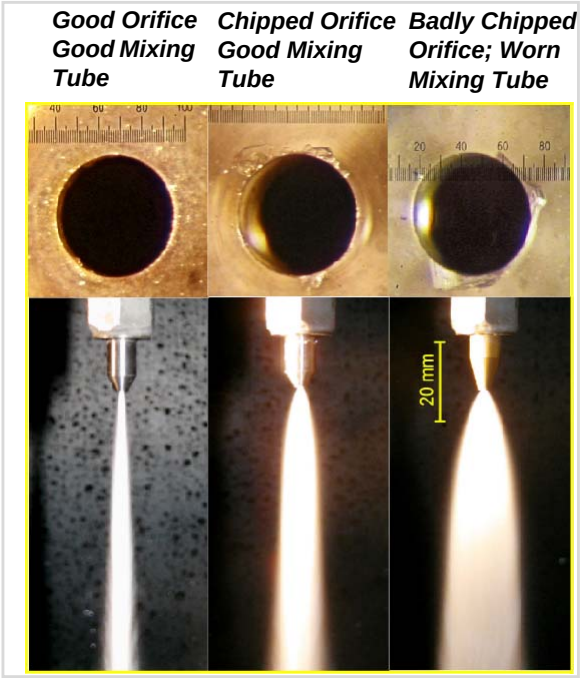


Figure 3-9

e. During the jet stream test, adjust the pump RPM to develop the desired low-pressure, then write down the pump RPM and PSI values from the pump LCD screen for the low pressure test.

f. Click **Stop** to end the low-pressure pump test:

Figure 3-10

23. Test nozzle operation at **High-pressure**:

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* (3.81 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 that 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. MAXIEM also offers an armor plating package as an optional accessory.***

a. If necessary, click the **Test** button to again display the nozzle test options.

b. Select **Water Only** and **High** pump pressure then click **Start Test** to begin the test.

c. When the jet stream begins, pinch the **abrasive feed tube** until blocked to examine the quality of the jet stream, verifying that it's straight and narrow as illustrated in Figure 3-9.

d. During the jet stream test, adjust **pump RPM** to achieve the desired high-pressure, then write down the pump RPM and **PSI values** from the pump LCD screen for the high-pressure test.

e. 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.

f. Click **Stop** to end the high-pressure pump test (Figure 3-10).

24. Test nozzle operation using **Water and Abrasive**:

a. If necessary, click the **Test** button to display the nozzle test options (refer back to Figure 3-7).

b. Select **High** and **Water and Abrasive** then click **Start Test**.

c. Verify an increase in the **sound level** and **stream diameter** from the abrasive flow.

d. Click **Stop** to end the water and abrasive test (Figure 3-10).

25. Measure the **abrasive flow rate**:

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

a. Remove the **abrasive feed block** from the abrasive valve cylinder (Figure 3-12) by pulling it straight back.

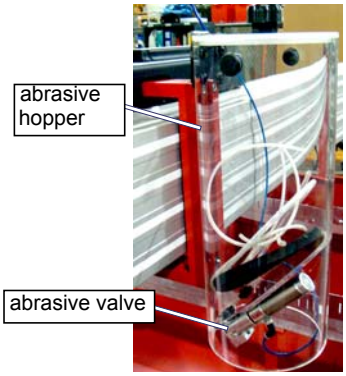
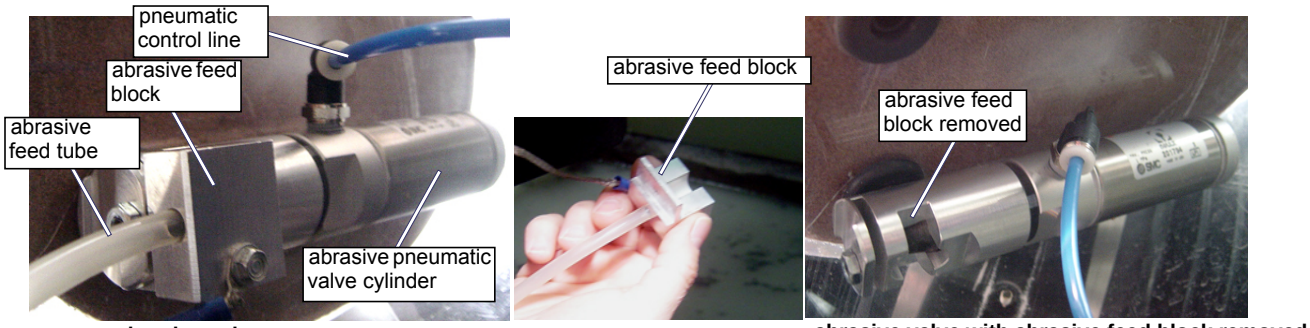


Figure 3-11



abrasive valve components **abrasive valve with abrasive feed block removed**

Figure 3-12

b. Place a container directly below the abrasive valve to catch the abrasive as it's released during the measurement flow.

c. Click the **Test** button to display the nozzle test options (refer back to Figure 3-7).

d. Click **Abrasive Only** then click **Start Test** to begin the abrasive flow.

Note: *By default, the abrasive flow automatically stops after one minute.*

e. 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!**

f. Replace the **abrasive feed block** by pressing it back into the abrasive valve.

26. Set the Adjustable Dump Orifice pressure ensuring it is within 1-2 Ksi, but not above the nozzle cutting pressure.

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 that the ADO be disassembled to unjam the stem.***

If the tapered stem is accidentally forced too far and becomes stuck, follow the instructions provided on page 3-22, Removing a Stuck Tapered Pin.

a. Power up both the pump and the MAXIEM Controller.

b. Remove the pump's top cover to access the adjustment knob on the ADO.

Figure 3-13

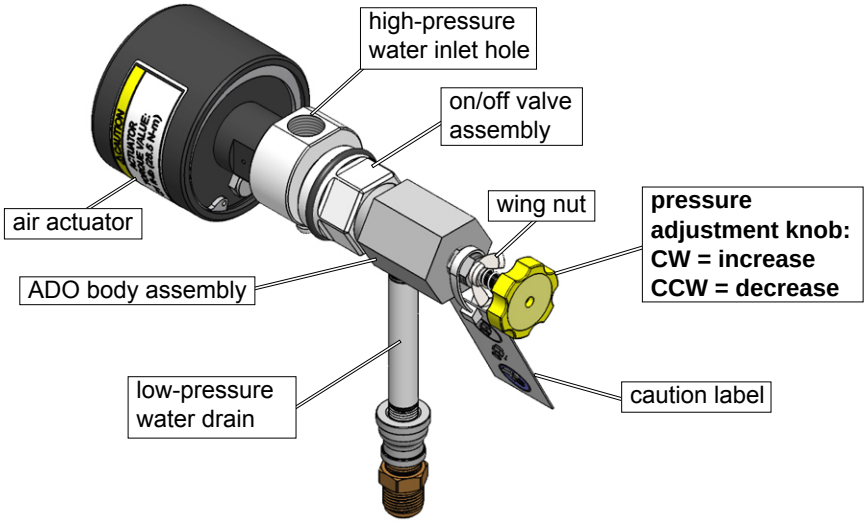


Figure 3-14

c. To ensure the valve stem is correctly positioned once the pump starts, first, screw the wing nut towards the knob until the spring makes initial contact with both the wing nut and knob (Figure 3-15).

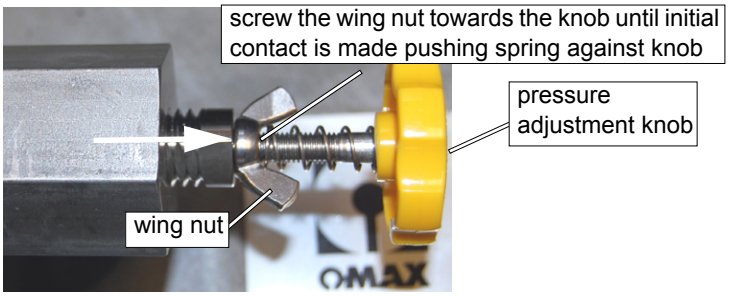


Figure 3-15

d. Second, screw the knob into the ADO body until the wing nut makes initial contact with the ADO body.

e. Hold the knob, preventing it from turning, and screw the wing nut back towards the knob, leaving approximately a 1/4th inch (0.635 cm) gap between the ADO body 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 ADO body 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.

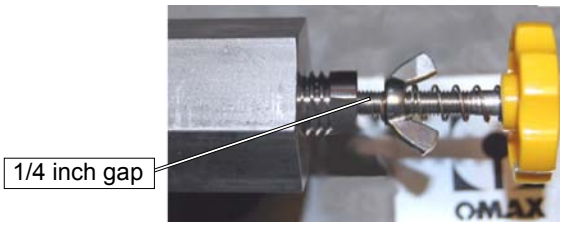


Figure 3-16

Caution: ***The safety valve may activate due to excessive pressure if the pump runs with the nozzle shut off and the ADO valve completely closed.***

f. Click the **Test** button and select **Pump Only (Dump Valve open)** and **High** pump pressure.

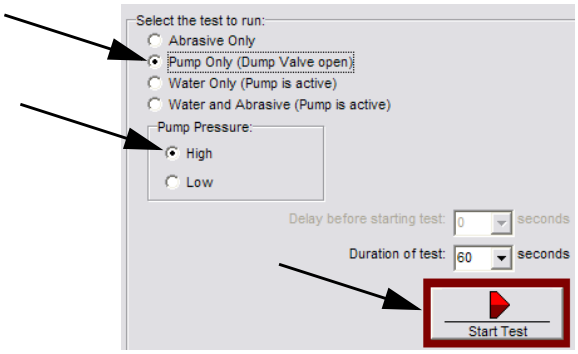


Figure 3-17

g. Click the **Start Test** button to activate the pump.

h. At the ADO, turn the Pressure Adjustment Knob (Figure 3-18) until the pressure indicated on the pump's control panel LCD is within 1 - 2 Ksi of the nozzle high-pressure valve.

Note: *A 3/16 inch Allen wrench inserted into the end of the knob will assist in fine tuning the ADO pressure adjustment.*

Figure 3-18

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 KSI below nozzle pressure.*

WARNING! ***Never continue unscrewing the adjustment knob until it's able to detach itself from the ADO body while the water is under pressure.***

i. Once the correct pressure is set, hold the knob in place to prevent it from rotating, then tighten the wing nut to lock the knob in position.

j. Click the **Stop** button (Figure 3-10) to halt the test.

k. Replace the pump cover.

l. Adjustment of the ADO pressure is complete.

Note: *The ADO pressure will require readjusting anytime a different sized orifice is installed in the nozzle, or a defective or worn jewel is replaced with a new one. It is recommended that this pressure be verified during machine startup.*

27. Verify the “Pump 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. Also, it is critical that the nozzle setup exactly match the nozzle installed on the machine. If not properly matched, poor cutting and frustration results.***

a. Click **Setup** in Make and select **Pump and Nozzle Settings...**:

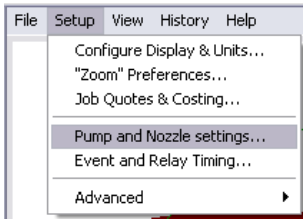


Figure 3-19

b. Correct any values being displayed that differ from those recorded when testing the MAXIEM machine.

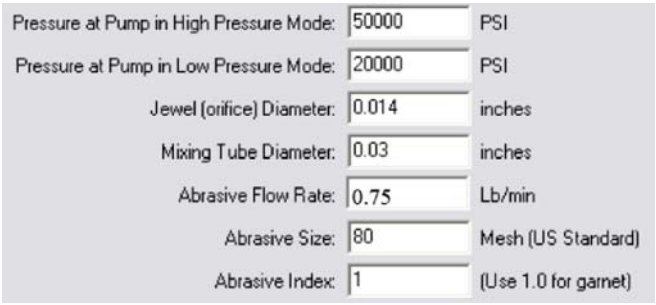


Figure 3-20

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

28. From **Setup**, click **Event & Relay Timing**. Make sure that the values displayed are correct for the machine and cutting situations. Click **OK** to save any changes made.

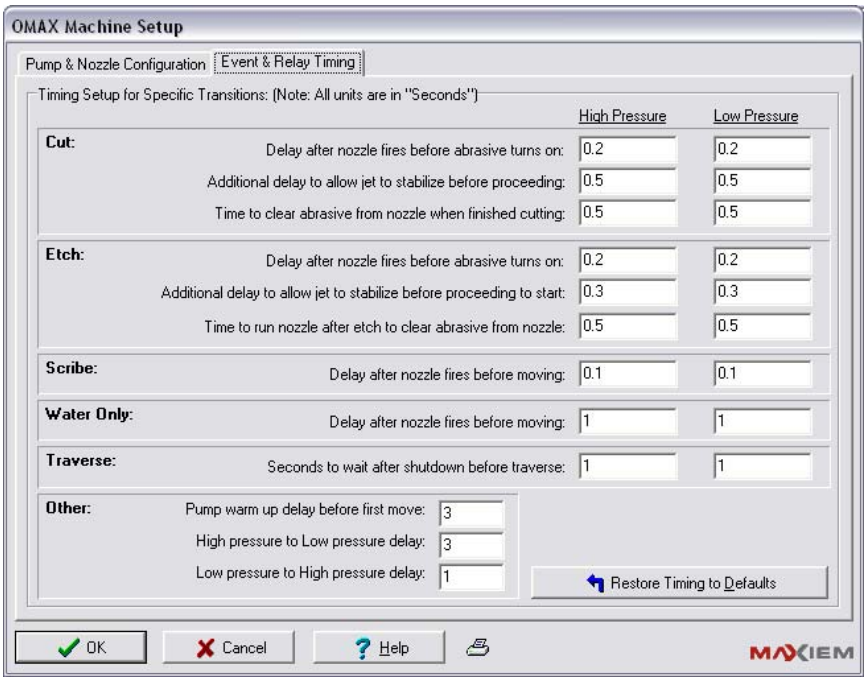


Figure 3-21

Note: *For determining values for Event and Relay Timing, it is best to start with the default values and then adjust these values to match your own requirements.*

Configuring the Make Software

1. Select the drawing for your part:
   a. Click the **Change Path Setup** button (or use **File/Open (Change Path Setup)** from the menu bar) and follow the path to where drawing file is stored.
   b. When located, clicking the **.ord file name** opens that drawing in the adjacent preview screen.

Note: *If the drawing was developed using another PC other than the MAXIEM table controller, unless networked, you must move it to the controller by copying it onto a USB memory stick. and inserting in into one of the USB ports on the MAXIEM monitor.*

2. From the same window previously opened by clicking **Change Path Setup** (step 1a above), enter the **Material Setup** values:

Figure 3-22 Example

Cutting the Material

1. Move the nozzle to an out-of-way area on the table that allows ample working room for the material to be placed and secured to the table.
2. Place the material to be cut on the slats and use adequate fixturing to keep the material flat and stable during cutting.
3. Position the nozzle to begin the cut and set the Path Start Home to zero:
   a. Place the nozzle above the material being cut, ensuring adequate material for the part.

Note: *The distance from path start is always zeroed automatically when Begin Machining is activated.*

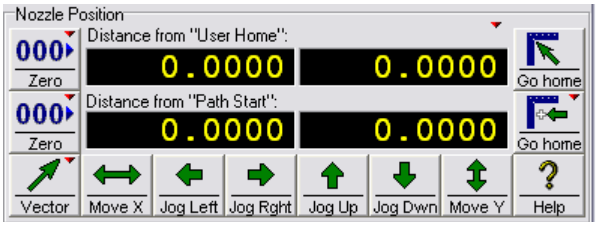


Figure 3-23

4. Set the nozzle standoff above the material at 0.040 - 0.060 inches (1.02 - 1.52 mm) and **zero** the Z-axis:

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

   a. Adjust the **nozzle standoff** at 0.040 - 0.060 inches (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.
   b. When adjusted, click **View/Show Z Coordinates** to display the Z Height Coordinates pop-up window:

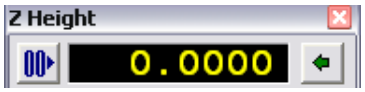


Figure 3-24

   c. On the **Z Height** display (Figure 3-24), click the **00>** button to set the Z Height coordinates at zero.

5. Conduct a dry run to verify the cutting path:
   a. Click the **Begin Machining** button to display the MAXIEM Path Control window.
   b. *Right-click* the **Start** button to display the options window.
   c. Click **Dry run at full (Rapid transverse) speed...** (or another speed of your choice) to initiate 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 muff or splash guard.
7. Lower the nozzle to its zero Z-axis coordinates (click the arrow on the right side of the Z Height pop-up display).
8. Begin cutting by clicking **Begin Machining**/**Start**.

Caution: ***Always remain near the MAXIEM during the cutting process. In the event of a serious problem, use the Emergency Stop switch to immediately halt operations.***

9. Once machining stops, close the MAXIEM path control window, raise the nozzle, rinse the abrasive debris from the cut material, and remove the cut part(s) from the machine.

MAXIEM Startup Check List

When starting the MAXIEM, 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 MAXIEM Waterjet.***

1. ❒ Main breaker box POWERED ON.
2. ❒ Air supply valve OPENED.
3. ❒ Water supply valve OPENED.
4. ❒ Charge Pump POWERED ON.
5. ❒ Open the charge pump water outlet valve and verify cooling water flows from the 3 white tank hoses.
6. ❒ Allow water to run for 15 minutes or until water temperature is ≤ 70º F prior to operating the pump at high pressure. Open water flow valve as needed.
7. ❒ Close the water flow valve when water reaches the operating temperature.
8. ❒ Table Controller main power disconnect SWITCHED ON (Figure 2-5).
9. ❒ Table Controller Green Power Switch PRESSED ON (Figure 2-6) before the PC boots; if not also press the Reset button.
10. ❒ Pump power disconnect switch turned ON.
11. ❒ Pump green power switch pressed ON,
12. ❒ Intelli-MAX Standard Make software STARTED.
13. ❒ Table AUTO HOMED to ensure that absolute home position is correct.
14. ❒ Soft Limits set and enabled.
15. ❒ Verify nozzle orifice and mixing tube size.
16. ❒ Nozzle POSITIONED between slats, 1 to 1.5 inches (2.54 - 3.8 cm) above the water level.
17. ❒ Nozzle low-pressure water test STARTED. Click “Test”, “Low”, and “Water”.
18. ❒ Straight and narrow jet stream VERIFIED while pinching the abrasive feed tube.
19. ❒ RPM and Pressure ADJUSTED and RECORDED from the pump keypad display.
20. ❒ Nozzle low-pressure test STOPPED.
21. ❒ Nozzle high-pressure test STARTED. Click “Test”, “High”, and “Water”.
22. ❒ Straight and narrow jet stream VERIFIED while pinching the abrasive feed tube.
23. ❒ RPM and Pressure ADJUSTED and RECORDED from the pump keypad display.
24. ❒ Inspect high pressure system (tubing, fittings, swivels, pump) for leaks.
25. ❒ Nozzle high-pressure test STOPPED.
26. ❒ Adjust ADO pressure as needed (page 3-11)
27. ❒ Water and Abrasive test STARTED. Click “Test”, “High”, and “Water & Abrasive”.
28. ❒ Increased sound level and stream diameter CONFIRMED.
29. ❒ Water and abrasive test stopped.
30. ❒ Verify abrasive type and size.
31. ❒ Abrasive flow rate MEASURED.
32. ❒ Abrasive added to hopper as needed.
33. ❒ Setup, Pump and Nozzle settings VERIFIED correct.
34. ❒ High- and Low-pressure values SET to match pump settings above.
35. ❒ “Event & Relay Timing” settings VERIFIED correct.
36. ❒ Cut kerf check part and adjust tool offset as needed.

You are now ready to begin machining.

MAXIEM Shutdown Check List

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 MAXIEM Waterjet.***

1. ❒ Nozzle POSITIONED between slats, 1 to 1.5 inches (2.54 - 3.8 cm) above the water level.
2. ❒ Nozzle high-pressure test STARTED. Click “Test”, “High”, and “Water”.
3. ❒ Pump RUN for approximately 20 seconds to clean and clear all abrasives, then test stopped.
4. ❒ Nozzle POSITIONED at desired location for shut down.
5. ❒ USB/other media REMOVED from MAXIEM USB ports.
6. ❒ Make software CLOSED.
7. ❒ Windows “Shut Down” CLICKED.
8. ❒ High-pressure pump POWERED OFF.
9. ❒ Table Controller shutdown VERIFIED (blank monitor screen, etc.).
10. ❒ Table Controller main power disconnect SWITCHED OFF (Figure 2-5).
11. ❒ Charge pump POWERED OFF.
12. ❒ Main water supply valve CLOSED.
13. ❒ Main air supply valve CLOSED.
14. ❒ Main breaker box POWERED OFF.
15. ❒ Clean machine.

The MAXIEM equipment is now properly shutdown.

Shutting Down the MAXIEM Equipment

1. Position the nozzle between two table slats at 1 (2.54 cm) to 1.5 inches (3.8 cm) above the water surface.
2. Allow the pump to run for approximately 20 seconds with water only to clean and clear all abrasives from the nozzle:

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.***

a. Click the **Test** button to display the Test Pump and Nozzle test options:

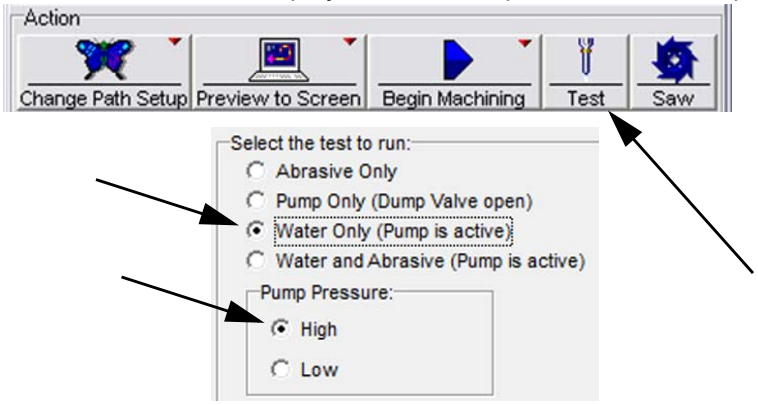


Figure 3-25

b. Select **Water Only** and **High** for pressure**,** then click **Test** Start to begin the jet stream.

c. After approximately 20 seconds, click **STOP** to halt the jet stream.

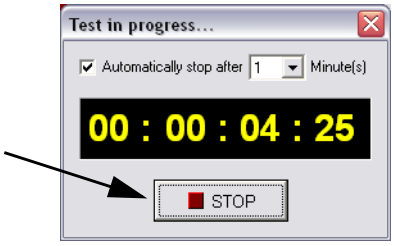


Figure 3-26

3. Move the nozzle to a table area where it will be out of the way during cleanup.
4. Wipe down the machine table and surrounding area, cleaning up any splashed water and abrasive material.
5. Remove any debris floating in the water.
6. Complete any shop-specific clean-up procedures.
7. Remove any USB memory stick that may still be in the USB port.
8. Close **Make** and all other software applications running on the MAXIEM controller.
9. Click the Windows **Start** button, select **Shut Down**, and verify that the computer has powered down.
10. Switch the pump power **OFF**.
11. Power the MAXIEM controller disconnect switch **OFF**.
12. Switch the charge pump **OFF**.
13. Turn the water supply valve **OFF**.
14. Turn the air supply valve **OFF**.
15. Disconnect the breaker box that provides main power to the MAXIEM equipment.

Operating the MAXIEM High-Pressure Pump

WARNING! ***When operating this equipment, always observe the safety precautions listed in Chapter 1 of this document. Failure to do so can result in bodily injury or death.***

Pump control is shared between the Make software (Remote operation) and the pump's keypad (Local operation). See Figure 2-10.

Preparing the Pump for Operation

Before starting the high-pressure pump:

1. Visually inspect 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.
2. Verify the oil level in the pump crankcase is sufficient for operation (3 quarts required).
3. Ensure the pump's cover lid and belt cover are in place and properly secured.
4. Ensure the nozzle and mixing tube are the correct sizes and installed properly.
5. Familiarize yourself with the location and function of the controls identified previously in Figures 2-6 and 2-9.

WARNING! ***Prior to starting the pump, verify everyone is clear of the high-pressure cutting nozzle.***

6. Open the building's inlet valve that provides water to the charge pump.
7. Power **ON** the main electrical disconnect switch.
8. Power **ON** the charge pump.
9. Open the water valve on the charge pump.
10. Open the flow valve on the pump to flush warm water from the charge pump.
11. Press the pump's **ON** switch.

Note: *Always run the charge pump for a few minutes following an initial power up to drain warm water from the pump. This flushes out the warmer water, ensuring that the seals are cooled prior to high-pressure pump operation.*

Caution: ***It is essential that cylinders surrounding the dynamic seals stay below 70 degrees F during high-pressure operation. Operating the pump at high pressures when seal temperatures are 80 degrees F or more dramatically reduces their useful life. Cylinder temperature will begin to rise immediately following a shutdown with the charge pump off. 80 degrees F could easily be reached during a prolonged shutdown. As a precaution following an extended shutdown such as during a lunch break, always run the charge pump for as long as it takes to lower the water temperature exiting from the charge pump cooling lines to that of the inlet water temperature prior to resuming cutting.***

Setting Pump RPM

The pump RPM determines cutting pressure and may be adjusted up or down using either the keypad's **arrow** buttons while the pump is in the **LOC** (local) mode or using the pump's High or Low knob adjustments (Figure 3-27) while the pump is in **REM** mode (remote) and **Make** is operating in its **Test** mode (Figure 3-7).

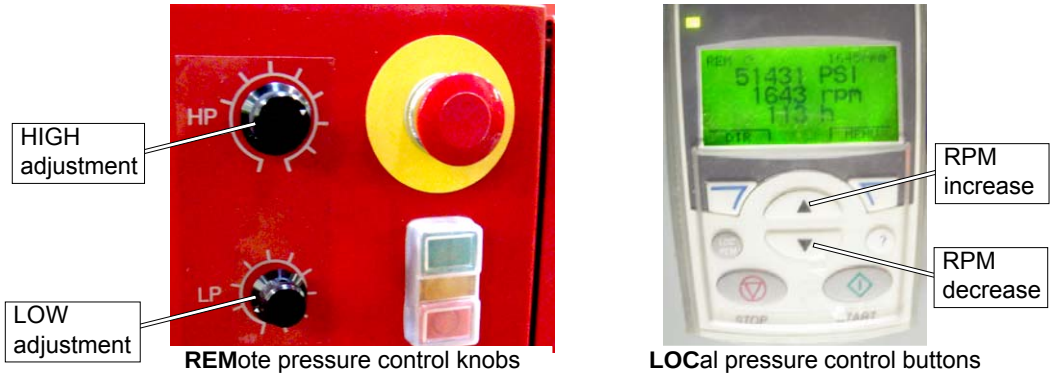


Figure 3-27

1. To adjust the pump RPM when in the **LOC** mode:
   a. Press the keypad's **LOC REM** button so that **LOC** appears in the keypad display's top, left-hand corner.

Note: *When in **LOCAL** mode, only the dump valve is opened. The nozzle can be activated only when in the REMOTE mode using the MAXIEM **Make** software. The **Make** software has no control over pump operation while the pump is in the **LOCAL** mode. For pump control from the **Make** software, place the pump in the **REMOTE** mode. Likewise, when in the **REMOTE** mode, the pump keypad has no control.*

   b. Press **START** on the keypad to start the pump.
   c. To increase the high-pressure value displayed on the keypad, press the keypad's **up** arrow.
   d. To decrease the high-pressure value displayed on the keypad, press the keypad's **down** arrow.
   e. When finished, press **STOP** on the keypad to shut down the high-pressure pump.
2. To preset the pump PSI value at the normal cutting pressure (high) or the piercing pressure (low), when in the **REM** mode:
   a. Ensure that the cutting nozzle is positioned between slats, 1 to 1.5 inches (2.54 - 3.8 cm) above the water level.
   b. Press the keypad's **LOC REM** button so that **REM** appears in the keypad display's top, left-hand corner.
   c. In **Make**, click the **Test** button (Figure 3-29) to display the **Test Pump and Nozzle** options:

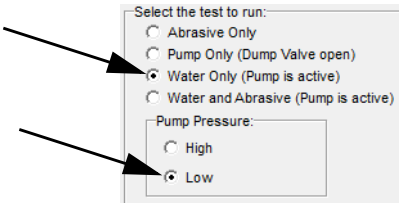


Figure 3-28

   d. 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.***

   e. Click the **Start Test** button to start the nozzle test in the low pressure mode.

f. Use the **LOW** pressure adjustment knob on the pump's front panel (Figure 3-27) 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 only by a signal from the controller software (Make) while the pump is in the REM mode.

g. Next, return to the Pump and Nozzle options and select **Water Only** and **High** pump pressure.

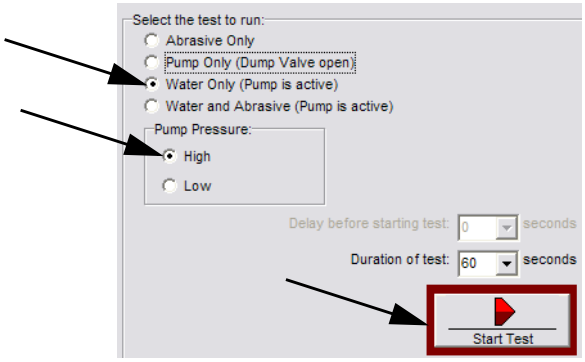


Figure 3-29

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.***

h. Click the **Start Test** button to start the nozzle test (Figure 3-29) in high pressure mode.

3. Use the **HIGH** pressure adjustment knob on the pump's front panel (Figure 3-27) to set the desired preset high pressure cutting pressure. The high pressure setting is the value that the pump normally returns to when started. It can be activated only by a signal from the controller software (Make) while the pump is in the REM mode.

Note: *Tests will run for one minute unless stopped sooner by pressing the displayed **Stop** button.*

Removing a Stuck Tapered Pin

If the tapered pin becomes stuck in the tapered seat:

1. Shut the pump down by locking 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 valve.
4. Rotate the yellow 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 pin.
5. Insert a pin (0.049 inches to 0.055 inches diameter) into the opening of the seat and using a small hammer, tap loose the tapered pin from the seat.
6. Reassemble the On/Off valve onto the ADO.

Stopping the High-pressure Pump

During normal cutting operation, the Make software automatically starts and stops the high-pressure pump as required. The pump can also be stopped using the pump's keypad when in the **LOC** mode and pressing the **Stop** button, and by pressing the **Pause** button located on the external Emergency Stop/ Pause switch box (see page 2-3).

The pump can be immediately stopped at any time by pressing either the **Emergency Stop** switch, located on the pump control panel, the MAXIEM controller, and the external Emergency Stop/Pause switch box (see page 2-3 and Figure 2-6 for locations).

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. The pump cannot be restarted following an emergency stop until the emergency stop switch is returned to its original position.***

To recover following an emergency stop, manually pull the Emergency Stop switch back to its original position, reset the MAXIEM by pressing the reset button, and re-establish machine's limits and auto-home positions. See page 3-5 for instructions.

Troubleshooting the MAXIEM Waterjet

The following lists most problems encountered with MAXIEM operation. Possible causes for each problem are provided with the most likely causes listed first. If you continue having a problem with the MAXIEM pump after following these procedures, contact MAXIEM Customer Service.

Problems

Refer to Solutions on page 3-25 to match a Corrective Action number listed below with the steps suggested to correct specific problems.

Condition and Possible Causes	Corrective Actions
High-pressure Pump Fails to Start	
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**
The "Fault 14, Ext. Fault 1" error message appears on the keypad display.	**4**
"Emerg Stop" message.	**5, 33**
Error code "2023".	**34**
Undefined error code.	**6**
Abrasivejet Nozzle Doesn't Move	
A soft limit has been reached.	**7**
The nozzle collided with the cutting material and stalled.	**8, 15**
"Baby Sit Triggered" Message	
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**
The mixing tube is excessively worn and unable to form a perfect jet stream.	**13**
The jewel that forms the jet is chipped, dirty, or out-of-tolerance.	**14**
The abrasive flow is 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 standoff between the abrasivejet nozzle and the material is excessive.	**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**
Standoff between the abrasivejet nozzle and the material being cut is too high.	**19**
Abrasive flow is stopped or has been reduced by the presence of dirt or wet abrasive.	**15**
Mixing tube has worn excessively and is 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 is 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 abrasivejet 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**
Keyboard or Mouse Doesn’t 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 Comes Up the Abrasive Tube	
On/off valve is leaking.	**29**

Mixing tube in the abrasivejet nozzle is plugged.	**22**
Standoff 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**
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 is stopped or has been reduced by the presence of dirt or wet abrasive.	**15**
Standoff 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 is stopped or has been reduced by the presence of dirt or wet abrasive.	**15**
Jewel orifice is plugged by foreign material in the water line.	**23**
Standoff 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 Spurts 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 3-23 for a list of problems encountered.

Corrective Action	Description
1	• Verify Charge Pump On/Off switch is in its ON position. • Verify Charge Pump's AC power source. • Verify Pump's On (Green) 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 switch may be defective. If the upstream gauge does not exceed about 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, have the Filter Cartridges replaced.
4	A "dead head" condition caused by the nozzle tip being plugged blocking off the water flow, an ON/OFF valve failure, colliding with a foreign object, or any other situation that halts the flow of water through the nozzle. ADO pressure higher than nozzle pressure. Remove the water flow restriction.
5	• High-pressure Pump power On/Off switch OFF. • Emergency stop switch was pushed in. • Reset the emergency stop switch by pulling it out. Whenever the emergency stop switch is used, it will be necessary to redefine the values for the machine's soft limits and homes.

6	Variable Frequency Drive Fault. Contact Customer Service.
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: • Machinability — 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
12	• Many abrasives do not cut as well as garnet, and the machinability 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" (0.13 mm), the mixing tube is near the end of its useful life for precise cutting.
14	Clean or replace the jewel assembly.
15	Disassemble plugged items, blowing them clean and dry with an air hose. Replace nozzle abrasive hose 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 standoff of 0.040" (1.02 mm) to 0.060" (1.52 mm) is generally recommended. Typically, lower standoff distances decrease the amount of taper, but a lower standoff increases the likelihood of nozzle plugging.
20	Change the orifice assembly first. If the jet remains elliptical, change the mixing tube.
21	Measure the pressure to see if it is below specification. Follow the 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 disassemble the nozzle and clean it, or replace the mixing tube.
23	Remove the nozzle and flush the lines. Replace the jewel assembly with a new one.
24	Verify the mouse and keyboard connections are firmly inserted.
25	Ensure the USB cables are plugged in firmly. Reboot the table controller.

26	Simply re-installing 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	Check the floating device to ensure it contains an adequate amount of the bacteria-killing chemicals supplied with the MAXIEM. **Note:** Never use chlorine products if using the EBBCO (closed loop system) as it will destroy the filters.
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	Emergency Stop switch activated. Pull Emergency Switch back into its run position and press the Reset button (Figure 2-6).

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 that 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!

MAXIEM 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 MAXIEM. The most critical of these nuts and bolts are identified in the photos below. These must never be loosened without having the required instruments available to ensure correct table alignment when retightened. **Always** contact MAXIEM technical support if you are unsure about the disassembly of any carriage components.

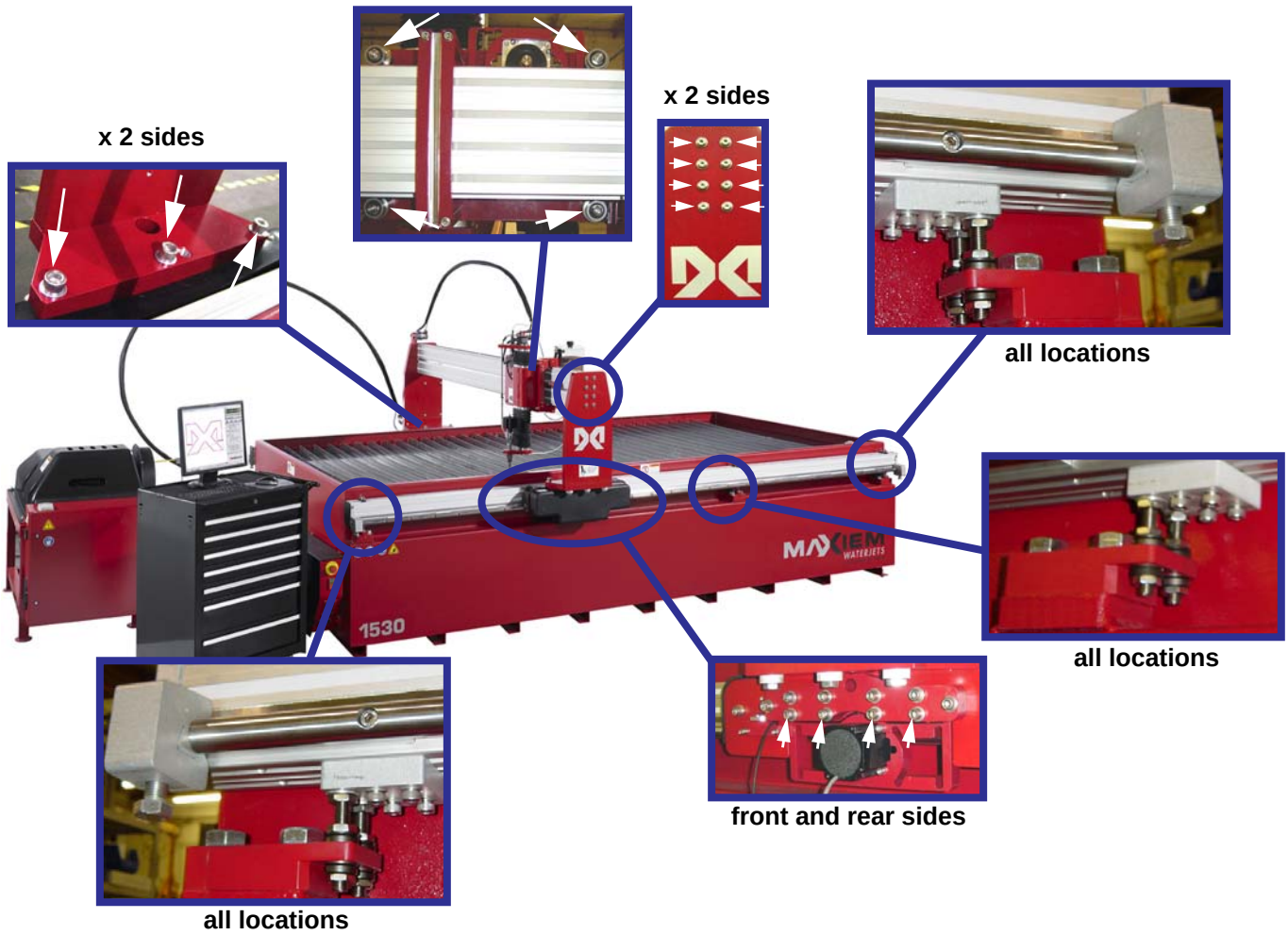


Figure 4-1

Tools Required for Pump and Table Maintenance

Tool Required	Nozzle Assembly	Dual On/ Off Valve	MAXIEM Pump	MAXIEM Table
Open End Wrench				
1/4"		X		
½"			X	
5/8"			X	
9/16"			X	
11/16"	X			
13/16"		X	X	
7/8"			X	
1"	X	X	X	
1-1/4"	X			
1-1/2"		X	X	
Crow's Foot wrench				
5/8"			X	
¾", 3/8" drive			X	
1-1/8"		X		
Sockets				
15/16" (24 mm); ½" drive			X	
Ratchet Wrench				
½"			X	
Breaker Bar				
½" drive			X	
3/8" drive			X	
Torque wrenches				
175 ft.-lb. (237 N-m)			X	
250 in.-lb. (28.2 N-m)		X	X	X
100 ft.-lb. (136 N-m)		X	X	
Allen Wrenches				
3/32"			X	
3/16"			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	

Tool Required	Nozzle Assembly	Dual On/ Off Valve	MAXIEM Pump	MAXIEM Table
Small flat-blade			X	
3/16" 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
MAXIEM Special Tools				
Check valve removal tool			X	
Removal/installation tool			X	
0.124" diameter anti-rotation pin, (1/8" x 2-3/4")			X	
Spanner wrench P/N 304512				X
Seal removal tool				X
Inspection Tools				
Magnifying glass (or microscope)			X	
1-inch (2.54 cm) micrometer			X	
Other				
Arbor Press	X		X	
Soft-jawed Vise			X	X
Soft-blow mallet			X	
Propane torch			X	
Grease gun			X	X
Scale for weighing abrasive flow			X	
Ultrasonic cleaner			X	
10" crescent wrenches			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 the 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.

Note: *If several fittings are to be assembled, placing a dime-sized amount of Blue Goop onto a clean, disposable surface.*

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 4-2

Assembling the UHP Fitting

Caution: ***Always use two wrenches when torquing UHP Fittings!***

1. After the tubing and body have been properly coned and threaded, slip the **gland nut** onto the **tubing**.
2. Screw the **collar** onto the threaded end of tubing, observing the following *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.

3. Apply a small amount of **Blue Goop** to the **gland nut threads**.
4. Insert the **tubing** into the **body cone**.
5. Screw the **gland nut** into the connection until finger-tight.

6. Finally, tighten the **gland nut** (use two wrenches) to its specified torque value (see Table 4-1).

Description	Torque Value
1/4" tube, coning and threading, 60 Kpsi	25 lb-ft, 34 N·m
3/8" 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

Table 4-1

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 tubing 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. An injury and/or a damaged system component could result.***

MAXIEM Pump and Table Maintenance

WARNING! ***When preparing your equipment for maintenance and service, ensure standard lock-out/tag-out practices and procedures be implemented that isolate the equipment from all energy source(s). Turn system power OFF at the main AC disconnect. Shut down the water and air supplies at the mains. Bleed all air from the system by opening the air hose.***
All electrical and maintenance work described in this chapter should be undertaken only by qualified service personnel. Always read and follow all safety instructions presented in this manual.

General Maintenance Activities

Task	Frequency
Pump Power-end Maintenance	**MAXIEM Pumps**
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 temp., 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
Inspect and adjust tension or replace belt	Periodically inspect, adjust tension, and replace as needed
Water filtration	
Change water filters	Whenever the difference in pressure between the inlet and outlet filter gauges is equal to, or larger than 20 psi.
Change the last chance nozzle filter	Weekly or more frequently if needed.
Wet-end Maintenance	
Pump Rebuild	**M20, M30** Rebuild every 500 hours, alternating between Minor and 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
Electric Motor	
Lubricate the ball bearings	5000 hours of service/year - every 3 years Continuous service - each year Seasonal (6 months + idle) - each year beginning of season Continuous High Ambient Temp - every 6 months Dirty or moist locations - every 6 months High vibrations - every 6 months
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 deadhead is a clogged DUMP valve orifice. Rebuild the DUMP VALVE and replace the orifice.
Rebuild Safety Valve	When leaking occurs. Replace if the safety valve continues to leak after rebuild.
Rebuild Adjustable Dump Orifice assembly	When cold water leaking occurs at the adjustable orifice (dump valve) when the nozzle is running.

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). Replace the O-rings as needed based on wear. Lubricate the O-rings with Lubriplate.
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). Replace the O-rings as needed based on wear. Lubricate the O-rings with Lubriplate.
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 is dripping 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)
High-pressure lines	Replace if damaged or if continued leaking occurs. Do not try to repair!
High-pressure fittings	Replace if damaged or if continued leaking occurs. Do not try to repair!
Rotate the nozzle mixing tube 90 degrees	After every 8 hours of cutting.
PC Controller	
Clean Keyboard and Mouse	As needed
Clean monitor screen	As necessary for sharp viewing
Reboot PC Controller	Daily
Run Windows Defragmenter program	Monthly
Update OMAX Software	When updates are released by OMAX
Replace CMOS battery in the PC Controller	as needed (normally will last approximately 5 years or more)
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 the OMAX Solids Removal System (SRS)
Add anti-bacterial chemicals to the tank water (controls tank odor and bacteria growth)	Add anti-bacterial chemicals if needed to control tank odor. *****Do not add to the tank if using a Closed Loop System*****
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 strip	Daily or as needed to maintain smooth operation

Rotate/replace Nozzle Mixing Tube	Rotate 90 degrees (one quarter turn) every 8 hours of cutting to even wear. Replace as needed.
Clean Nozzle orifice (or the whole nozzle body if using the MAXJET5i)	Clean the jewel/nozzle orifice assembly once a week minimum to prevent mineral buildup in the jewel assembly.
Abrasive tubing (hopper to nozzle)	Inspect weekly, replace as needed
Rebuild the abrasivejet nozzle* *If using the MAXJET5i Integrated Diamond Nozzle, replace the whole nozzle body – do not rebuild!	As required to maintain cutting quality.

Flush Machine After Maintenance

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

1. Remove both the nozzle assembly and final filter from the Z-axis.
2. Position the Z-axis about 4-5 inches 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. Open Make.
4. In the main menu, select **File**/**Open**.
5. Right-click in the white space to open your permanent bookmarks.
6. Left-click **OMAX Sample files** (for all users).
7. Select **Machine_Diagnostic_Files**.
8. Scroll down the list, select **CycleTest_NoAbrasive_100_Cycles.ord**, and click **OK**.
9. Click **Begin Machining** then click **Start**.
10. Inspect the system for leaks and repair as needed.
11. Replace final filter and nozzle components.
12. Conduct a water only, low-pressure and high-pressure test, again inspecting for leaks and repairing any found.

Belt Maintenance

The heavy-duty belt connecting the MAXIEM 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's cover lid:

Figure 4-3

4. Take the belt cover guard off by removing the 12, 6mm screws (Figure 4-3).

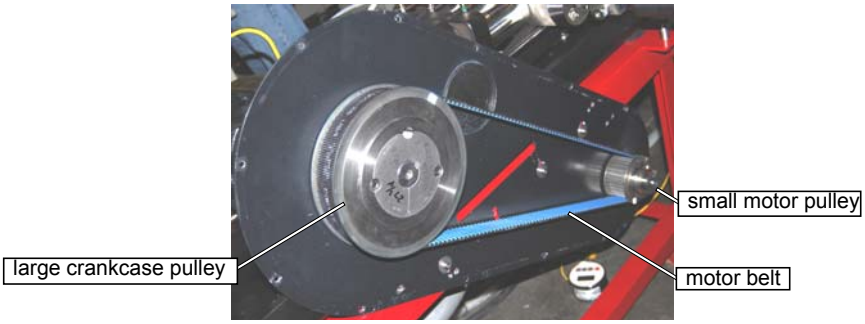


Figure 4-4

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 between the large and small pulleys to verify proper deflection with the specified force applied:

   The belt should deflect 1/4" - 5/8" (6.5 -16 mm) when pushed with a force of approximately 34 - 37 pounds (15 - 17 Kg) midway between the pulleys. If the belt deflects more or less than 1/4" - 5/8" (6.5 -16 mm) when pushed, the belt may require its tension adjusted or replacement. Contact MAXIEM 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

Note: *These greases can be mixed.*

To lubricate the motor's ball bearings:

1. Disconnect the pump's AC power source.
2. Access the shaft-end of the motor (refer to Figure 4-5):
   a. Remove outside belt guard cover.
   b. Remove inside back plate and shaft guard.
3. Locate grease fittings located on each of the motor ends.
4. Remove pipe plugs located opposite the grease fittings.

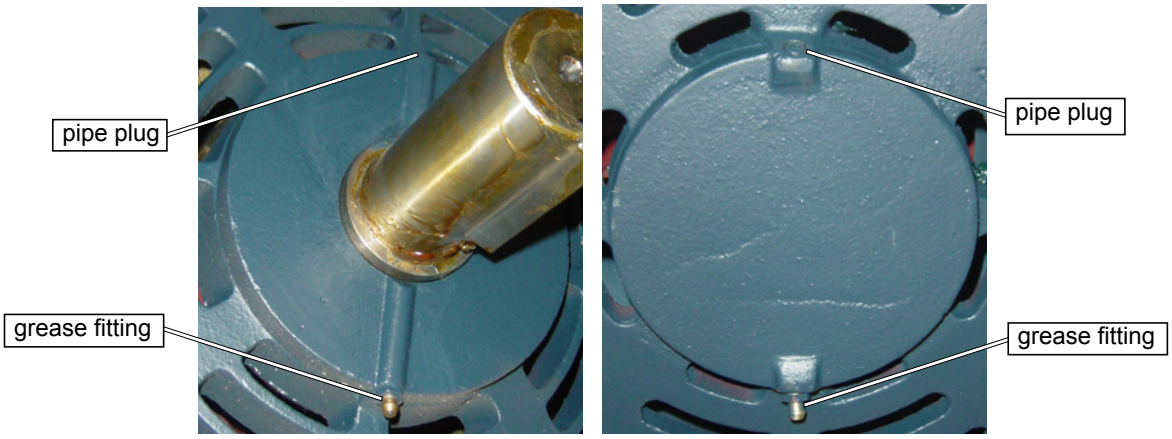


Figure 4-5

5. Wipe the tip of each grease fitting clean and connect the grease gun.
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's cover lid.
10. Run motor for 20 minutes before replacing the pipe plugs.

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.

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 three quarts (2.8 liters) of oil.

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

To change oil:

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

4. Remove crankcase drain plug.

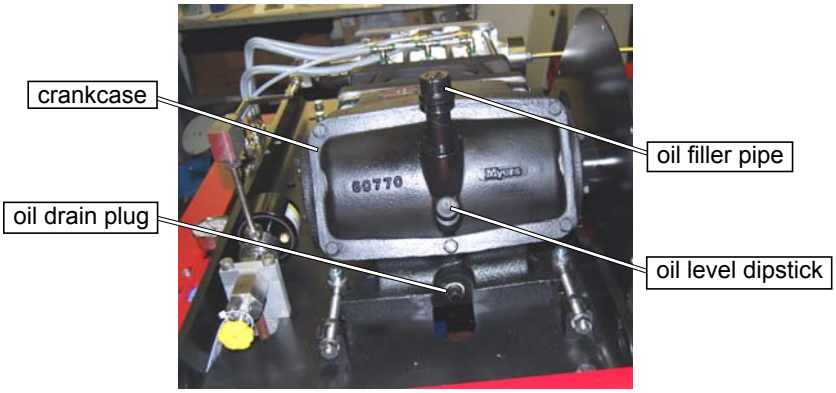


Figure 4-6

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 drain plug.
7. Fill correct amount of oil through the filler pipe.
8. Remove the oil level dipstick and verify correct amount of oil was added.

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

9. When you replace the **dipstick**, verify the following:
   a. The **O-ring sea**l 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 (see below).

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

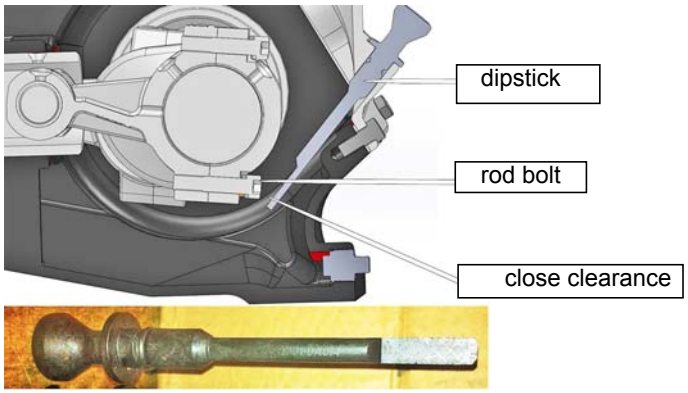


Figure 4-7

10. Replace filler pipe cap.

11. Replace pump cover lid.
12. Always dispose of discarded oil according to your local environmental regulations.

Maintain the Water Filtration System

Proper maintenance of water filters in your low-pressure water system will directly impact performance of your MAXIEM machine.

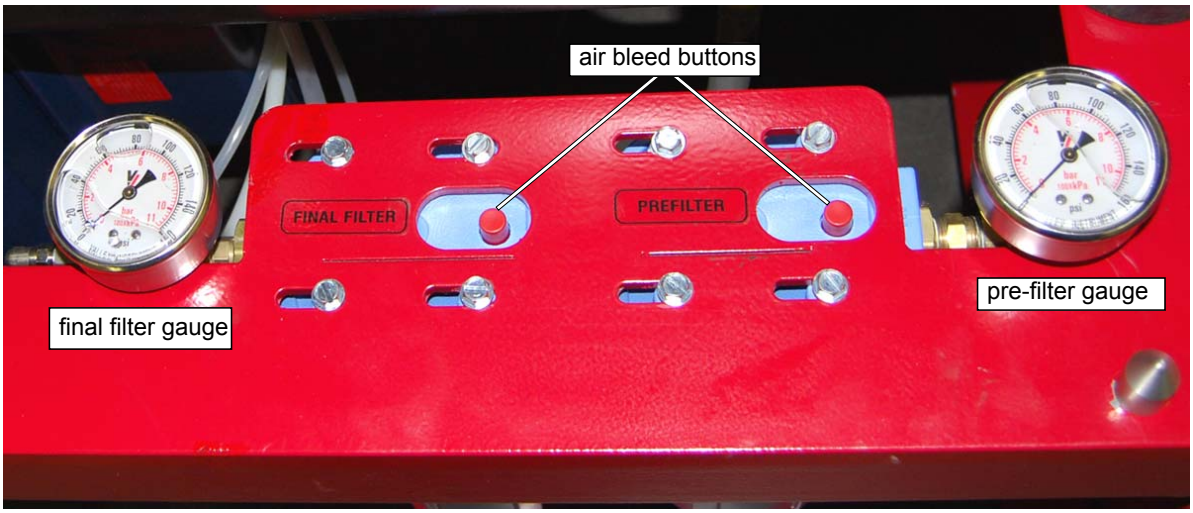


Figure 4-8

How the low pressure water system filtration works:

1. Water from your local source is piped into your building and is plumbed to the MAXIEM Charge Pump (Figure 2-11).
2. When the Charge Pump is turned ON, water from the charge pump is fed to the two 10” filters in the pump cabinet (Figure 4-9).

Note: *The pre-filter gauge (Figure* 4-8*) reads the pressure of the charge pump before the filters (pressure should read higher than 75 psi).*

3. Water travels from the charge pump to the high-pressure pump’s pre-filter (1 micron), through the 2nd final filter (.45 microns), and then to the high-pressure pump.
4. The final filter gauge reads the pressure after water has flown through both filters.

Note: *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.*

Preventing problems in the low-pressure water system:

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.

This situation can be prevented by following these suggestions for filter maintenance:

- When one filter requires replacement, change both filters.
- If pressure difference between the gauges is more than 20 psi when running the pump at high RPM, change both filters. Record time between all filter changes.

Note: *If problems with your water supply are suspected, send a sample of water from the charge pump to OMAX for a water test. Take the sample after running the pump for approximately 20 minutes. This sample will let you know if additional water treatment may be required.*

Change Water Filter Cartridges

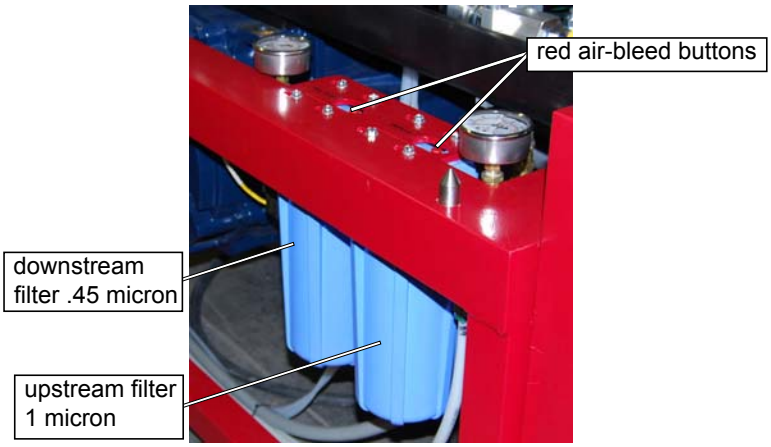


Figure 4-9

To replace water filter cartridges:

1. Position waterjet nozzle in a safe location, or remove the nozzle.
2. Turn OFF charge pump.
3. Remove pump's cover lid.
4. Unscrew each filter housing, using wrench provided.
5. Remove and discard filter elements.
6. Wash and rinse filter housings to remove all sediment and coatings from inside the housing.
7. Rub a thin coating of oil (Lubriplate or equivalent) on the ends of the coarser 1 micron filter element. Install it upstream. Reinstall the upstream filter housing.
8. Rub a thin coating of oil (Lubriplate or equivalent) on the ends of the finer 0.45 micron filter element. Install it downstream. Reinstall the downstream filter housing.
9. After replacing the two elements, turn ON **only** the charge pump.
10. Hold down the red buttons on top of the filters next to the pressure gauges (Figure 4-9) to bleed air from the filters.

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

11. Turn OFF charge pump.
12. Replace pump cover lid.
13. Reinstall nozzle.
14. Verify pressure differential at pump high RPM.

Rebuilding the Safety Valve

The safety valve in the MAXIEM pump activates to prevent an excessive build up of water pressure in the system plumbing. An activated valve should reseal itself, but could begin to leak after resetting itself a number of times. When leaking occurs, rebuilding the safety valve using a new ball and seat is required.

WARNING! ***Never attempt to adjust the safety valve, doing so creates a safety hazard!***

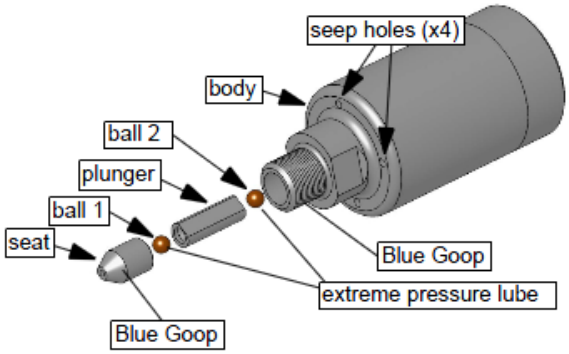


Figure 4-10

1. Use two 1" open end wrenches to unscrew the safety valve from the tee fitting.

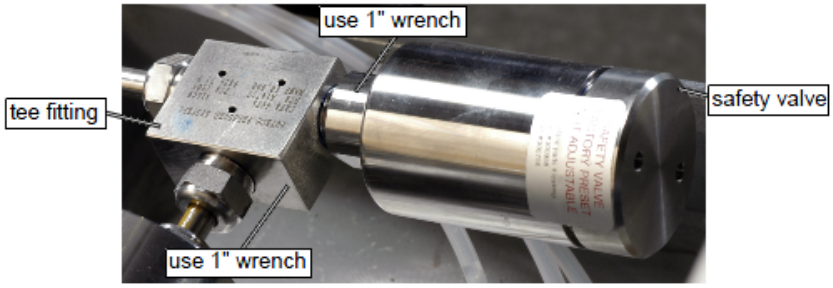


Figure 4-11

2. Remove and discard the two ceramic balls and seat (Figure 4-10).
3. Clean the plunger and safety valve body with water, using air to flush the water out of the spring chamber.
4. Spray some LPS lubrication into the holes and blow out with air to prevent rusting of the valve.
5. Apply a light film of Blue Goop to the sealing surfaces on both ends of the seat and the threads of the safety valve.
6. Apply a thin coating of extreme pressure lubrication (P/N 202496) on the two ceramic balls.
7. Stack the parts together (refer to Figure 4-10) and screw the assembled body into the tee fitting by hand.
8. When screwed in as far as possible by hand, torque the body to the tee fitting using the 1" open end wrench on the tee fitting and the 1" crows foot and torque wrench on the Safety Valve (refer to Figure 4-11). Tighten to 50 - 75 foot pounds.
9. Lower the RPM at startup for a few minutes to ensure no pressure spikes occur that will fail the valve again.
10. With the pump running at high pressure, inspect the safety valve closely for any signs of water leakage.
11. Correct all leakage problems before continuing.

MAXIEM Table Maintenance

WARNING! ***All table maintenance activities must be performed by MAXIEM qualified personnel.***

Clean X and Y Rails

X and Y rails should be cleaned/wiped down daily to maintain uninterrupted X and Y movement. To clean, spray non-abrasive cleaner onto a rag and wipe down the rails and wheels. Wipe off any excess moisture with a dry rag.

Caution: ***Never spray cleaner onto the rails directly as the cleaner may come in contact with the magnetic encoder strip, compromising the sealant on the strip.***
Never oil or lubricate the rails as this may cause the wheels to slip on the rails during operation.

Clean Magnetic Encoder Strips

The magnetic encoder strips should be wiped down daily with a clean, damp rag to prevent uninterrupted signals.

Caution: ***Never use any type of cleaner on the magnetic encoder strip as this can compromise the strip's protective sealant.***

Z-axis Lubrication

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

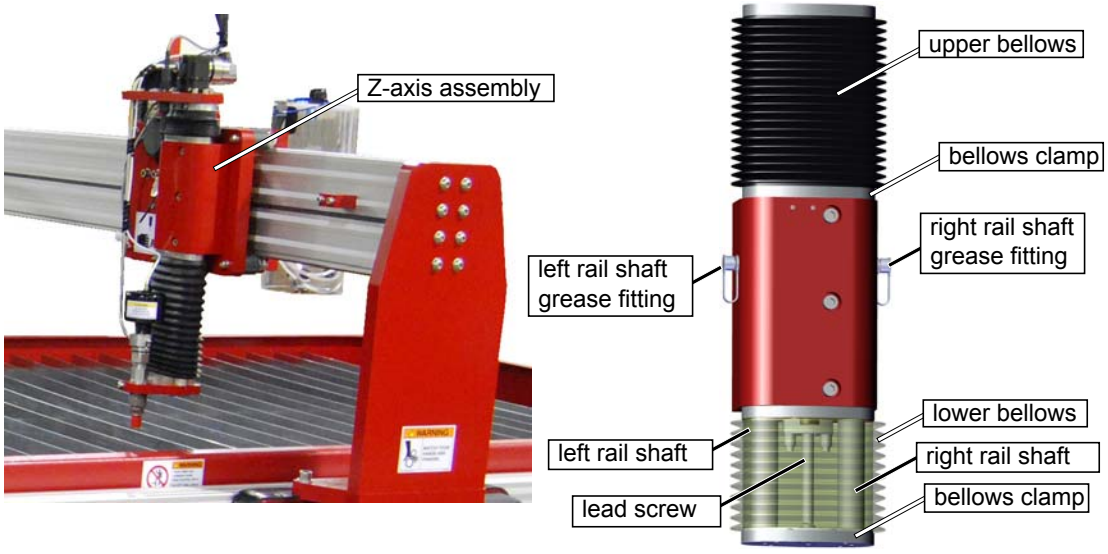


Figure 4-12

Lubricating 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 fittings.

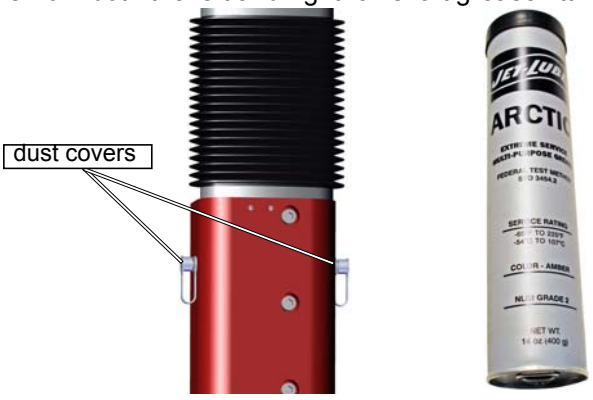


Figure 4-13

4. Attach a grease gun filled with **Arctic Extreme Service Grease** to each of the rail shaft grease 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 4-17). Do confuse the two types!***

5. Wipe off excess grease from the two grease fittings and replace the two dust covers (Figure 4-13).
6. Loosen the two 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 bottom bellows and lightly apply a thin grease coating to the bottom 2-3 inches of each rail shaft using **Arctic grease**.

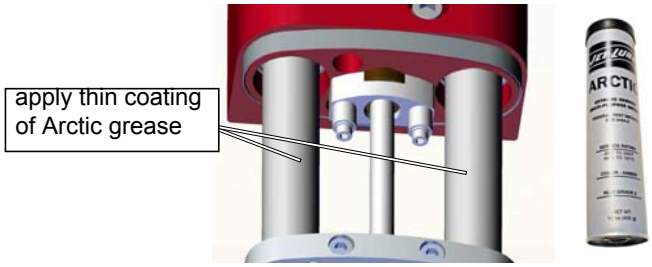


Figure 4-14

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 shafts using **Arctic grease**.

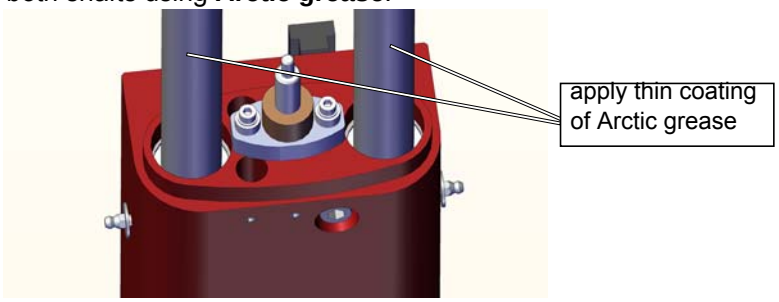


Figure 4-15

Lubricating the Lead Screw

9. Lift bottom bellows 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.

Caution: ***Grease required for lead screw lubrication is not the same as the Arctic grease used for the two rail shafts (see Lubricating Rail Shafts, page 4-15). Do not confuse the two types!***

Note: *Jet Lube 550 grease, previously used to grease the Motorized-Z, Tilt-A-Jet, and A-Jet Z-axis lead screws, is being replaced by Jet-Lubes synthetic moly grease, P/N 309325, effective immediately. Customers operating in extreme conditions will benefit from the fully synthetic JetLube TempGuard grease. Begin using the synthetic moly grease at your next scheduled lubrication, or earlier if instructed by Technical Support. The synthetic moly grease is compatible with Jet Lube 550. For best results, clean off excess Jet Lube 550 grease before applying the new Synthetic Moly grease.*

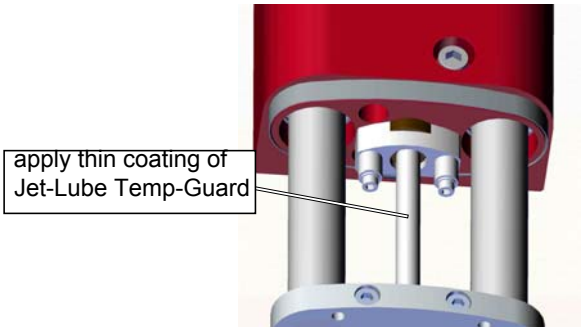


Figure 4-16

10. Lift top bellows 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.

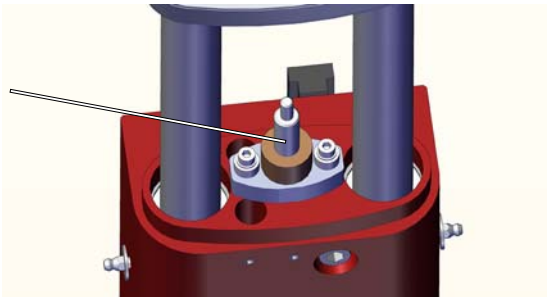


Figure 4-17

11. Pull both bellows down and tighten each clamp securely to its Z-axis mounting surface, ensuring each bellows is fully mounted and unable to slip off during operation.

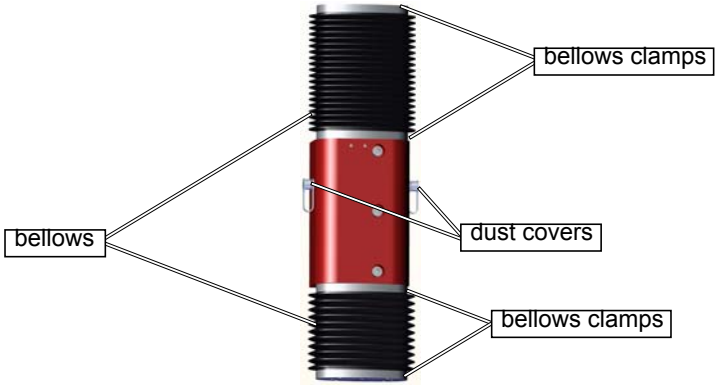


Figure 4-18

12. Move Z-axis assembly up and down over its full operating range a few times to distribute grease evenly along screw threads and rails.

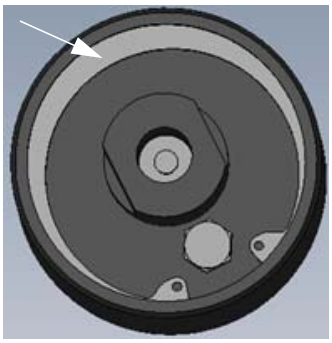
Lubricate the On/Off Valve Air Actuator O-ring

It is recommended that the O-rings be inspected on startup and on a weekly basis. Replace the o-rings as needed based on wear. Lubricate the o-rings with Lubriplate. If during weekly inspections, everything appears to be well lubricated, inspection/lubrication of the O-ring can be done on a two week basis. An increase in lubrication time will be required for high cycle machines.

To lubricate the air actuator O-ring for the nozzle and ADO:

1. Remove the actuator assembly.

2. Remove the actuator snap ring.



Caution: ***Always use the proper snap ring removal tool!***

3. Remove the actuator's internal components.

4. Inspect the O-rings for damage and replace if necessary.
5. Lubricate the O-rings with Lubriplate.
6. Re-install the actuator's internal components.
7. Re-install the snap ring.
8. Place the actuator back on the nozzle or ADO.
9. Cycle the valve to verify smooth operation.

Software Updates

Software updates are available from the MAXIEM Customer Support Web site at www.support.maxiemwaterjets.com/support. Requires a user name and password, which you can obtain by registering on the MAXIEM website.

Caution: ***Do not manually uninstall the current version of your MAXIEM software before successfully installing its replacement. You may lose valuable history and settings files, causing your MAXIEM Waterjet to make substandard parts. Run the installation program for the new software to install it.***

Consumable Parts

This section identifies consumable parts and accessories for the MAXIEM that wear out or otherwise need replacement on a variable basis during normal system operation.

Refer to assembly drawings provided with your MAXIEM for part numbers specific to your model. For assistance in ordering consumable parts, contact MAXIEM Technical Support.

Part	Description	Reference Number
MAXJET®5 Nozzle Assembly	For nozzle parts and their individual part numbers, refer to the MAXJET 5 Nozzle Assembly drawing included with your MAXIEM documentation.	400585
Filters	10" (25.4 cm) Cartridge, Fine, 0.5 micron, Charge Pump Pre-filter	
	10" (25.4 cm) Cartridge, Fine, 0.2 micron, Charge Pump Pre-filter	
	Filter/Seal Assembly with O-ring	
	Air Filter, bottom of pump enclosure	
	Filter/Seal Assembly, Nozzle Assembly Last Chance Filter	
Miscellaneous		
	Table Slat for MAXIEM models	
	Tubing, Abrasive feed, 1/4" OD x 3/16" ID (0.64 cm x 0.48 cm)	
	Tubing, Abrasive Feed, 1/8" ID x 3/16" OD (0.32 cm x 0.48 cm)	
	Nozzle Splash Guard	
	Garnet, 80 Mesh Abrasive HPX, 50 LBS (22.7 kg)	

Additional items recommended:

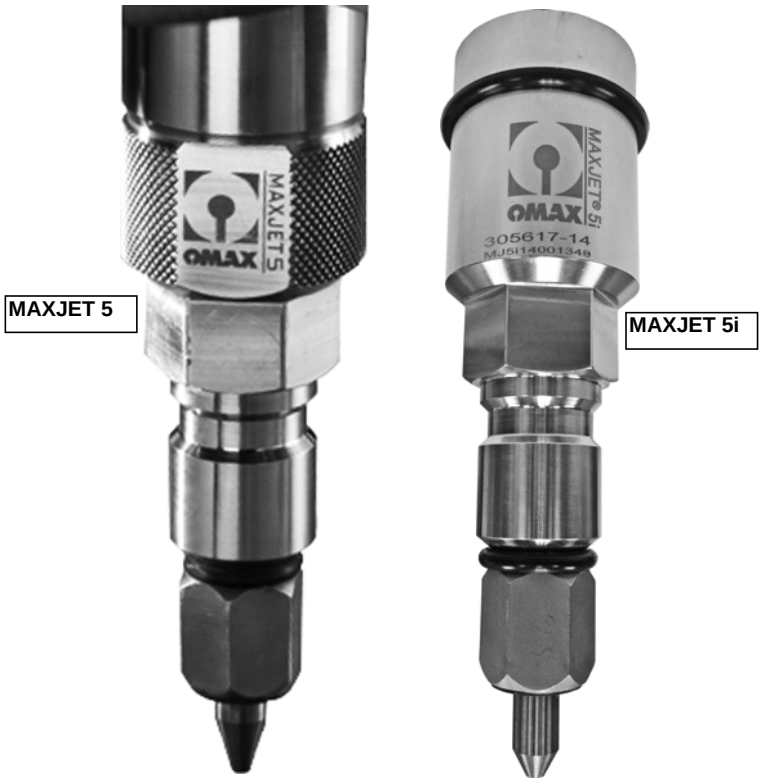
- Sponges for cleanup
- Spreader bars for securing parts on table
- Ultrasonic Cleaner
- Arbor press

Chapter 5

Nozzle Care and Maintenance

Correct operation of the nozzle assembly is critical for cutting accuracy. Damaged or worn nozzle components, parts assembled incorrectly, or grit and dirt inside the nozzle can adversely impact nozzle cutting accuracy, pressure, and operating costs.

Note: *Before doing any nozzle installation, removal, or maintenance, first identify nozzle assembly type and then proceed with the applicable nozzle procedures.*



MAXJET® 5i Integrated Diamond Nozzle

Note: *The following nozzle instructions do not apply to the MAXJET 5 nozzle assembly. See page 5-3 for those procedures.*

Introduction

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

Caution: ***The MAXJET 5i Nozzle Assembly contains an integrated nozzle body (Figure 5-1). Components in the integrated nozzle body (shown in the exploded diagram) are factory-assembled and should not be taken apart. Doing so will void the warranty.***

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

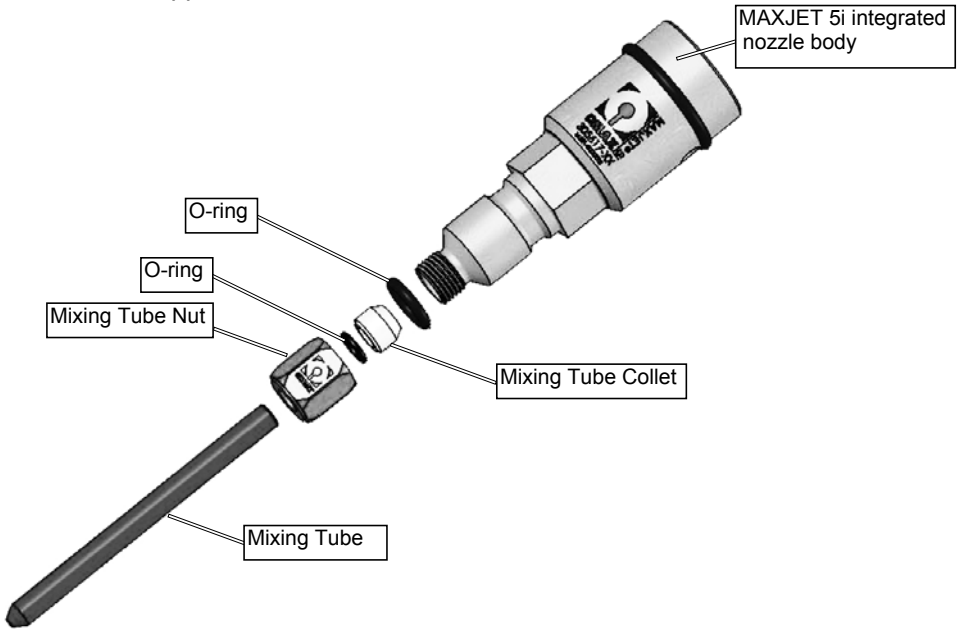


Figure 5-1

Nozzle Removal

To remove the MAXJET 5i Nozzle Assembly:

1. Place material under the nozzle assembly on table slats to prevent components from falling into the tank.

Caution: ***Never remove the nozzle body without first removing the Mixing Tube.***

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 nozzle inlet body.
5. Replace nozzle Filter Seal Assembly.

Nozzle Cleaning

The MAXJET 5i Nozzle Assembly should be cleaned once a week. To clean the integrated nozzle body:

1. Submerge integrated nozzle body into an ultrasonic cleaner filled with white vinegar.
2. Run ultrasonic cleaner for 3-5 minutes or until the jewel orifice is clean.
3. Rinse nozzle body with clean water prior to reinstalling.

Nozzle Installation

Remove existing nozzle assembly from the machine (if applicable) then install the MAXJET 5i Nozzle as follows:

1. Put a light sheen of Blue Goop on the threads of the nozzle inlet body and on the threads of the MAXJET 5i Nozzle Assembly.

Caution: ***Do not over tighten as this will damage the alignment of the orifice assembly inside the nozzle body. The plastic Ring Seal on the Nozzle Filter Seal Assembly in the inlet body accomplishes the sealing without excessive tightening.***

2. Carefully screw the MAXJET 5i Nozzle Assembly onto the inlet body and hand tighten until snug (not to exceed 25 ft-lb)
3. Insert Mixing Tube so it sits firmly against the mixing chamber inside the nozzle body.

Caution: ***Never install and tighten the Mixing Tube, Mixing Tube Nut, O-ring, and Collet on the nozzle body unless the nozzle body is installed on the inlet body. Doing so can place an upward force on the integrated nozzle components forcing them out of alignment.***

4. Hold Mixing Tube firmly in place and attach the Collet, O-ring, and Mixing Tube Nut. Tighten until snug (tight enough so the Mixing Tube is firmly seated in the nozzle body).

If you experience a water leak, ensure all components are clean and free from dirt and abrasive. Replace the Ring Seal and O-ring (apply a light film of Lubriplate to the O-ring and Ring Seal). Over tightening will damage the sealing surface.

MAXJET® 5 Nozzle Assembly

Note: *The following nozzle rebuild instructions **do not apply** to the MAXJET 5i integrated diamond nozzle. See page 5-1 for procedures.*

The MAXJET 5 nozzle assembly includes individual parts from the inlet body to the tip of the nozzle mixing tube (see Figure 5-2).

Note: *Refer to applicable nozzle assembly diagram for part numbers and most current nozzle information.*

Item	Quantity	Description
❶	1	Nut, SBR, MAXJET5
❷	1	Mixing Tube Collet
❸	1	Mixing Tube
❹	1	O-ring
❺	1	Nozzle Body
❻	1	Mixing Chamber
❼	1	Mixing Chamber Disc
❽	1	Orifice Assembly
❾	1	Filter Seal Removal Tool
❿	1	O-ring

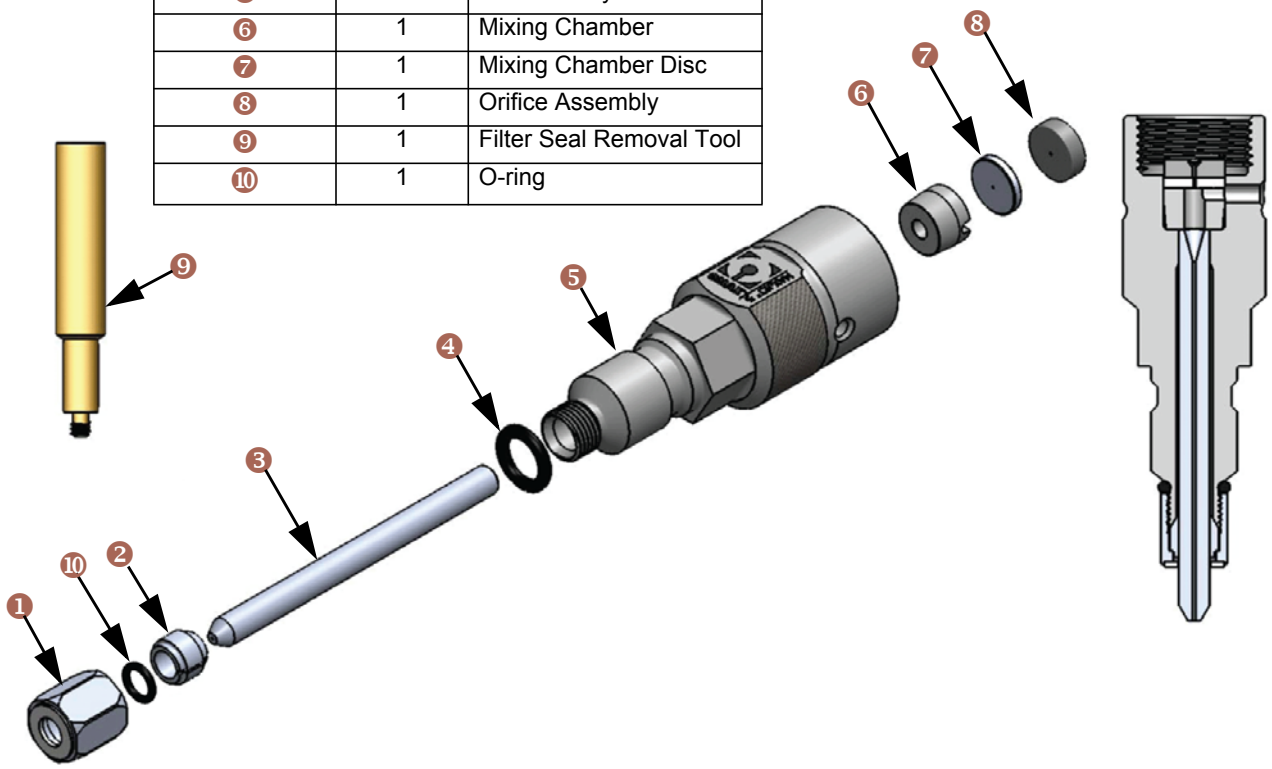


Figure 5-2

Rebuilding the MAXJET 5 Nozzle Assembly

Refer to the nozzle rebuild DVD for a demonstration of the steps involved in the MAXJET 5 nozzle rebuild process.

Consumable Components

- Nozzle Filter Seal Assembly including o-ring
- Mixing Tube
- Mixing Chamber Disc
- Mixing Chamber
- Orifice Assembly including the Jewel
- O-rings
- Mixing Tube Nut, collet, O-ring
- Inlet Body

Indications Nozzle Repair is Needed

- Water leaks out of the weep hole in the nozzle assembly
- Jet stream is not well formed (see Figure 3-9, page 3-9)
- Cutting quality and accuracy is degraded or reduced
- Errors occur when cutting round holes or other dimensional objects
- Skipped cuts, or no cutting at all

- Abrasive flow slows or stops
- Water and abrasive back up through the feed tube and cutting stops

Tools Needed for Nozzle Rebuild

For a list of tools required for a nozzle rebuild, refer to *Tools Required for Pump and Table Maintenance,* page 4-2.

Remove Nozzle Assembly

1. Clean or rinse off the **cutting head** and **nozzle assembly** to remove any debris or possible contamination.

Caution: ***It is extremely important to maintain cleanliness when working with the nozzle assembly. Even a small piece of garnet or other foreign particles can severely impact nozzle performance.***

2. Raise Z-axis to a height that allows the **nozzle assembly** to be easily accessed and removed.
3. Move **nozzle head** to an X-Y position allowing easy **nozzle assembly** removal.
4. Shut down any open applications on the MAXIEM controller by following proper shutdown procedures.
5. Power OFF MAXIEM **controller**.
6. Power OFF MAXIEM **pump**.
7. Power OFF MAXIEM **charge pump**.
8. Power OFF the **main AC power**, **air**, and **water** sources to the MAXIEM. Tag and lock them out according to established safety practices. Follow all company-specified safety procedures while servicing this equipment.

Remove Nozzle Mixing Tube

1. Remove **abrasive hose** from the **nozzle**.

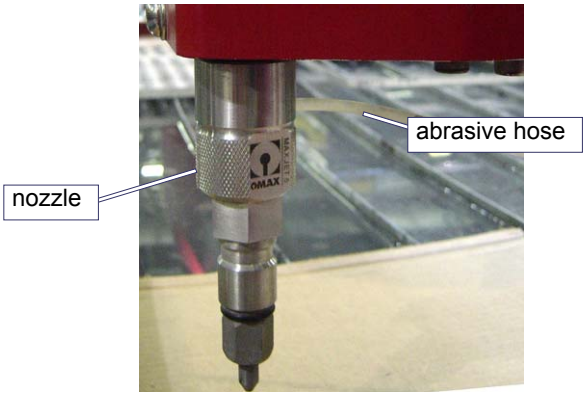


Figure 5-3

2. Place a piece of material directly under the **nozzle** to prevent any accidentally dropped parts or tools from falling into the tank.
3. Remove **nozzle mixing tube**:

a. Place a **1" open-end wrench** on the **nozzle body** to counteract any torque while loosening the **mixing tube locking nut** (Figure 5-4).

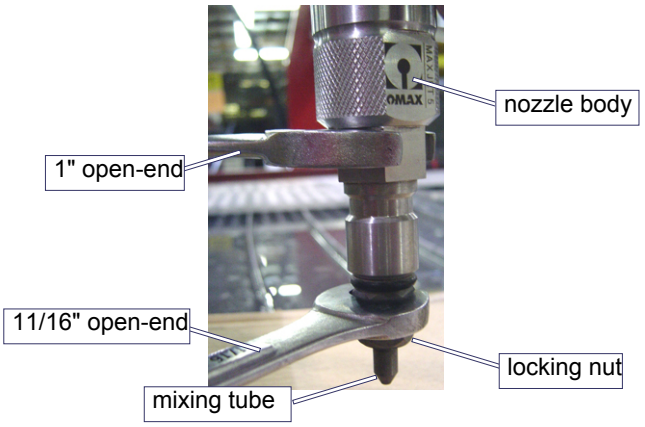


Figure 5-4 Removing the Mixing Tube

b. Loosen the **mixing tube locking nut** using an **11/16" open-end wrench**. While loosening, hold the **mixing tube** with your fingers to prevent it from suddenly falling.

c. Remove the **mixing tube** along with the **locking nut**, **collet** and **O-ring**.

Remove the Nozzle Body from the Inlet Body

1. Place a **1-1/4" open-end wrench** on the upper hex portion of the **inlet body** to hold it in place when removing the **nozzle body**.
2. Using **a 1" open-end wrench** placed on the **nozzle body**, loosen the right-hand threaded **nozzle body** from the **inlet body** using both wrenches.

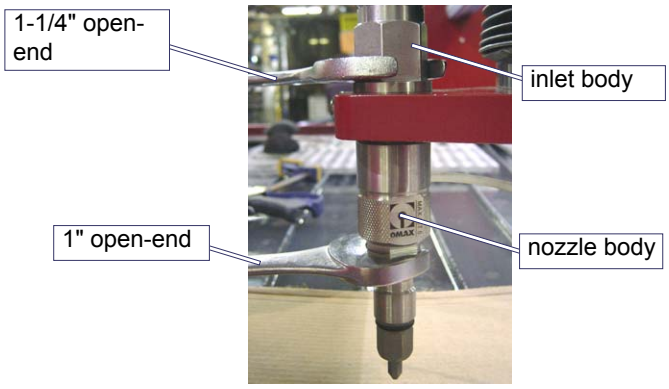


Figure 5-5

3. Carefully unscrew the loosened **nozzle body** by hand.

Note: *It is not necessary to remove the inlet body from the machine unless leaks are noted in this area.*

Remove Filter Seal Assembly from the Inlet Body

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

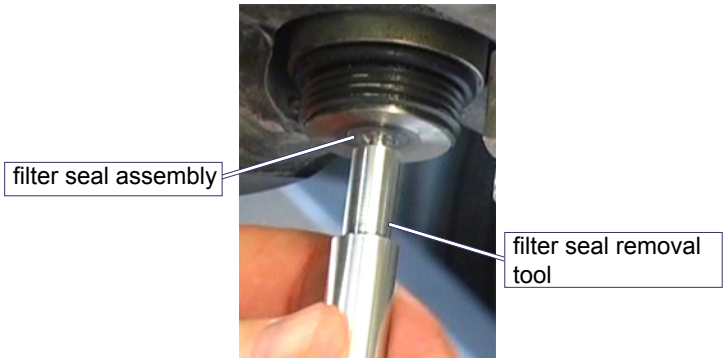


Figure 5-6

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

Remove Orifice Assembly

Carefully remove the **orifice assembly** from the **nozzle body**.

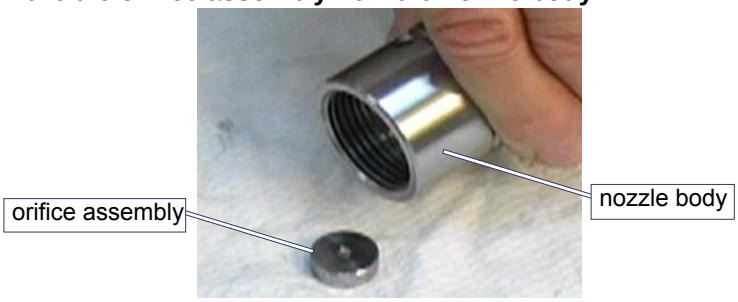


Figure 5-7

Remove Mixing Chamber Disc

The **mixing chamber disc** sits directly beneath the **orifice assembly**. To remove the **mixing chamber disc**, gently strike the **nozzle body** onto the palm of your hand, forcing the **disc** to release from the **nozzle body**.

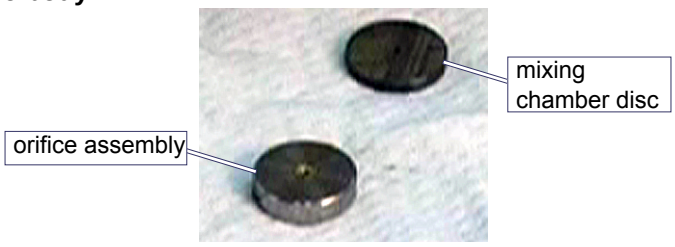


Figure 5-8

Note: *If the mixing chamber disc does not easily fall out of the nozzle body, carefully blow compressed air into the abrasive inlet, ensuring the disc will fall out into your hand or onto a soft surface to avoid cracking or breaking. If compressed air does not remove the disc, carefully push down on the disc from the mixing tube end of the nozzle body using a tool slender enough to be inserted down the end of the nozzle body without scratching the surface.*

Remove Mixing Chamber (if applicable)

1. Inspect the **mixing chamber** prior to removing it.
2. If the **mixing chamber** needs to be replaced, clean area above the chamber.
3. Press the **mixing chamber** out of the **nozzle body** using an **arbor press** and a makeshift tool for pushing down through the mixing tube opening in the nozzle.

Figure 5-9

Note: *To facilitate removal of the mixing chamber, it may be necessary to heat the nozzle body using either a heat gun, boiling water, or similar heating technique.*

4. Remove the **nozzle body** O-ring (Figure 5-24).
   O-rings should be inspected for wear and replaced during the nozzle rebuild when necessary.

Clean and Inspect Nozzle Components

Cleaning nozzle components and maintaining cleanliness is critical when reassembling nozzle components. 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 hands are clean prior to handling clean nozzle components. Wash all parts using a non-abrasive, mild soap with water, or an ultrasonic cleaner.

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

Caution: ***Re-use of any damaged or defective nozzle component will negatively impact performance of your MAXIEM abrasivejet.***

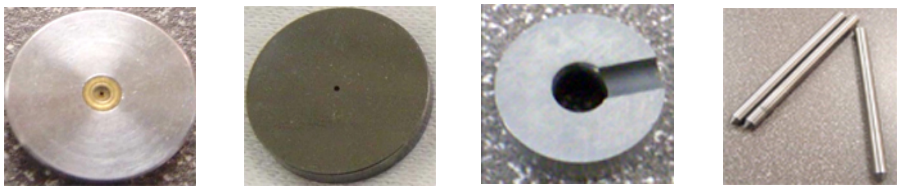
2. Ensure dirt and grit are removed from all nozzle parts.
3. Rinse each part using clean water and carefully blow dry.
4. Clean the **orifice** or **jewel assembly** using an **ultrasonic cleaner** filled with **white vinegar**.

Figure 5-10

Inspecting

There are four primary nozzle assembly components that should be inspected for wear or damage:

- orifice or jewel assembly
- mixing chamber disc
- mixing chamber
- mixing tube



jewel assembly **mixing chamber disc** **mixing chamber** **mixing tubes**

Figure 5-11

In addition, carefully inspect any nozzle component that shows signs of water leakage. Some cracks may be extremely fine and not easily detected.

Orifice or Jewel Assembly

The orifice assembly (Figure 5-11) with the center jewel is a consumable item that requires inspecting, cleaning, and replacing if damaged. The jewel may have a small chip or mineral buildup that is difficult to see with the naked eye. It can also be plugged, cracked, worn, or misaligned.

In Figure 5-12, note the edges in the good jewel orifice are clean and sharp and the center hole is completely round. No cracks or chips appear in the area around the hole, and no deposits are plugging the hole.

good jewel orifice **chipped jewel orifice**

Figure 5-12

Particles of debris traveling at high speeds through the orifice can easily chip or damage the jewel by hitting an edge of the orifice.

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 in the internal diameter of the orifice can form a hollow cone surrounding the small hole in the center of the jewel, resulting in poor jet quality.

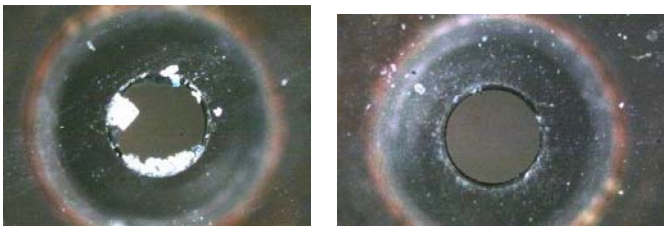


Figure 5-13

If in-line filters are not used, particles that are too large to pass through the orifice will plug or damage it, causing the pump to fault. A fine particle filter, called the “last chance filter” (Figure 5-20) is installed just before the orifice to prevent particles upstream in the high-pressure system from entering the orifice.

A misaligned jet stream is one that cannot pass through the mixing tube without touching the inside bore when run at low pressure. Garnet, grit, dirt, or other contamination trapped between the orifice mount and the carbide disc, or between the disc and the carbide mixing chamber, can throw the jet out of alignment, causing premature wear of the mixing tube.

Caution: ***If a jewel is damaged, misaligned, or not producing a well-formed jet, the life of the mixing chamber disc and the mixing tube will be dramatically reduced if the damaged jewel is not replaced.***

If orifice chipping is a chronic problem and not corrected by using filters or by following proper procedures, consider using a diamond orifice assembly or the MAXJET 5i Integrated Diamond Nozzle. Diamond orifices are highly resistant to chipping from particle impact and have a far longer wear life.

Mixing Chamber Disc

The mixing chamber disc (Figure 5-11) is a consumable item. Inspect with magnification to detect wear or disc damage. Measure the internal diameter of the hole in the mixing chamber disk using a 0.026" (0.66 mm) pin gauge. The internal diameter of this hole for a new mixing chamber disc is 0.030" (0.76 mm). To inspect the disc, measure the internal diameter of the hole in the mixing chamber disc using a pin gauge. If the internal hole diameter is **greater than** 0.060" to 0.070" (1.52 mm to 1.78 mm), the disc should be replaced.

As the hole in the mixing chamber disc wears, the probability that garnet can travel above the orifice increases, resulting in a chipped orifice. When a mixing chamber hole is no longer round, it indicates uneven wear. Figure 5-14 provides examples of worn mixing chamber discs.

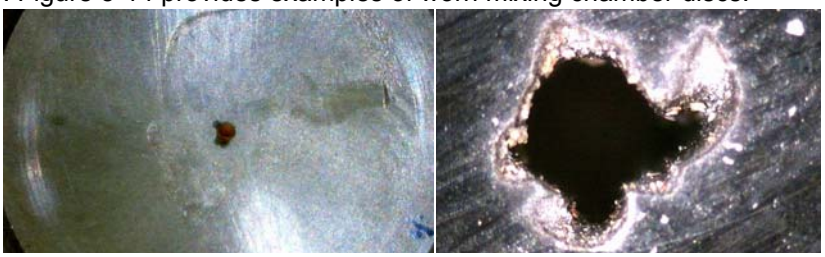


Figure 5-14

A 'star shaped' pattern generally means the orifice or jewel is chipped. This pattern develops because the chip is on the edge of the jewel where the jet is formed, resulting in a small segment of the jet shooting off at a fairly large angle to the opposite side of the jet from where the chip is located. Multiple chips cause multiple segments of the jet to shoot off to different locations around the edge of the jewel and erode the star shaped hole.

Erosion or a wear pattern that prevents the mixing chamber disc from seating flat on the mixing chamber leads to a misaligned jet, causing wear on the mixing tube. Erosion on the bottom surface of the mixing chamber disc will occur. Severe erosion may weaken the disc, leading to its eventual cracking.

Note: *The mixing chamber disc may be prevented from seating flat on the mixing chamber because garnet particles are present.*

Mixing Tube

Although the mixing tube (Figure 5-11) is made from an extremely hard material, the flow of high-pressure water and abrasive wears 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 5-15 provides some examples of worn mixing tubes. A cross section of these mixing tubes reveals the irregular wear of their internal diameter.

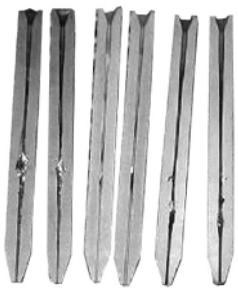


Figure 5-15

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 chipped 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 abrasivejet. It can range from 0.021" (0.53 mm) to 0.060" (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 is small 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. From MAXIEM's **Make** software, click the **Test** button to display the *Test Pump and Nozzle* options:

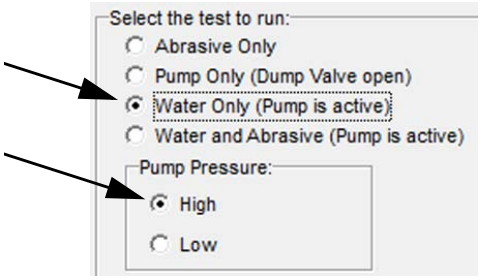


Figure 5-16

2. Select **Water Only** and **High pump pressure,** then click the **Start**Test button to activate the jet stream.
3. Turn the water 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 all required power shutdown and safety procedures.
5. Remove the **mixing tube** from the **abrasivejet nozzle**, turn it upside down, and tighten it in the **nozzle body**.
6. Start up the **MAXIEM Waterjet**.

7. Again, click the **Test** button and repeat the **Water Only** test to try and dislodge the clogged material.

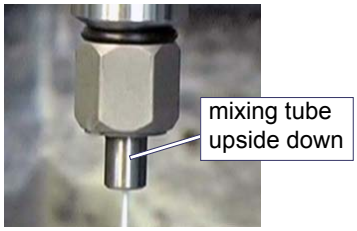


Figure 5-17

Nozzle Filter Seal Assembly
The nozzle filter is a consumable item that should be discarded and replaced each time you replace the orifice or disassemble the nozzle for maintenance. See Figure 5-20.

Mixing Chamber
The mixing chamber is an infrequent consumable item but may need to be replaced if the internal diameter of the mixing chamber hole has grown larger than 0.260" (0.66 mm) or shows excessive oblong wear.

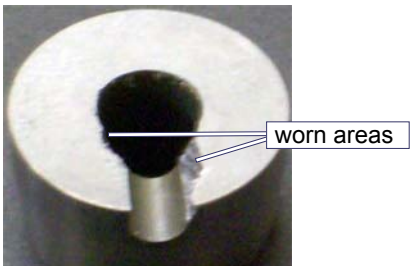


Figure 5-18 Worn Mixing Chamber

Assemble the Nozzle Assembly

1. After cleaning, inspecting, and obtaining replacement **nozzle components**, you are ready to assemble the **nozzle assembly** and install it on the nozzle's inlet body.

Caution: ***Always maintain cleanliness throughout the nozzle assembly and installation process. Any contamination that gets into the nozzle components during reassembly will negatively impact cutting performance and shorten life of the nozzle components.***

2. Purge the **high-pressure plumbing** to flush out any particles or contamination using the **nozzle test** with the **Water** only, **Low** pressure options (see Figure 5-16 for test menu example). Repeat this test two or three times.

Figure 5-19

Install Nozzle Filter Seal Assembly

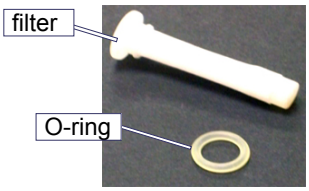


Figure 5-20

1. Apply a light coating of Lubriplate to the filter's **O-ring**.
2. Slide lubricated **O-ring** onto the **filter**.
3. Push **filter** with **O-ring** installed up into the **inlet body**.

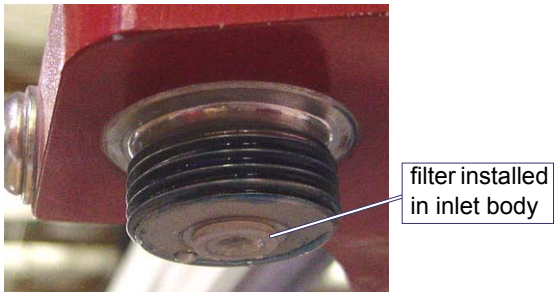


Figure 5-21

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

Install Mixing Chamber (if replacement required)

1. Place a small dab of **extreme pressure lube** onto a finger tip and lubricate the outside of the **mixing chamber**.
2. Place the **mixing chamber** in the **nozzle body** with its groove aligned with the abrasive inlet hole:

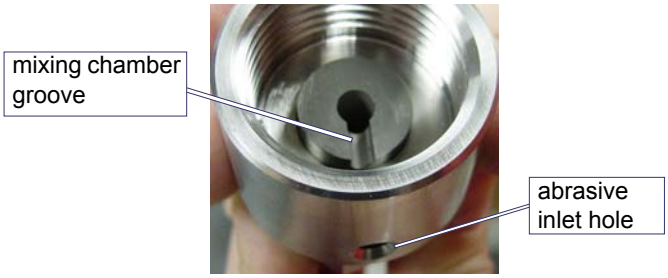


Figure 5-22

Note: *An assembly trick is to mark the top edge of the nozzle body with a marker to identify where the abrasive inlet hole is located when lining up the mixing chamber.*

3. Place the **nozzle body** in the **arbor press** and press the **mixing chamber** into the nozzle body bore using a **deep-well socket** as a push tool.

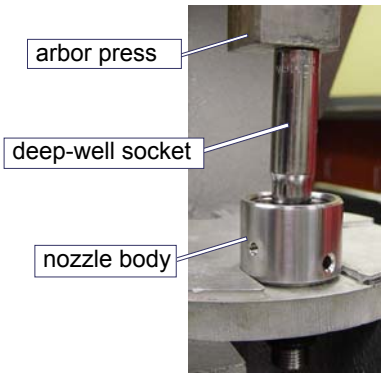


Figure 5-23

4. Measure the internal depth of the remaining bore in the **nozzle body** from the top of the bore to the top of the **mixing chamber**. This gap must measure approximately 0.130" (3.3 mm) in order to accommodate the **mixing chamber disc** and **orifice assembly** when inserted.

Mixing Chamber Disc and Orifice Assembly

1. Install **O-ring** onto the **nozzle body** (if removed).

Figure 5-24

Caution: ***Ensure nozzle body, mixing chamber disc, and mixing chamber surfaces are clean and contamination free.***

2. Assemble **mixing chamber disc** and **orifice assembly** inside the **nozzle body**:
   a. Place **mixing chamber disc** on the **mixing chamber** in the center bore of the **nozzle body**.

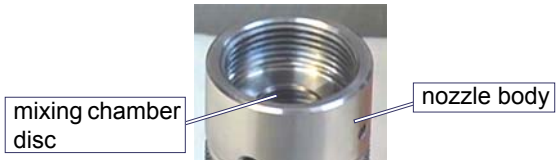


Figure 5-25

   b. Ensure the **mixing chamber disc** sits flat on the **mixing chamber**, leaving a 0.030" (0.76 mm) deep bore to accommodate insertion of the **orifice assembly**.

c. Insert **orifice assembly** with jewel side facing up into the **nozzle body bore** and on top of the **mixing chamber disc**.

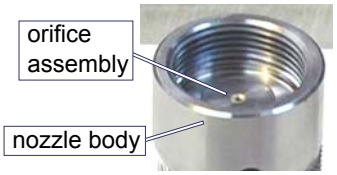


Figure 5-26

Note: *Ensure the orifice assembly is well-seated in the 0.030"* (0.76 mm) *counter bore above the mixing chamber disc. Ensure no contamination exists between the orifice assembly and the mixing chamber disc as this will impact jet stream alignment.*

Nozzle Body

1. Apply light coating of **Blue Goop** to the male threads of the **nozzle body inlet**.

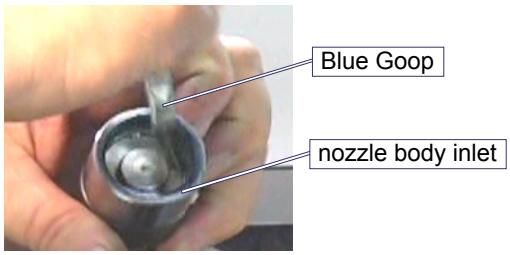


Figure 5-27

2. Carefully hold the **nozzle body** to keep the **mixing chamber disc** and **orifice assembly** leveled and centered in their positions in the bore.
3. Carefully begin to screw the **nozzle body** with the **orifice assembly** onto the machine's **nozzle inlet body**.

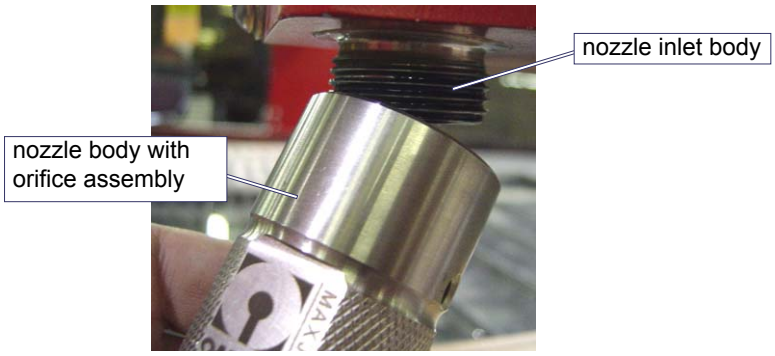


Figure 5-28

4. Twist the **nozzle body** slowly to keep the **mixing chamber disc** and **orifice assembly** seated flat and centered in their correct positions. Twist until you begin to feel resistance from the **nozzle body** and the **nozzle inlet body**.

If the orifice assembly is not seated properly prior to tightening, it can cause damage to the inlet body. Check the seating of the components inside the nozzle assembly to ensure that they are centered and seated properly (specifically, check to see if the orifice assembly is still seated in the bore). Refer to Figure 5-29 for

an example of an orifice that had been tightened several times while off-center and not correctly seated in its bore.

Figure 5-29

Place a **1-1/4" open end wrench** on the upper hex portion of the inlet body to hold the **inlet body** in place to counteract any torque when tightening the **nozzle body**.

5. Using a **1" open-end wrench** placed on the **nozzle body**, turn slowly clockwise to tighten the **nozzle body** to the **inlet body**. Tighten the **nozzle body** to approximately 25 ft lbs (33.9 Nm).

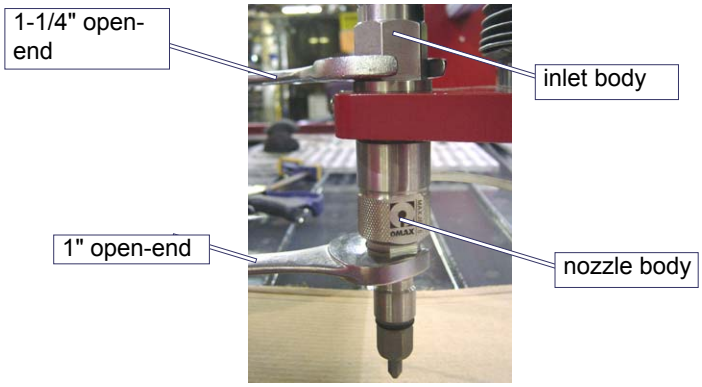


Figure 5-30

Mixing Tube

1. Insert **mixing tube** into the **nozzle body**.

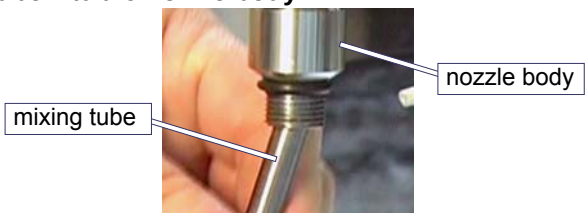


Figure 5-31

2. Slip **mixing tube collet**, **O-ring** and **nut** onto the **mixing tube** and insert the **mixing tube** all the way into the **nozzle body** until it bottoms out against the clean surface of the **mixing chamber**.

Figure 5-32

3. Ensure collet is assembled “taper-to-taper” as shown below.

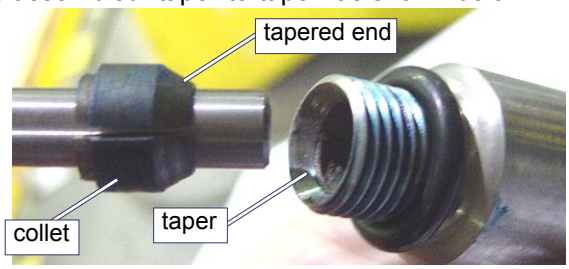


Figure 5-33

4. While holding the **mixing tube** in place, tighten the **locking nut** to a snug fit with an **11/16" open-end wrench**. To counteract any torque, place a **1" open-end wrench** on the hex of the **nozzle body** while the **nut** is being tightened.

Caution: ***Do not overtighten! Only a snug fit is required that holds the mixing tube in place.***

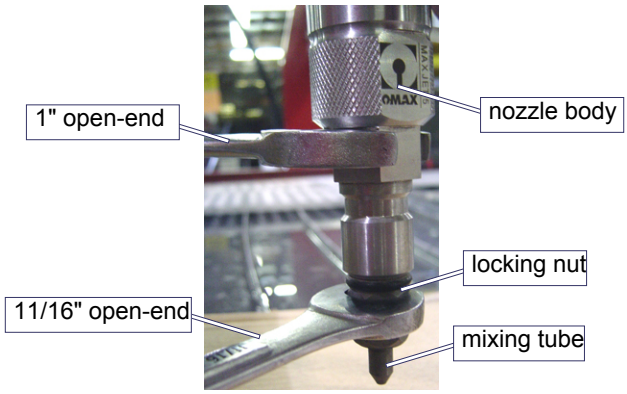


Figure 5-34

5. Reinsert **abrasive hose** into the nozzle (refer to Figure 5-3, on page 5-5),

Note: *The hole in the nozzle for the abrasive hose should always be positioned to allow the hose to exit directly towards the hopper. If the nozzle body was not loosened, this location should not have changed during nozzle rebuild. If the abrasive hose hole is not positioned correctly, you must loosen the nozzle body and readjust the nozzle rotation so that this hose routes directly to the hopper after all nozzle components have been securely tightened.*

Nozzle Tests

Once the nozzle is installed, run nozzle tests provided in the Intelli-MAX Standard Make software to verify water seal of the assembly fittings and jet stream quality:

1. Set tip of the **mixing tube** no higher than 1.5" above the water level to prevent the jet stream from piercing too far down into the tank.
2. Test **nozzle** operation with **Water** only at **Low** pressure. Follow by testing with **Water Only** at **High-pressure** and then **Water and Abrasive** at **High** pressure.
3. When running these **pressure tests**, inspect for water leaks from the **high-pressure fittings** and inspect jet stream to ensure it remains straight and focused. Refer to Figure 3-9, on page 3-9.

Caution: ***Always repair all problems noted during nozzle testing prior to operating equipment.***

Maximizing Nozzle Life

- Don't 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.

- Maintain part tolerances and extend Mixing Tube use by entering correct offset value in Make.
- Use different offset values to adjust for Mixing Tube wear.
- Prevent garnet contamination:
  - Don’t store garnet in open bags or buckets – store in closed containers.
  - Use a sharp blade to open abrasive bags.
  - Always keep top of the abrasive hopper covered to prevent water from entering.
- 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 on a regular basis.
- Consider using a diamond orifice assembly if orifice chipping is a chronic problem not overcome by using filters or by following proper procedures.
- Use only high-quality abrasive as it contains less dust and a more uniform particle size.
- Rotate Mixing Tube 90 degrees 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.
- Use a larger diameter mixing tube if kerf width is not critical.

To 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.

Rebuilding Dual On/Off Valve

Use the following procedure to repair a faulty Dual On/Off Valve. Refer to page 4-2 for a list of the tools and materials needed.

Removing Dual On/Off Valve

Figure 5-35 below illustrates the MAXIEM Dual On/Off Valve:

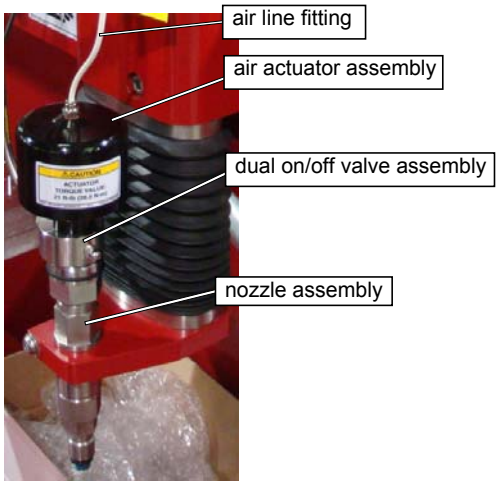


Figure 5-35

1. Switch OFF AC power for both pump and table. Disconnect main AC power breaker. Attach an “Out of Service” 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** (Figure 5-36) 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** from the **valve body** using a 1-1/8" open end wrench.

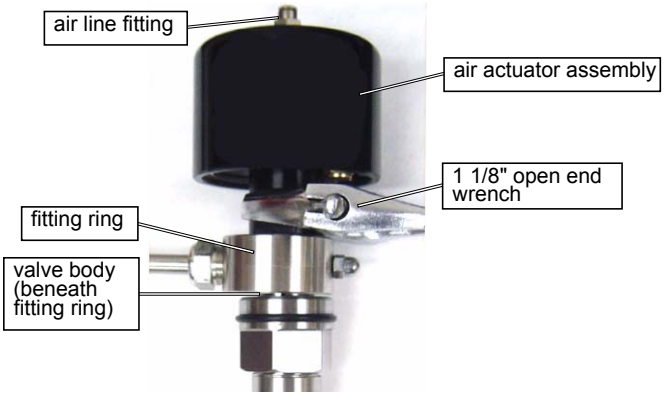


Figure 5-36

5. Remove **retaining screw** from **valve body** using ¼" open end wrench.

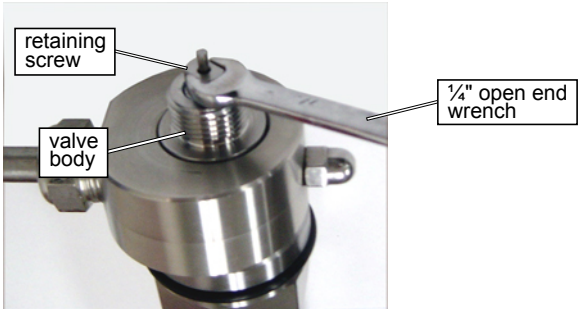


Figure 5-37

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

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

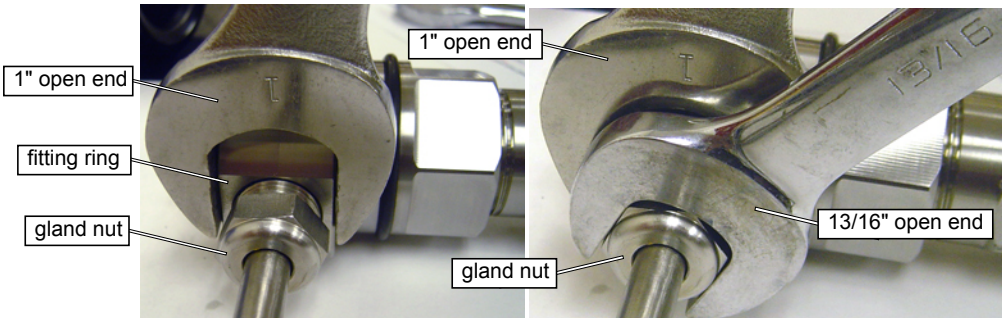


Figure 5-38

7. Loosen **valve gland nut** from **inlet body** by placing a 1-1/2" open end wrench on **valve gland nut**.

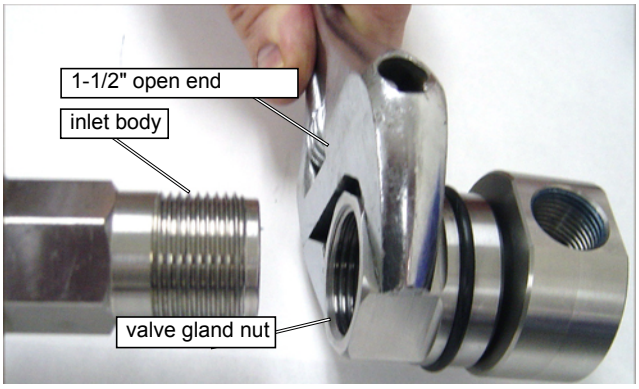


Figure 5-39

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 (Figure 5-38) 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.***

Disassembling Dual On/Off Valve

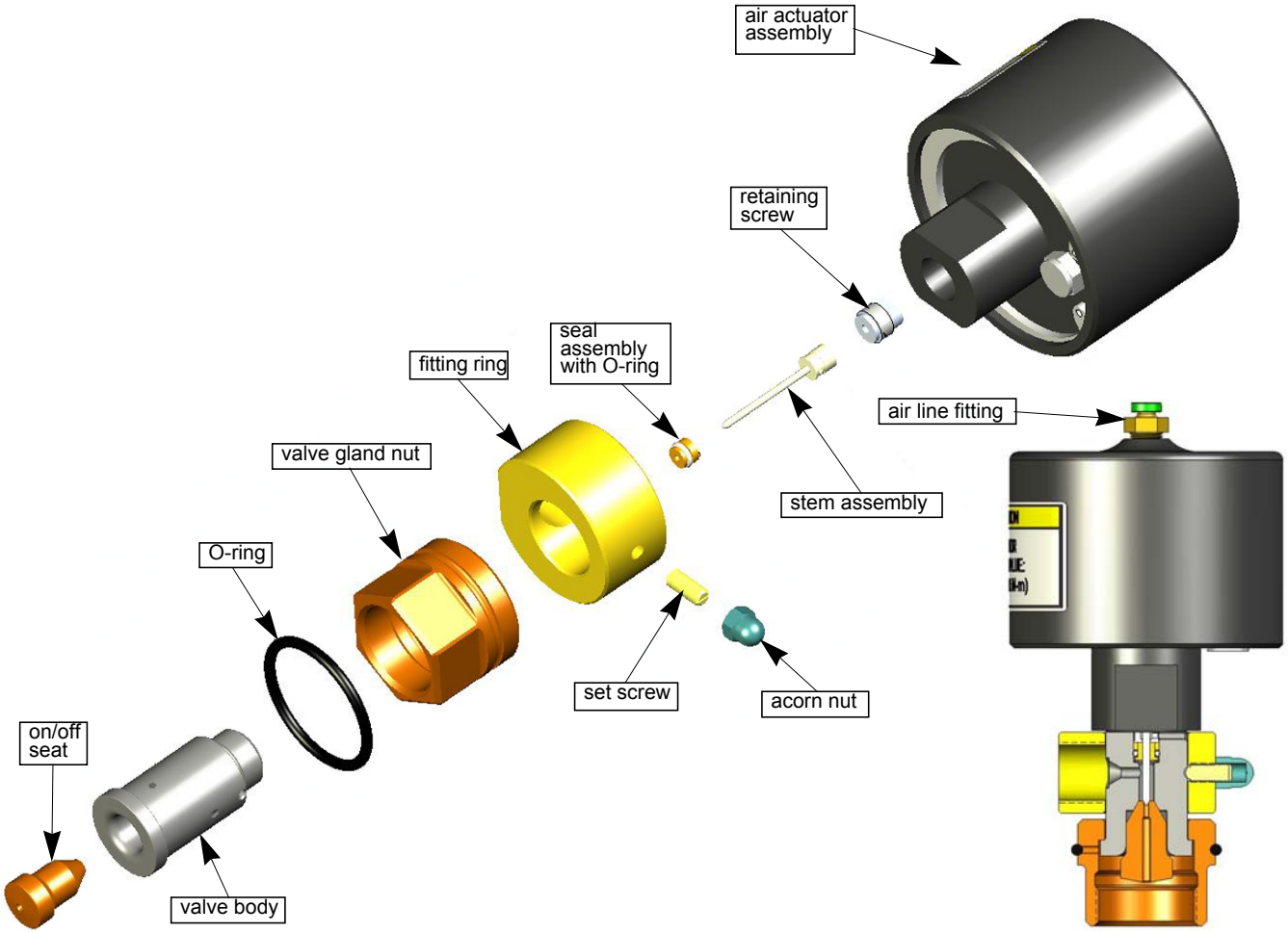


Figure 5-40

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

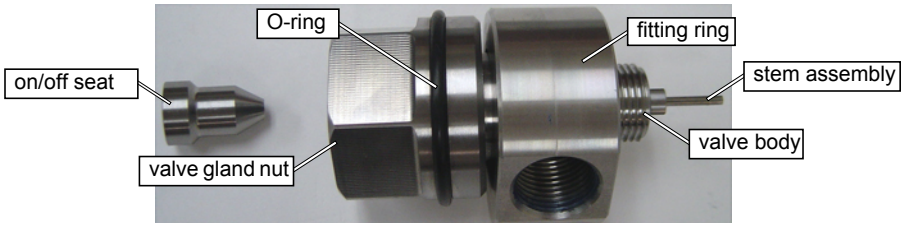


Figure 5-41

3. Use needle nose pliers to remove the **stem assembly** from the **valve body**.

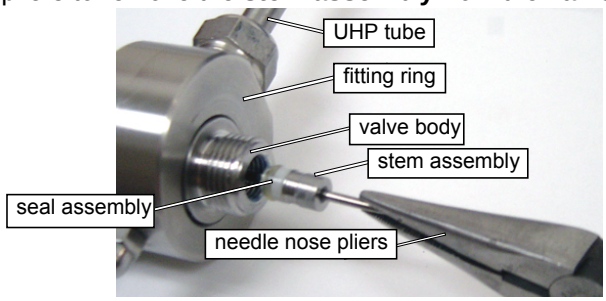


Figure 5-42

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

Figure 5-43

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

Figure 5-44

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-ri**ng, and **stem assembly**.
2. Slide **seal assembly** onto **stem assembly** shaft with **O-ring** facing towards **valve body** (Figure 5-46**).** Ensure the seal assembly slips over the **pointed end** of the stem assembly.
3. Lubricate both **seal assembly O-Ring** and **stem assembly** with Lubriplate grease:

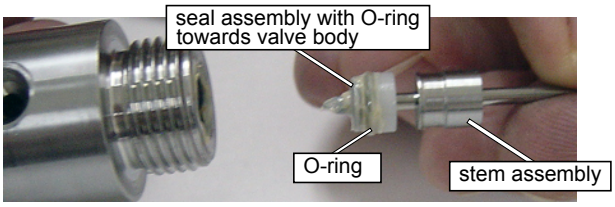


Figure 5-45

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

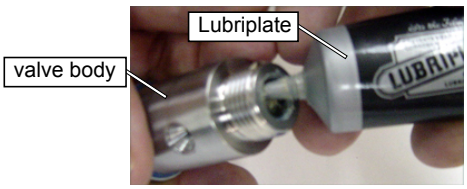


Figure 5-46

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

Figure 5-47

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** and install in the **valve body** using the ¼" open end wrench.

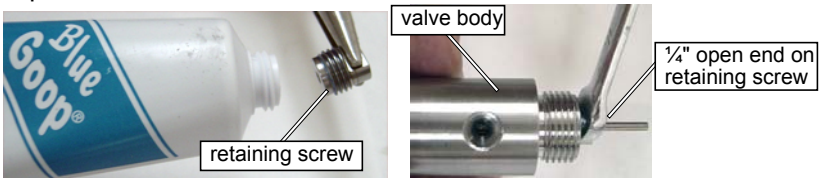


Figure 5-48

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

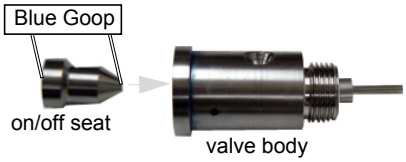


Figure 5-49

8. Slide **valve gland nut** and **fitting ring** onto the **valve body** (refer to step #2 in the disassembly instructions).

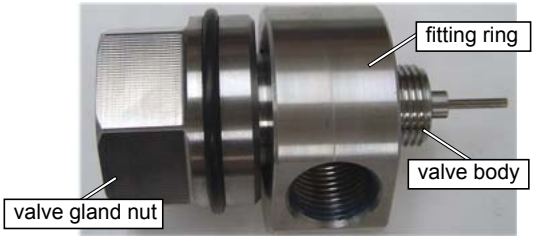


Figure 5-50

9. 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. Hand tighten the **valve gland nut** onto the nozzle inlet after rotating the **valve body** so the UHP line is in alignment with the opening in the **fitting ring**:

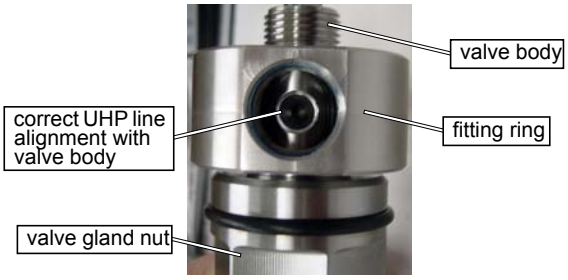


Figure 5-51

2. **Insert the UHP input line** into the **fitting ring**. Ensure threads on the high-pressure line have been applied with anti-galling compound (Blue Goop) and that three threads are showing:

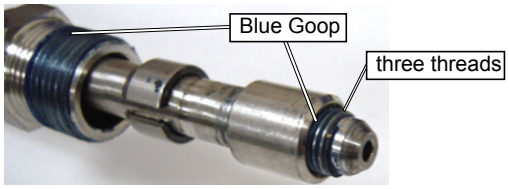


Figure 5-52

3. Tighten gland nut on the UHP input line using 13/16" and 1" open end wrenches. Tighten to 50 ft. lbs. (no greater than 75 ft. lbs. Refer to Figure 5-38).
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 Loctite 242** to the threads of the on/off **valve body**.

6. Reinstall the **air actuator assembly**. Use the 1-1/8" crows foot and torque to 252 in-lb (28.5 N·m). Refer to Figure 5-36.

7. Attach air line to the **air line fitting** on top of the **air actuator assembly**. Refer to Figure 5-35.

8. Prior to use, remove the nozzle body (1" open end wrench) and jewel. Flush system for at least 5 minutes using the **Test** nozzle command in Make. Select **High** pump pressure, **Water** only.

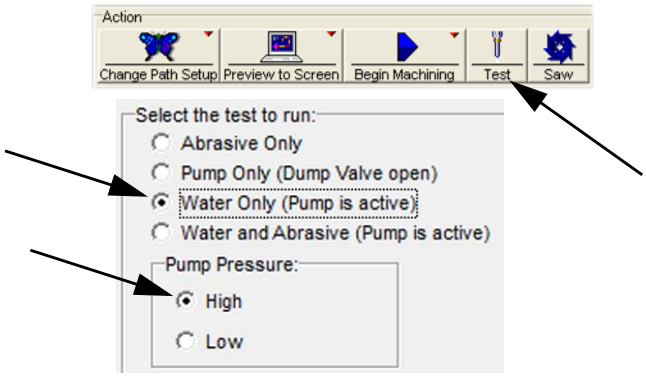


Figure 5-53

9. After five minutes of flushing, install nozzle body and jewel. Torque the Dual On/Off Assembly to the nozzle body at 25 ft. lbs. (33.9 Newton-meters).
10. Following installation, test nozzle operation using low, then high-pressure water only. Refer to Figure 5-53.

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

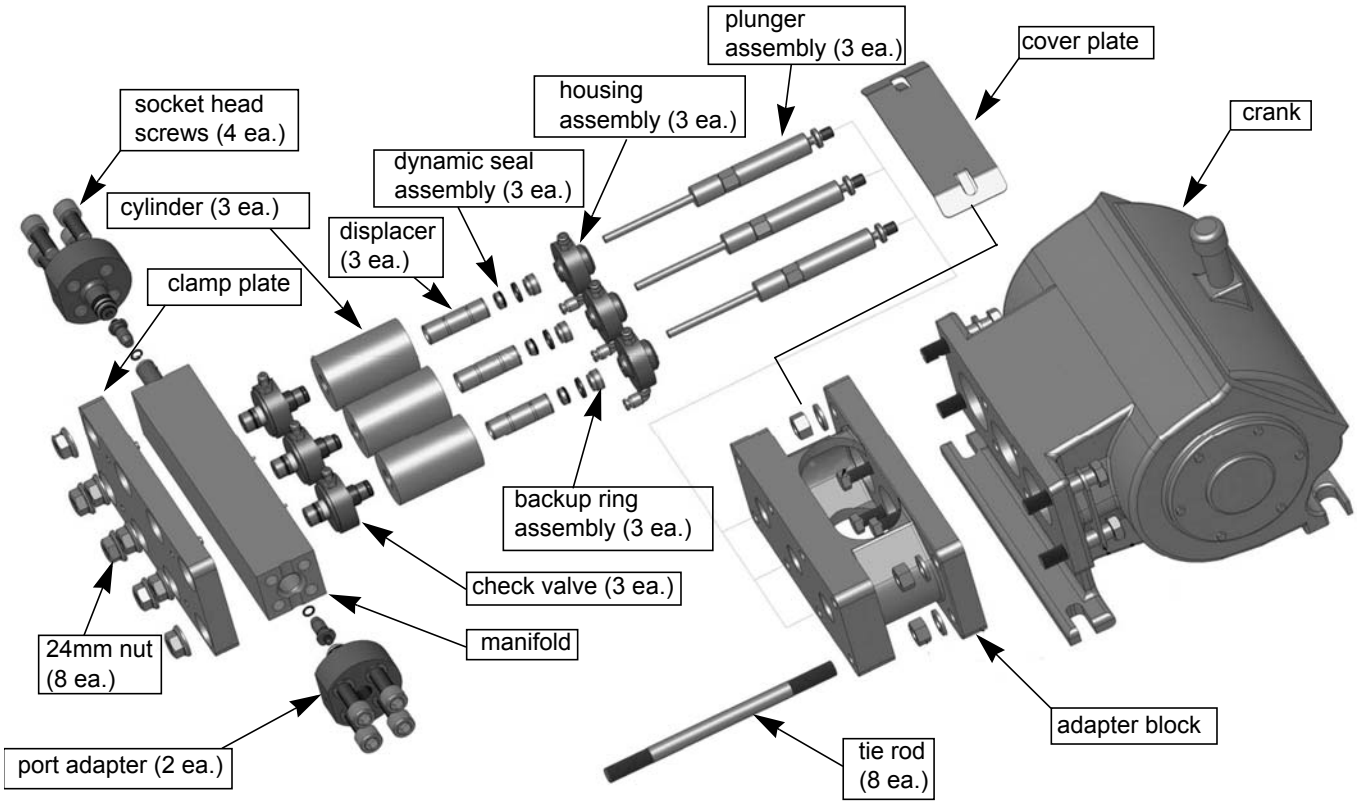


Figure 6-1

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. Refer to Figure 6-2. During disassembly, keep all parts together in related sets, noting the original position of each set.

Caution: ***Never use a pipe wrench on any MAXIEM 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 Pump Off at the main AC disconnect. Place a “lock-out 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 **hard plumbing** from the **port adapters**, using the 13/16" and a 1" wrench. See Figure 6-2:

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

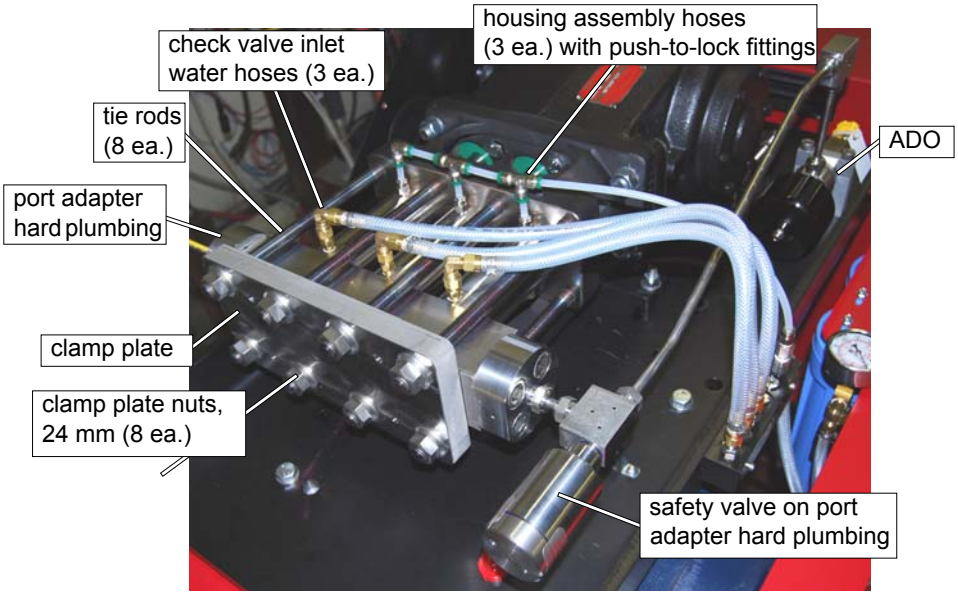


Figure 6-2

4. Remove **water hoses** from **housing assemblies** by pulling back on the green ring of the push-to-lock fittings. Remove the three **water hoses** from the **check valve inlets** using the 9/16" open-end wrench. Hold the fitting with the 1/2" open-end wrench to avoid unscrewing it from the check valve body.
5. Using the 24 mm socket (or 15/16" socket) and 1/2" breaker bar, remove the eight **24 mm nuts** from the **clamp plate** (Figure 6-2), being careful to remove the load on the **tie rods** 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 (Figure 6-3). Using the same pattern, back each nut off ½ turn until the load is removed from the tie rods.

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

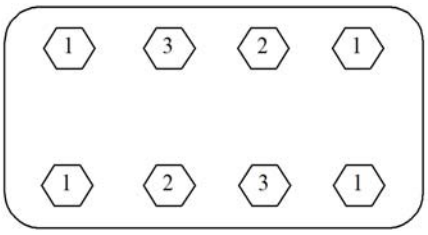


Figure 6-3

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

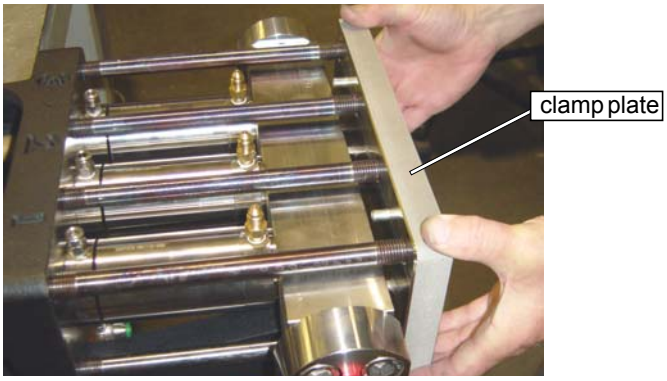


Figure 6-4

7. Slide the **wet end assembly** away from the **coolant housings**. See Figure 6-5. Keep the assembly level and square, being careful not to bind the internal Plungers. All components typically stay in the **cylinders** as the wet end assembly is removed.

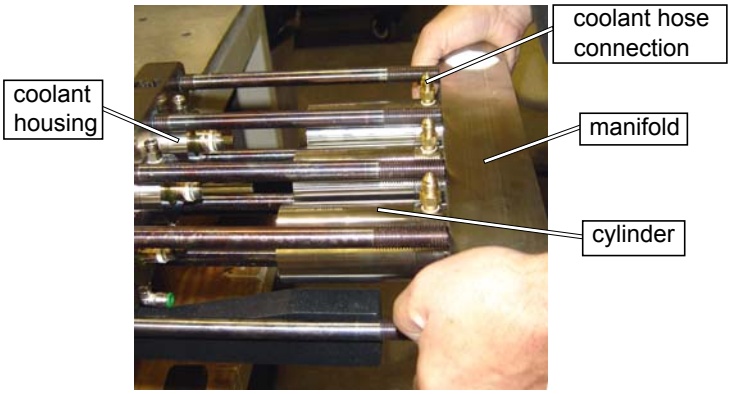


Figure 6-5

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 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 ring seals are not reusable and must be replaced.***

Disassembling the High-pressure Wet End Assembly

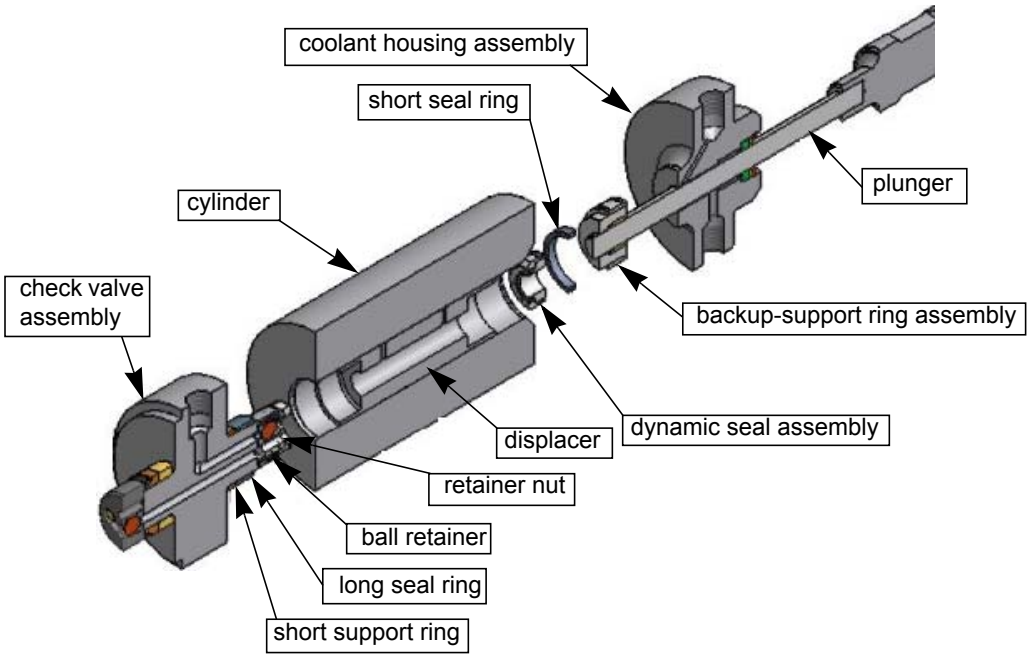


Figure 6-6

Note: *Maintain all removed parts in related sets, noting original position of each set.*

To disassemble the wet end assembly:

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

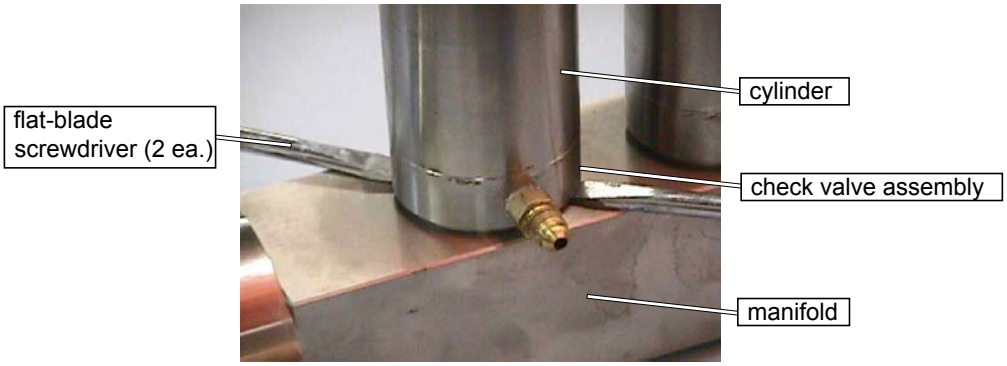


Figure 6-7

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" (1.27 mm) and should remove easily.*

2. Insert the **check valve removal tool** (Figure 6-8) through the **backup-support ring assembly** (Figure 6-6) of the first cylinder until it contacts the check valve retainer nut inside the cylinder:

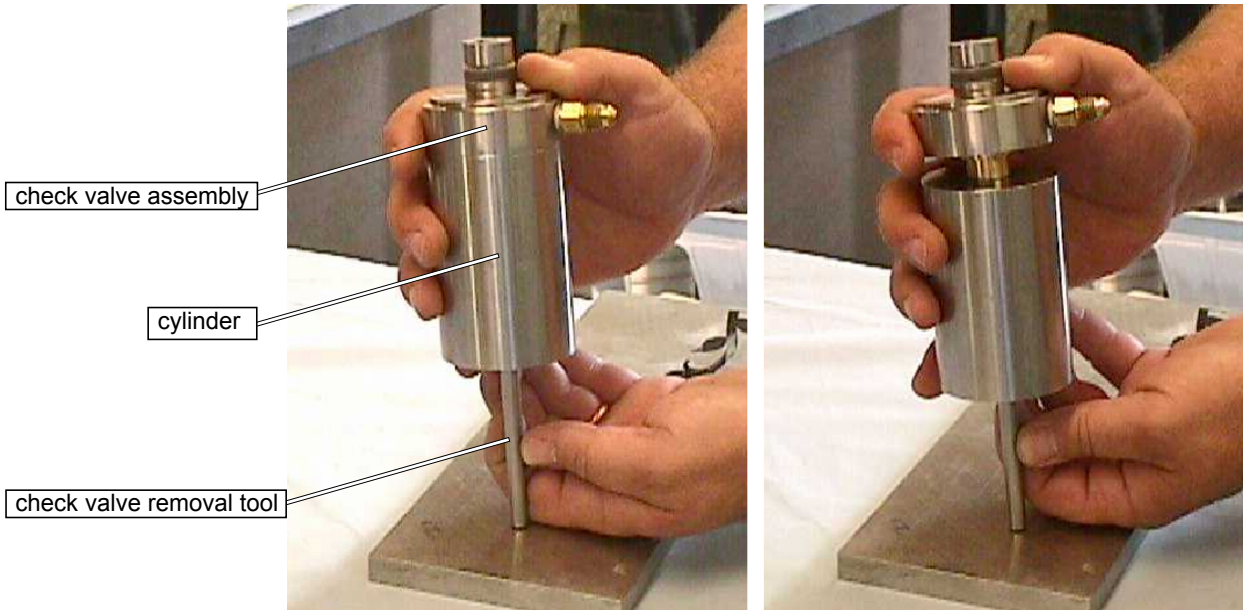


Figure 6-8

3. Strike the 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** (Figure 6-10), push the **sealing assembly** (displacer, retainer and seal assembly, short seal ring, and backup-support ring assembly - Figure 3-10) out of the cylinder from the check valve assembly end toward the coolant housing assembly end using an Arbor press (Figure 6-10). Repeat for the remaining two cylinders.

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

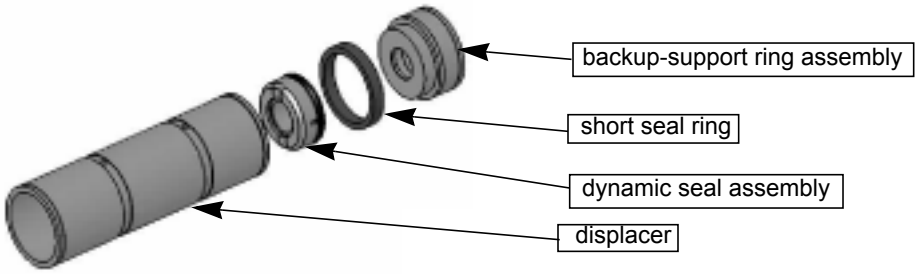


Figure 6-9

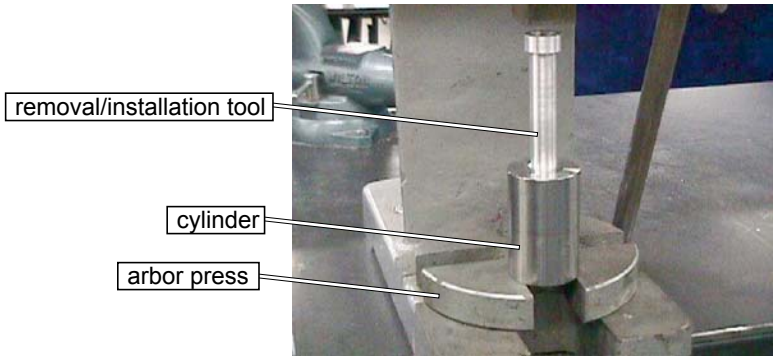


Figure 6-10

5. Separate the **backup-support ring assembly** from the **displacer** by placing the large end of the **removal/installation tool** (Figure 6-11) over the backup-support ring assembly and breaking the **short seal ring** loose from the displacer.

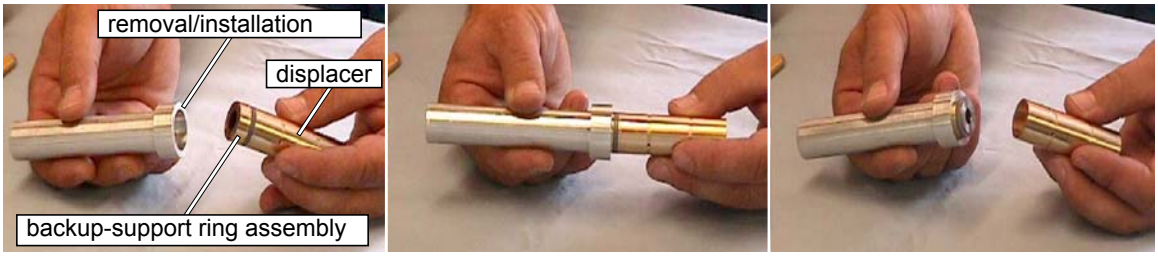
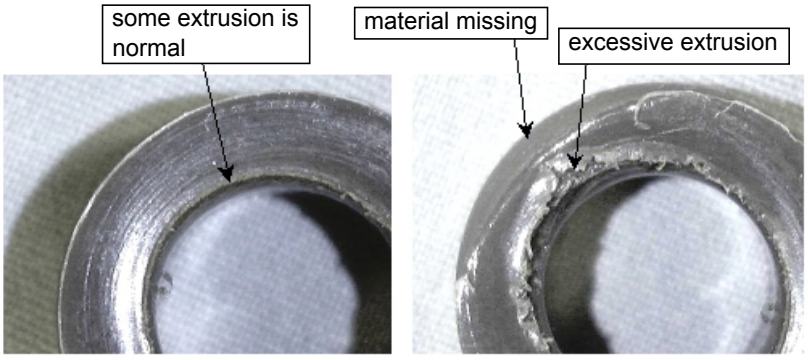


Figure 6-11

6. The **backup-support ring assembly** (Figure 6-14) 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 **short seal ring** from all three backup ring assemblies.
7. Before removing the **dynamic seal assembly** (Figure 6-9) from the displacer, inspect the **dynamic seal** for extrusion (Figure 6-12). 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.***



Normal wear - about 200 hours

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

Figure 6-12

8. Remove **dynamic seal assembly** from inside end of the **displacer**. Remove **large O-ring** from outside the dynamic seal. Separate components of the dynamic seal assembly by pushing the dynamic seal out of the retainer. Remove small O-ring from inside the retainer.

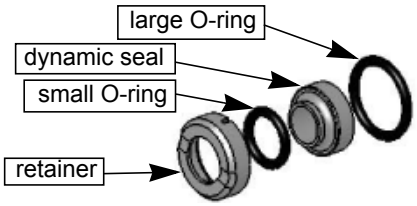


Figure 6-13

9. Repeat steps 4-8 for the remaining two **backup ring** and **displacer assemblies**.
10. 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 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** (Figure 6-15) 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 should be sharp and square with no nicks or gouges. There should be no evidence of rubbing on the lip.

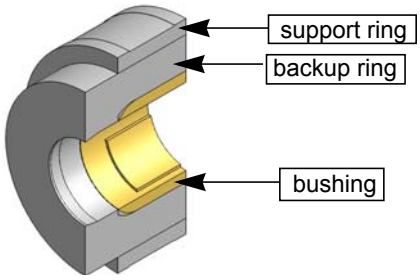


Figure 6-14

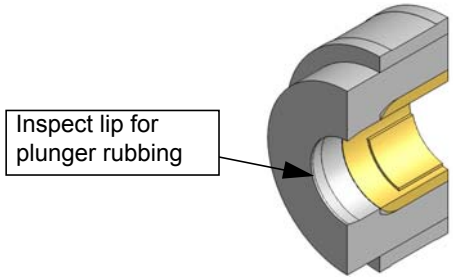


Figure 6-15

2. Figure 6-16 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.

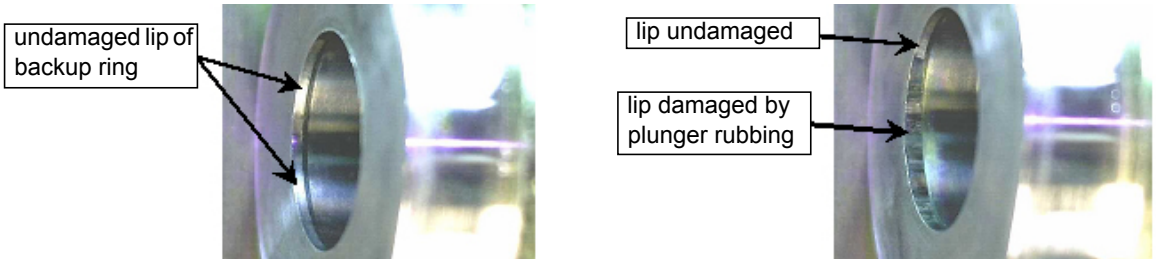


Figure 6-16

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

Inspect Liquid Displacers

The small flanges on each end of the liquid displacer should be 0.8115 to 0.8125 inches (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** (Figure 6-17) and use micrometer to measure outside diameters of each **displacer** end.
2. Any **displacer** that measures less than 0.8115 inches (20.61 mm) in diameter on either end should be replaced.
3. Inspect 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.***

.

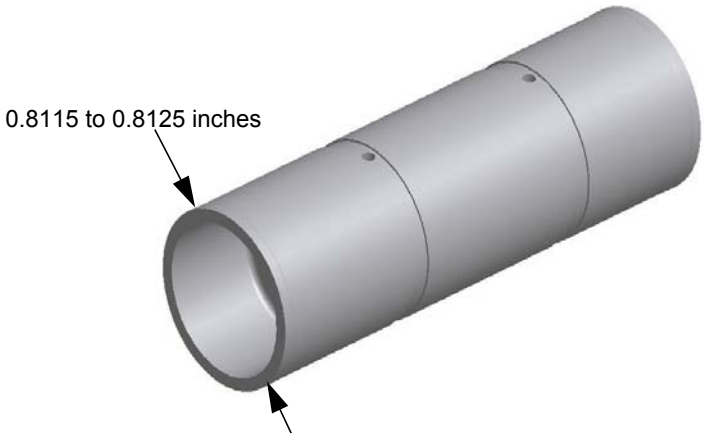


Figure 6-17

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 MAXIEM pump if the output pressure begins to drop by more than 4-6 KSI 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.

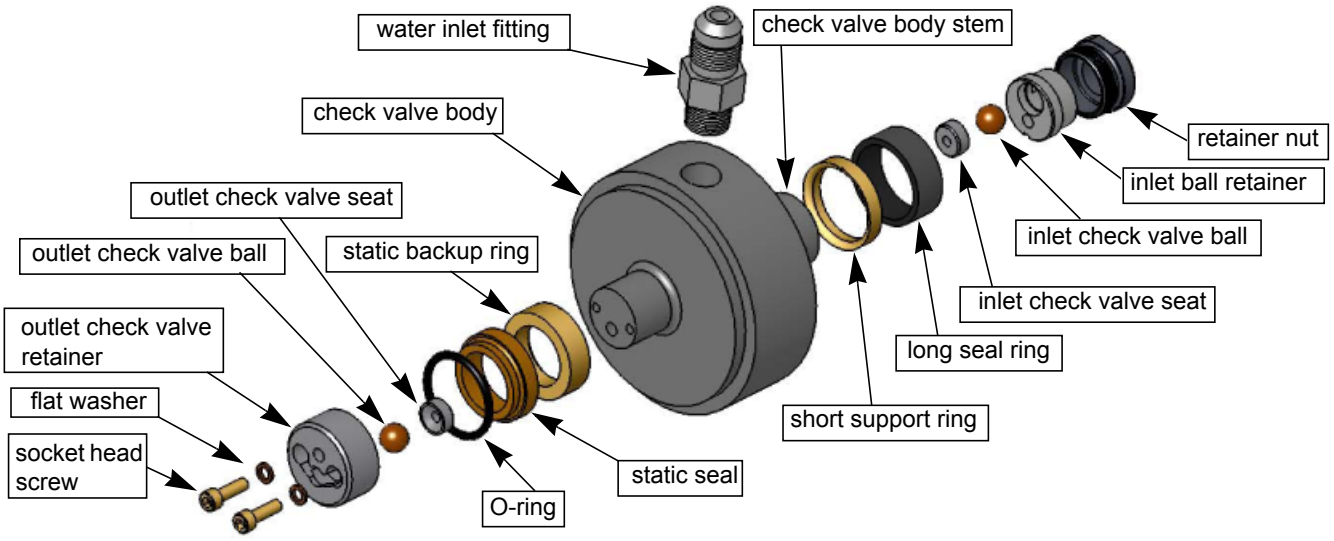


Figure 6-18

1. Begin disassembly of **check valve assembly** from the inlet (Cylinder) side. Clamp **check valve body** into soft-jaws of a vise. Use the 5/8" crows foot to remove the **retainer nut** (Figure 6-19).

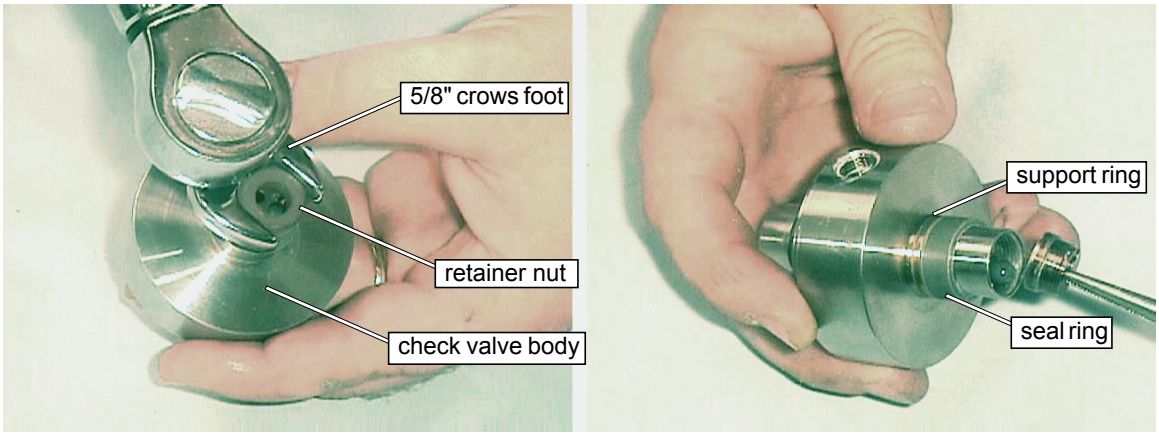


Figure 6-19

2. Referring to Figure 6-18, remove **inlet ball retainer**, **inlet check valve ball**, and **check valve seat**. Needle nose pliers can be helpful when removing the Inlet **ball retainer**.
3. If the **seal ring** did not remain in the end of the **cylinder** (Figure 6-1), 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.

6. A small amount of the **short seal ring** may have extruded under the **short support ring**, locking it to the **check valve body stem**. To remove the short 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 short support ring, allowing it to be removed by hand using a rag or a pair of channel lock pliers.

Caution: ***Once the short 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 6-20

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** for erosion across the **inlet check valve** Ball and on the flat sealing surface that contacts the **check valve body stem**. If erosion or damage is observed, replace seats.

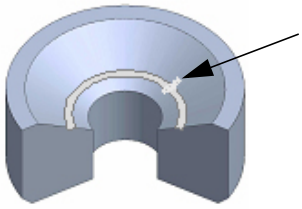


Figure 6-21

11. Turn the **check valve body** over and remove the **socket head screws** using the 3/32" Allen wrench. Remove the **flat washers** and the **outlet check valve retainer**. The socket head screws and washers should be replaced according to the maintenance schedule.
12. Perform the same inspection of the **outlet check valve ball** and **outlet check valve seat** (see steps 7-11 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 **manifold** and **cylinder** (Figure 6-1), 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

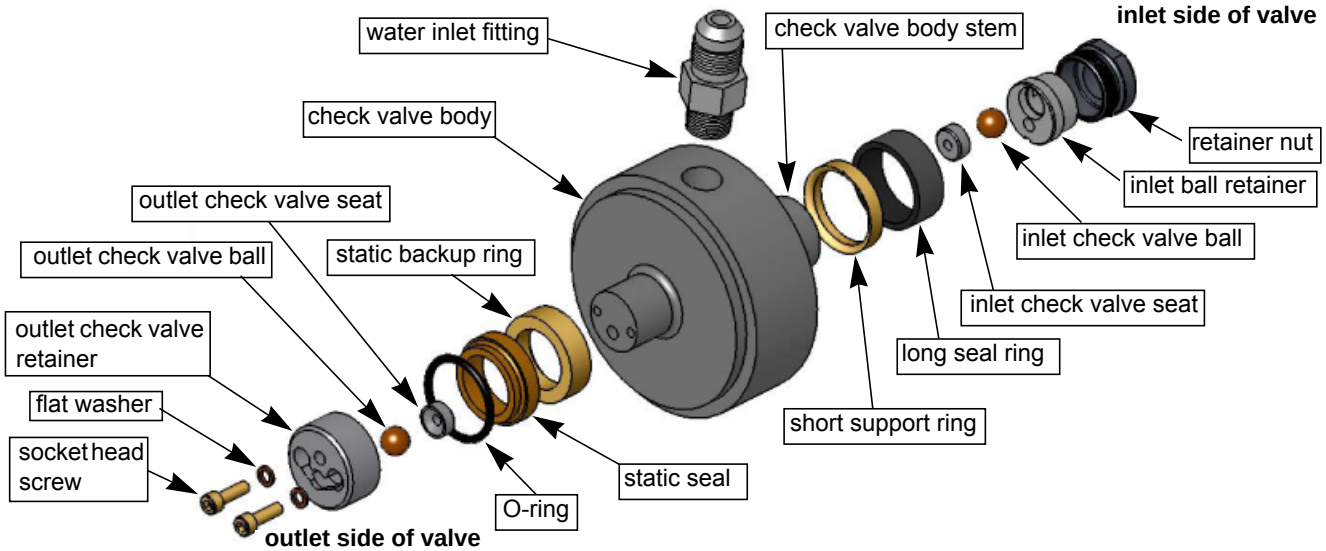


Figure 6-22

1. Assemble the outlet side of the **check valve assembly** first.
2. Apply **Lubriplate** to the **O-ring**. Place the **static backup ring**, then 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 6-23). 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 **socket head screws**. Install **flat washers** and the two socket head screws through the **outlet check valve retainer** (Figure 6-23):

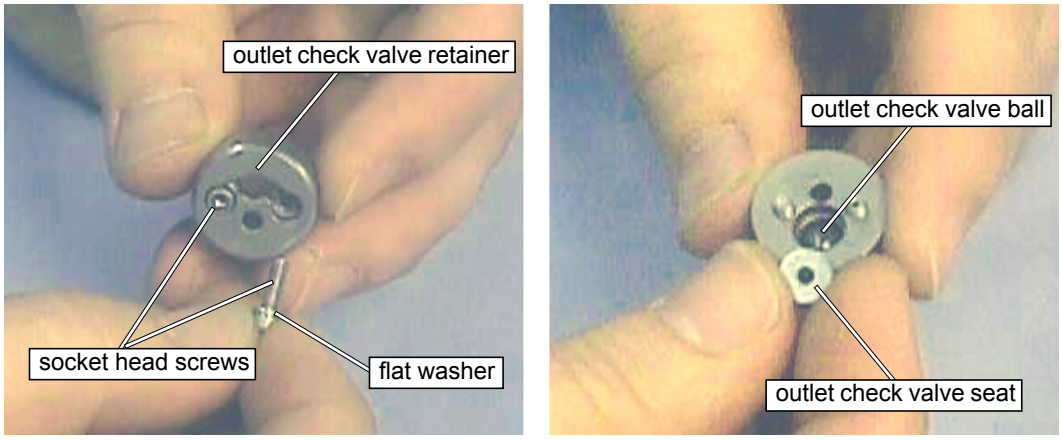


Figure 6-23

4. Place the **outlet check valve ball** followed by the **outlet check valve seat** in the **outlet check valve retainer**. Be sure the flat side of the outlet check valve seat faces away from the ball. The outlet check valve seat should be flush, or no more than 0.001" (0.0254 mm) above, the surface of the outlet check valve retainer.
5. Place assembled **outlet check valve retainer** on the outlet end of the **check valve body stem** with the **outlet check valve seat** up against the end of the stem (Figure 6-24).

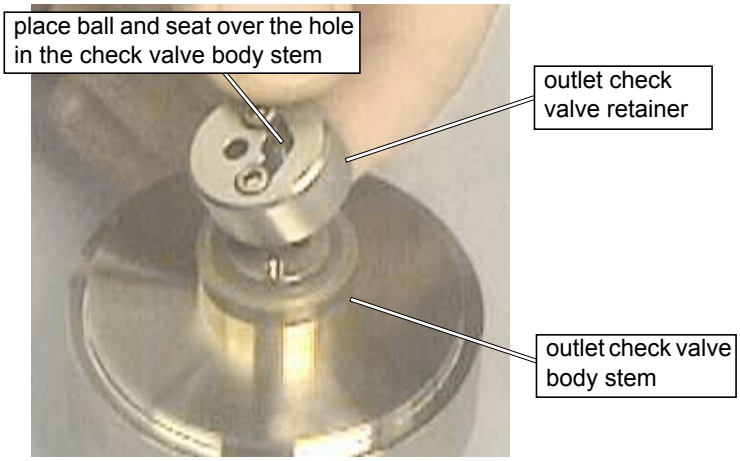


Figure 6-24

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. Using the 3/32" Allen wrench, tighten the two **socket head screws** from 3 to 5 in-lbs (.34 to .57 N-m). Holding the Allen wrench as shown in Figure 6-25 prevents over tightening the screws.

Figure 6-25

7. Repeat steps 1 through 6 for remaining **check valve body assemblies.**
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 **short support ring**, with the small notch facing down, over outside of the **check valve body stem** on the inlet side.

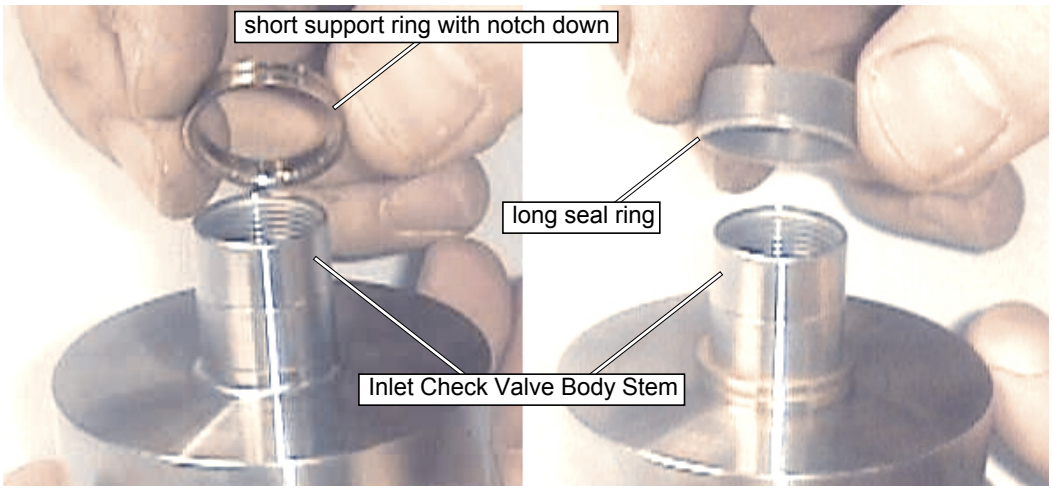


Figure 6-26

10. Install **long seal ring** over outside of the **stem** (Figure 6-26).
11. Next, insert the **inlet check valve ball** followed by the **seat** into the **inlet ball retainer** (Figure 6-27). 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.*

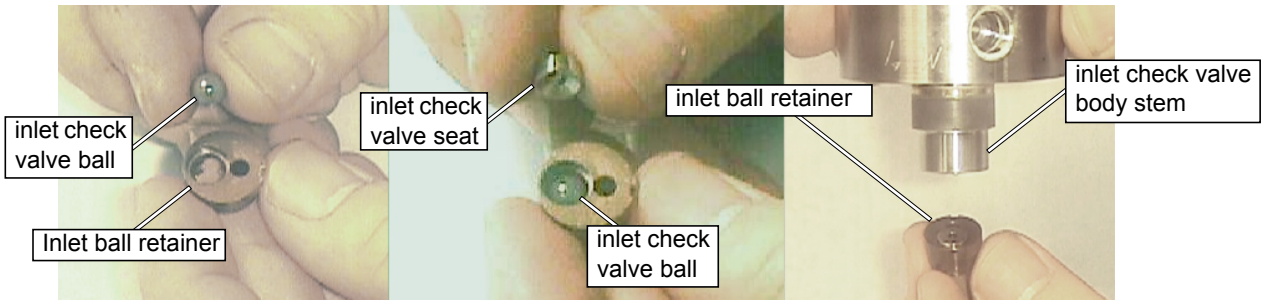


Figure 6-27

12. Hold the **check valve body** so its stem is facing down to enable insertion of the assembled **inlet ball retainer** (Figure 6-27).

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.*

13. Apply a small amount of **anti-seize compound** to threads of the **retainer nut** and bottom lip of the retainer nut that contacts the **inlet ball retainer** (Figure 6-28).

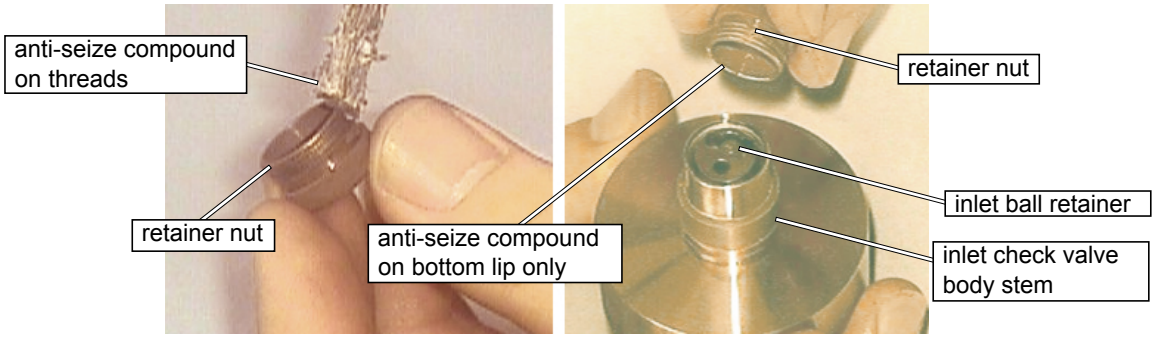


Figure 6-28

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** and insert it through the outlet port of the **check valve retainer** and into the **check valve body**. Clamp the outside diameter of the **check valve body** in the soft-jaws of a vise and torque the **retainer nut** to 200 in-lbs (22.6 Nm) using a 5/8" (16 mm) crows foot (Figure 6-29):

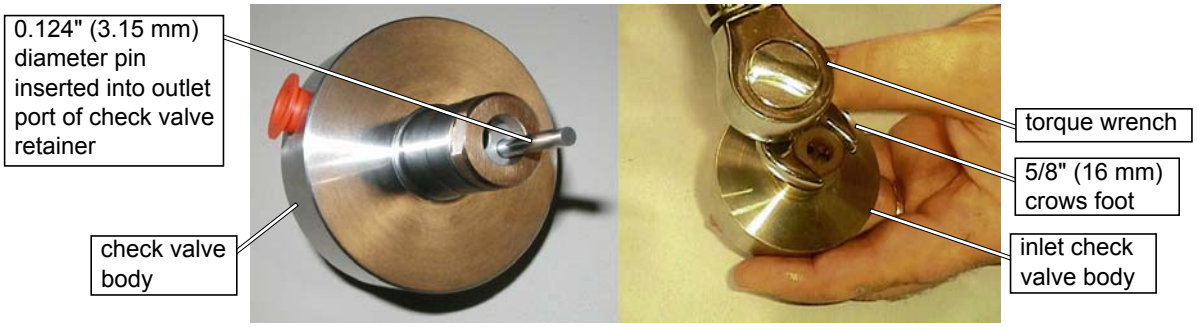


Figure 6-29

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 port adapter high-pressure 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.

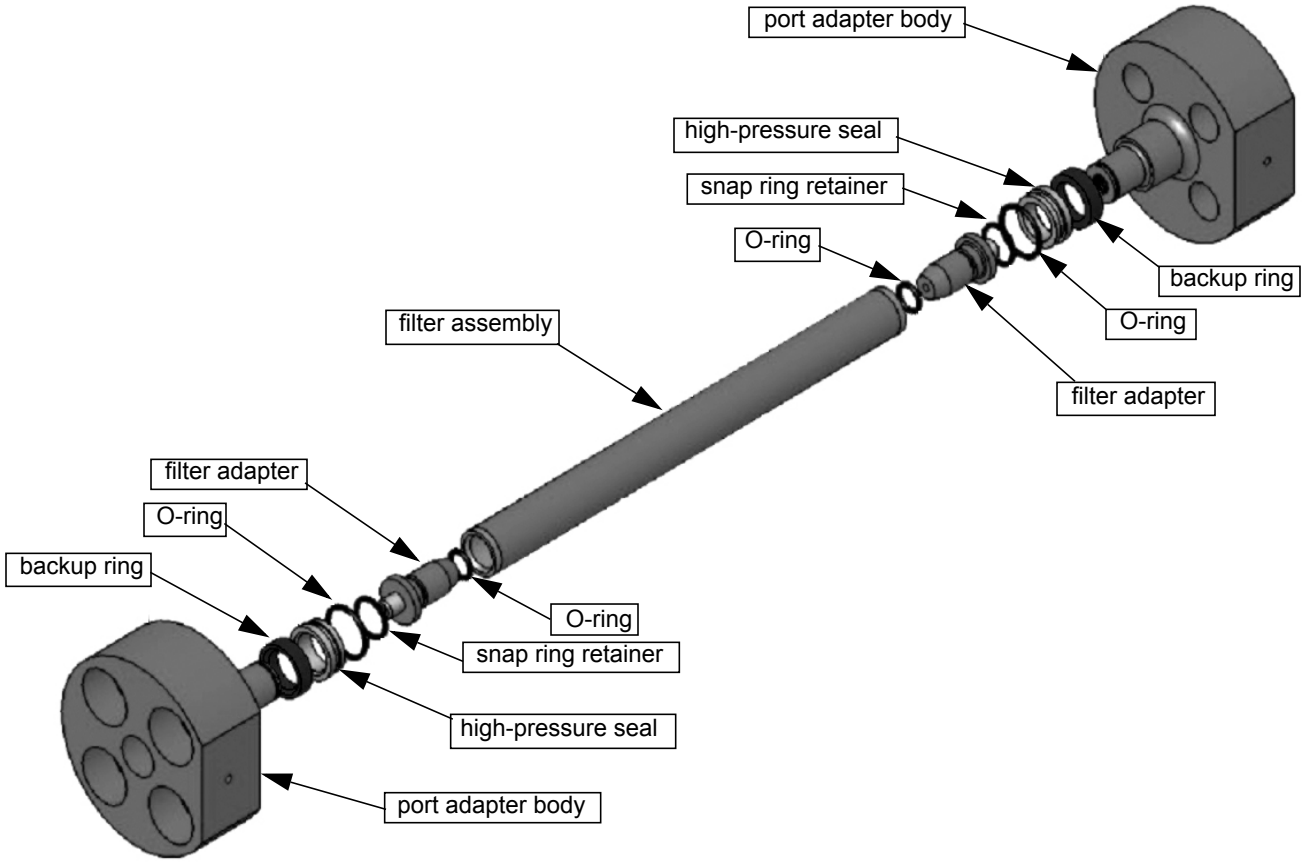


Figure 6-30

To replace the High-pressure Port Adapter Seals and Filter

1. Place **manifold body** (Figure 6-1) into a vise.
2. Using the 14 mm Allen wrench, remove the four **socket head screws** (Figure 6-1) from both **port adapters**.
3. With the soft-blow mallet, strike the **port adapter** on each side until a gap opens between the **manifold** and port adapter.
4. With two flat-tipped screwdrivers, pry the **port adapter** out of the **manifold**. Follow the same procedure to remove the second port adapter.

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

5. Remove the **filter assembly**. Using the 5/8" (16 mm) open-end wrench, remove the **filter adapters** from each **port adapter**.
6. Remove the **snap ring retainer** from end of the **port adapter stem** using snap ring pliers. Slide the **high-pressure seal**, **O-ring**, and **backup ring** off the stem of the port adapter body. discard high-pressure seal and o-ring.
7. Clean **backup ring** and **port adapter**. Examine edges of the backup ring to determine if edges are square and sharp. Check backup ring for cracks near the notch. Replace backup ring whenever problems are apparent.
8. Install the **backup ring** onto the stem of the **port adapter** with chamfer on the inside of the backup ring facing toward the port adapter body.
9. Place a small amount of **Lubriplate** on new **O-ring** and install it on a new **high-pressure seal**. Slide the high-pressure seal onto the stem of the port adapter body such that the large diameter portion of the high-pressure seal is next to the backup ring.

10. Install the **snap ring retainer**.
11. Place a small amount of **Lubriplate** on the **O-ring** and install it into the O-ring groove on the **filter adapter**. Thread the filter adapter into the stem of the **port adapter** body. Tighten until just snug using the 5/8" (16 mm) open-end wrench.
12. Repeat above rebuild procedure for remaining **port adapter assembly**.
13. Install **filter assembly** on one of the **port adapters** by sliding it over the end of the **filter adapter** until the filter adapter rests against filter adapter shoulder.
14. Apply a small amount of **Lubriplate** into **manifold** bores.
15. Position the **port adapter** with its flat side of the body facing away from the direction of the **cylinders** (Figure 6-1).

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 manifold.*

16. Place **manifold assembly** onto a flat surface with the **check valve** (Figure 6-1) ports facing up. Apply a small amount of **anti-seize lubricant** to threads of the four **socket head screws** (Figure 6-1) and tighten them sufficiently to hold the **port adapters** in place. Secure the manifold assembly into a vise and torque each socket head screw to 100 ft.-lbs (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 MAXIEM 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:

- 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.
- 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.

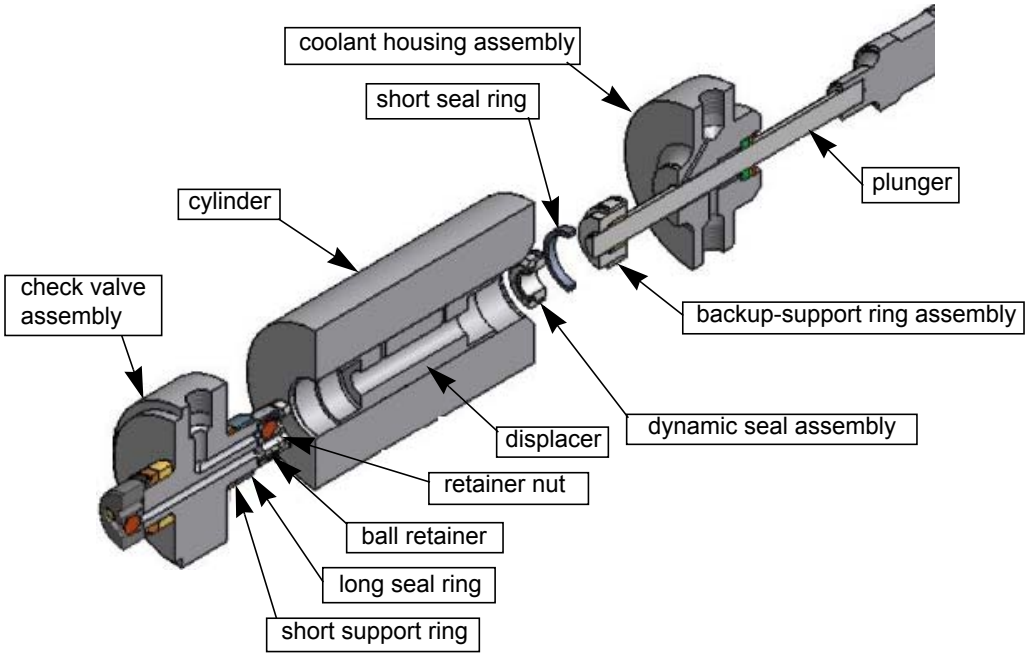


Figure 6-31

To assemble the wet end assembly:

1. Apply a light coat of **Lubriplate** to the interior of the holes on the **pressure manifold** (Figure 6-1) and **check valve body** (Figure 6-22) 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 **displacer** over the **inlet check valve retainer** (Figure 6-22) until it contacts the **long seal ring** (Figure 6-31). Repeat this for all three check valve assemblies.

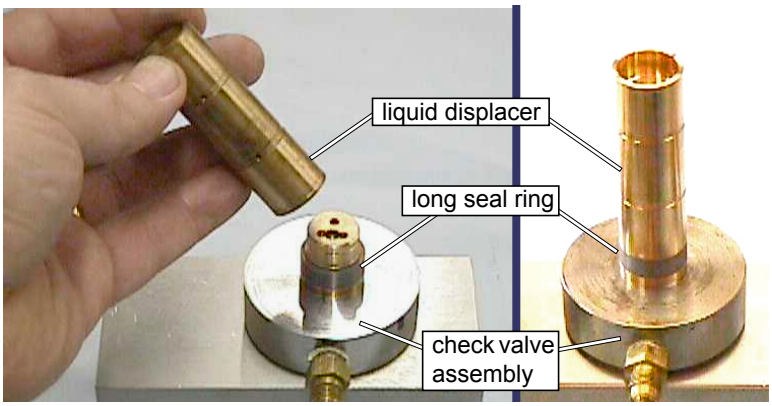


Figure 6-32

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 6-33. The end of the displacer must make contact with the seal ring.***

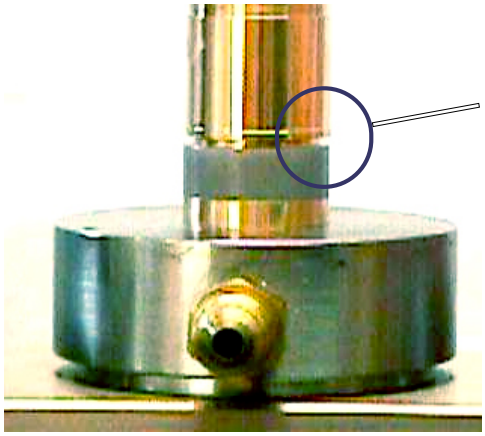


Figure 6-33

4. Apply a light coat of **Lubriplate** just inside the bore of the **cylinder** and on the end of the cylinder without the large chamfer (Figure 6-34). Slide the cylinder over the **displacer**, **long seal ring**, and **short support ring** until it comes in contact with the **check valve body**.
5. Verify the end of the **cylinder** WITHOUT the large chamfer is against the **check valve body**.

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 seal ring. 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.***

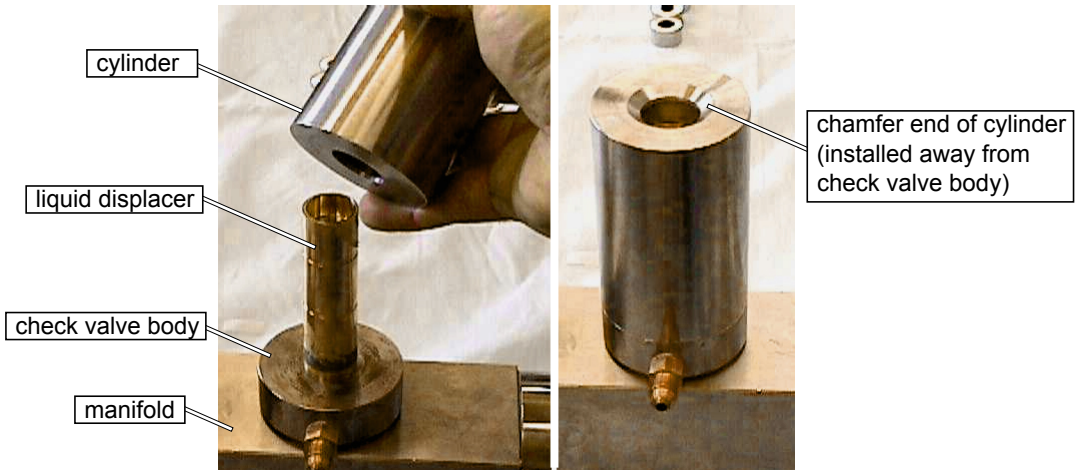


Figure 6-34

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

Replace Water Coolant Housing Seal

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

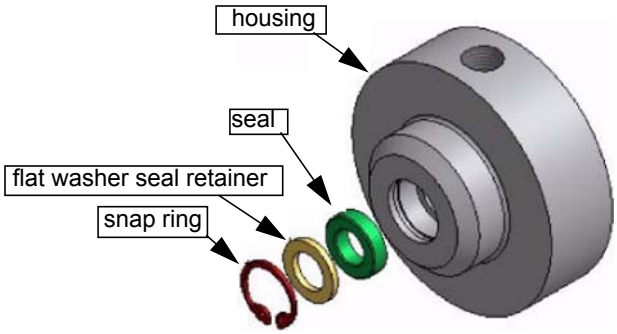


Figure 6-35

1. Remove **coolant housing assemblies** (Figure 6-36) by sliding them forward until they clear the end of the **plungers**. The **coolant housing** fits snugly to the bore in the **adapter block** (Figure 6-36) and may be difficult to remove. Use the two fittings, top and bottom, of the coolant housing to rotate the assembly while removing it. During removal, keep it aligned with the bore.

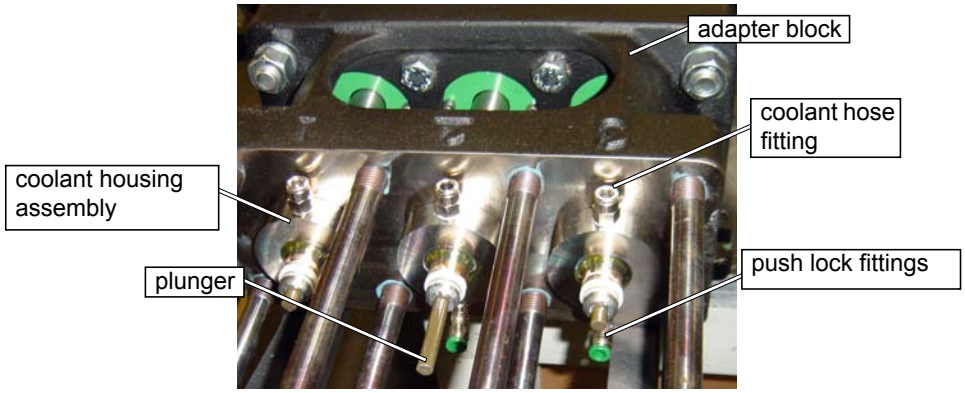


Figure 6-36

2. Pull coolant **hoses** out of the **push lock fittings** by pulling back on the outer ring of the fitting to release the locking device within the fitting while pulling on the coolant hose.
3. After removing **coolant housing**, remove **water hoses** from **housing assemblies** by pulling back on the green ring of the push-to-lock fittings.
4. Remove the **snap ring** (Figure 6-35) with the set of internal snap ring pliers. Use small screwdriver to lift **flat washer seal retainer** out of housing bore. Remove the seal in the same fashion.
5. Apply a small amount of **Lubriplate** to the lip of the new **seal** and install it with the pressure lip, or cup, facing into the **coolant housing**, followed by the **flat washer seal retainer** 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.***

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 seal must also be replaced along with the dynamic seal.*

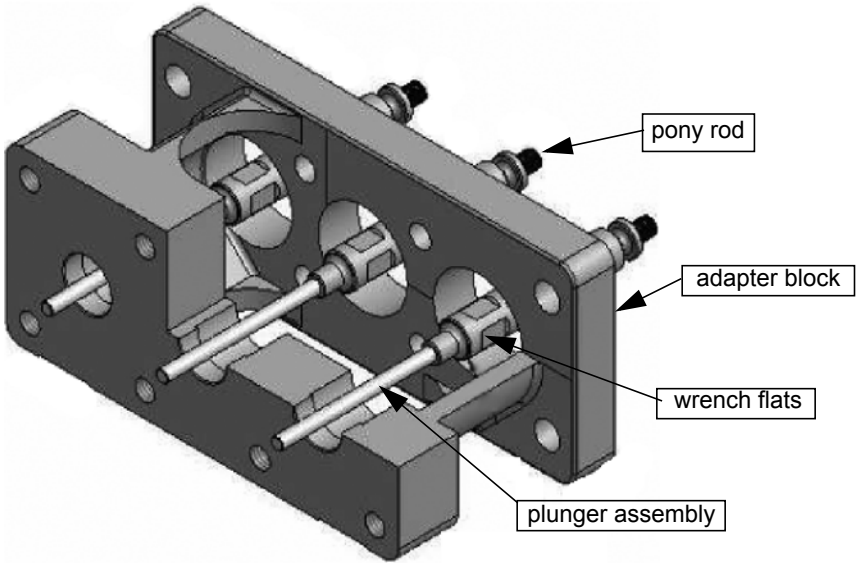


Figure 6-37

1. Remove **coolant housings** (Figure 6-36), if not already removed.
2. Access to the **wrench flats** on **plunger assemblies** is through an opening in the top of the adapter block. Remove metal **cover plate** (Figure 6-38) on top of the adapter block and set it aside.
3. Remove **rubber cover** from the belt **access hole** on the belt guard.

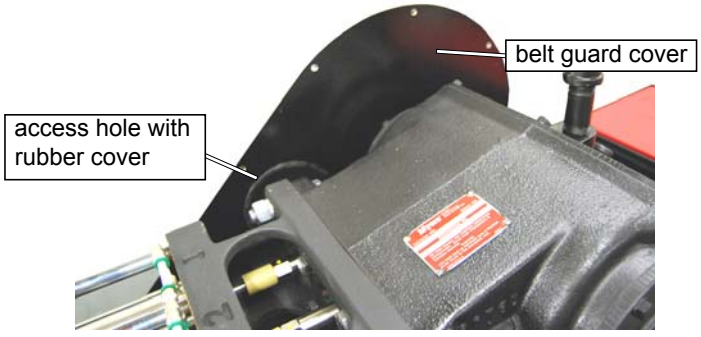


Figure 6-38

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. Use the 3/4" crows foot on a 3/8" drive breaker bar with a steady pull to loosen the **plunger assembly**. Avoid jamming the wrench and permanently bending the plunger assembly.

Install Plunger Assemblies

1. Ensure threads on **plunger assemblies** (Figure 6-37) 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. Using a 3/4" crow's foot and torque wrench, tighten each assembly to a torque of 225 in-lb, or 19 ft.-lb (25 N-m).

Assemble Dynamic Seal Assembly

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

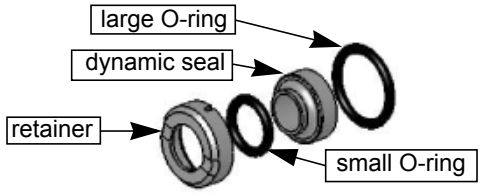


Figure 6-39

1. Place **small O-ring** on the extended lip of the **dynamic seal**.
2. Apply a small amount of **Lubriplate** to the outside of the **small O-ring**.
3. Snap the metal **retainer** over the **small O-ring** onto the **dynamic seal**. 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** over the outside of the back of the **dynamic seal**.

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.***

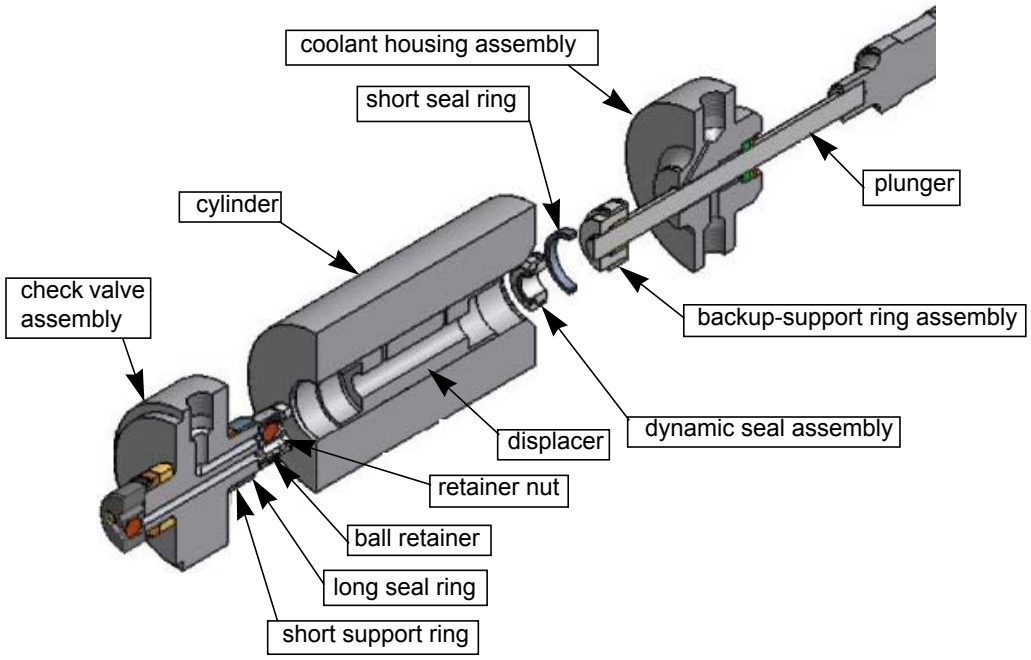


Figure 6-40

To assemble the pump:

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.

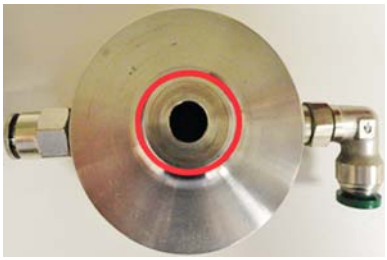


Figure 6-41

3. Slide the **coolant housing assembly** over the **plunger** until it is fully engaged into the bore in the **adapter block** (Figure 6-42). Note the plunger is not rigidly held and can be moved slightly for alignment with the coolant housing assembly.

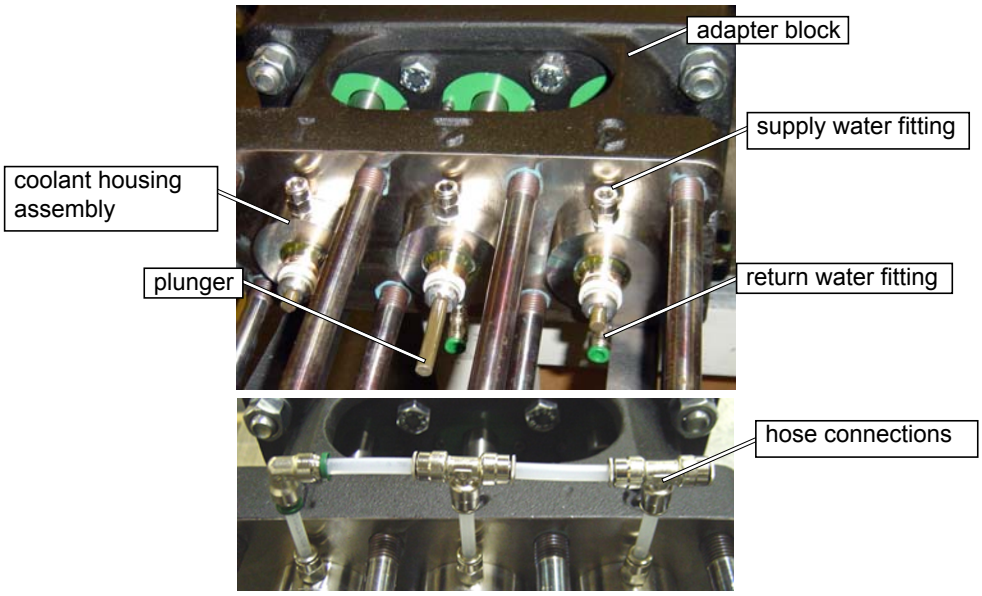


Figure 6-42

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

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 **short seal ring** onto the backup-support **ring assembly** and up against the support ring.

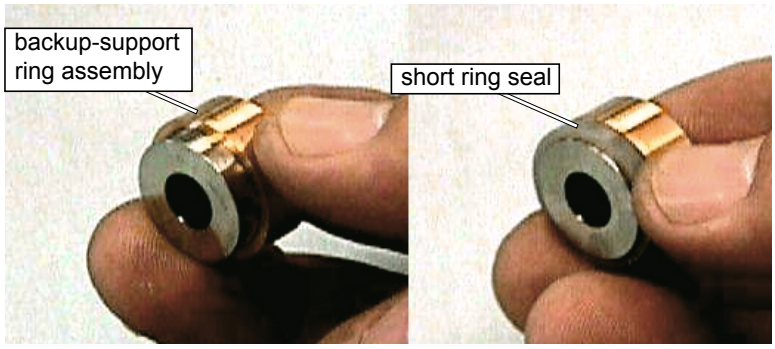


Figure 6-43

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

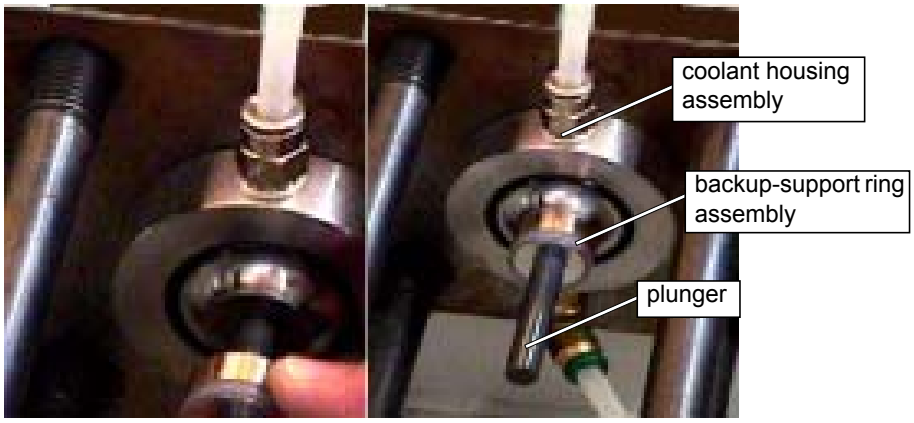


Figure 6-44

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

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

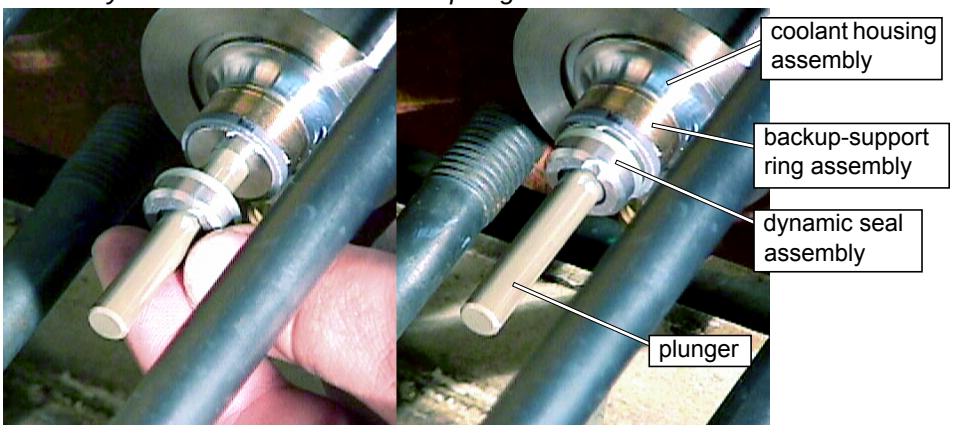


Figure 6-45

8. Apply a light coating of **Lubriplate** to the exterior surface of the outer ring on the **backup-support ring assemblies**.
9. Slide the **wet end assembly** over the **plungers**. 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** begin to slide over the **short seal rings** (Figure 6-46), they may, or may not go on all the way by hand. The small gap that occurs between the end of the cylinders and the coolant housings 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.***

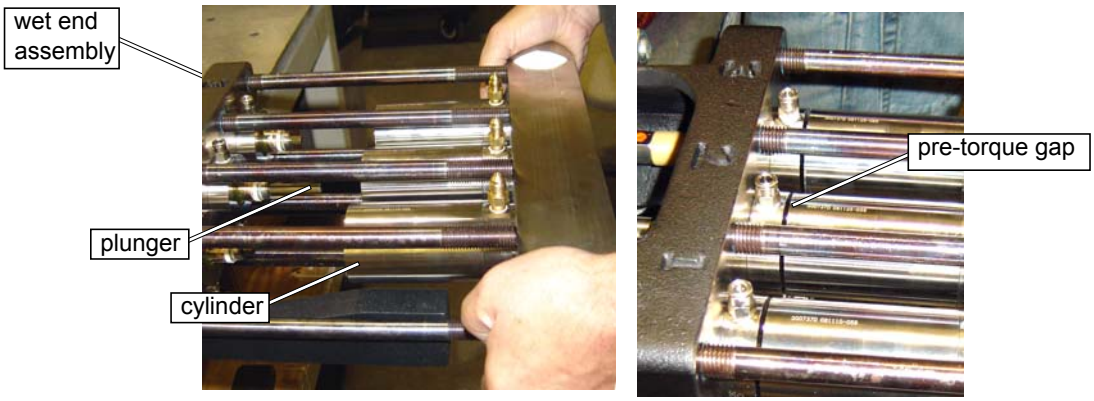


Figure 6-46

10. Install the **clamp plate** and two **nuts** on the **studs** numbered 1 and 2 in Figure 6-47, using a generous amount of anti-seize compound on both the **stud threads** and the side of the **nuts** that face the **clamp plate**. Tighten the two nuts evenly until they are snug. An even gap of approximately 0.070" (1.78 mm) should remain between the end of the cylinders and the coolant housing assemblies. Install remaining Nuts hand tight, again using a generous amount of anti-seize on Stud threads and Nut faces.

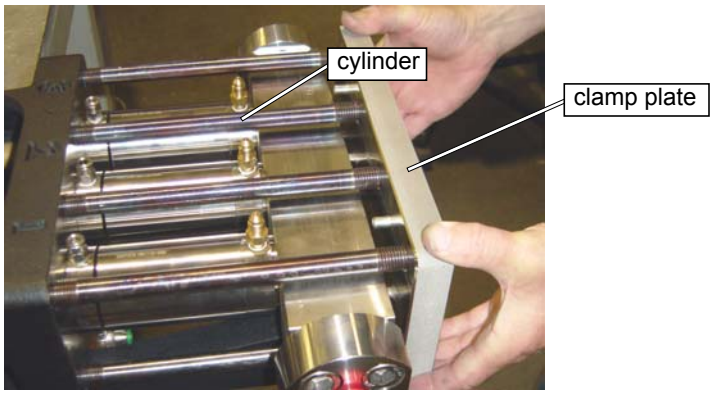


Figure 6-47

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 ring seals and studs.***

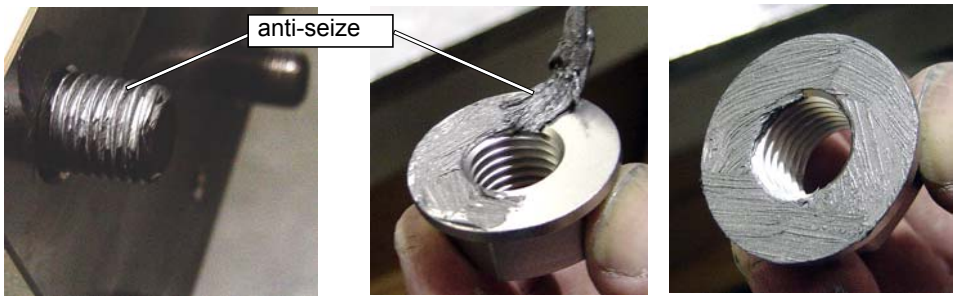


Figure 6-48

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

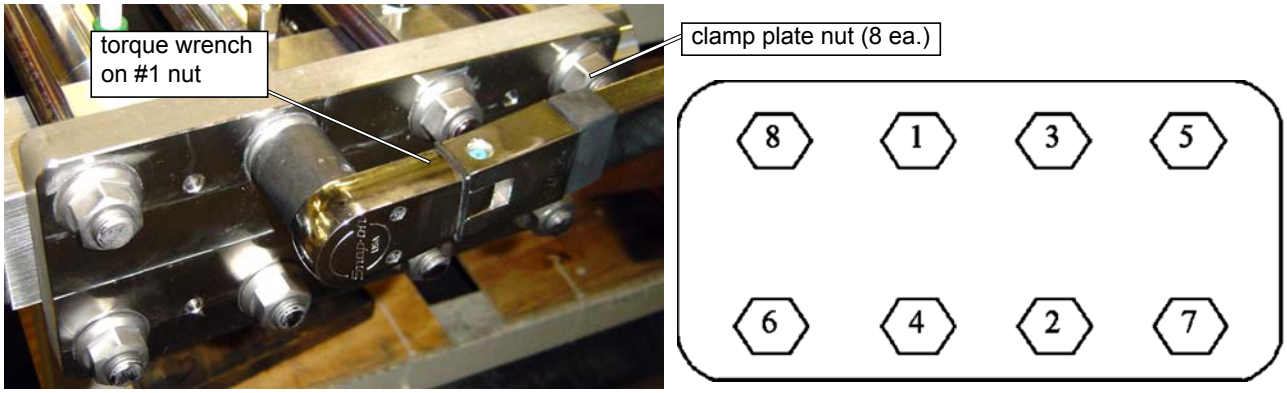


Figure 6-49 Torque Sequence for Tightening Clamp Plate Nuts

Caution: ***Verify all nuts are tightened evenly in the order specified in Figure 6-49 to avoid internal component damage and to achieve an even loading of ring seals and studs.***

12. 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.
13. Install **access cover** onto the **belt guard** (Figure 6-38).
14. Install plunger cover over the plungers.
15. Complete **pump** assembly by connecting outlet **high-pressure tubing** and **low-pressure inlet hoses**.

Chapter 7
Rebuilding the Adjustable Dump Orifice

This chapter explains how to replace wear items in a MAXIEM Adjustable Dump Orifice (ADO) using rebuild kit, P/N 306500. See Figure 7-1.

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

Verify the following parts are included in your ADO Rebuild Kit:

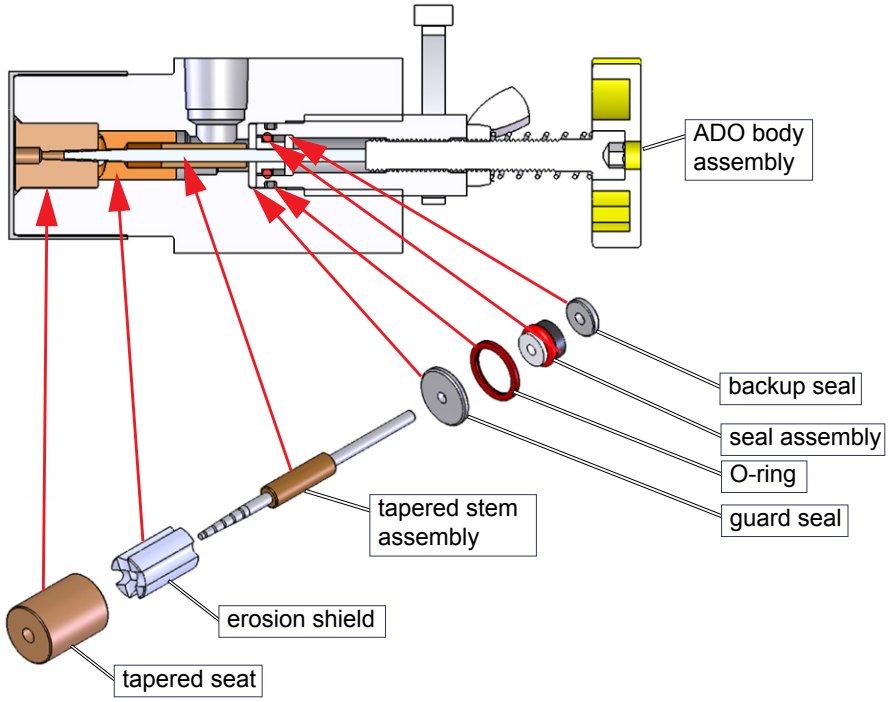


Figure 7-1

Tools and Additional Items Required

Refer to Tools Required for Pump and Table Maintenance on page 4-2.

Removing the ADO

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

1. Power down the abrasivejet, pump, and charge pump using approved tag and lockout procedures.
2. Shut down the main air and water supply.
   - 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.

3. Disconnect any air hose in the pump air supply system that allows all air pressure to vent.
4. Remove the upper pump cover:

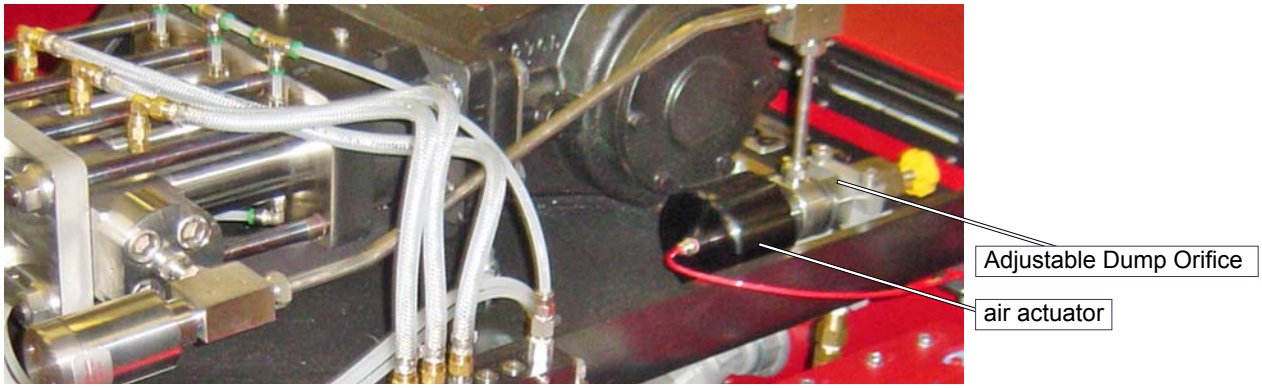


Figure 7-2

5. Disconnect the nipple from the ADO by unscrewing the gland nut on the high-pressure tubing (Figure 7-3) using the 13/16" open-end wrench.

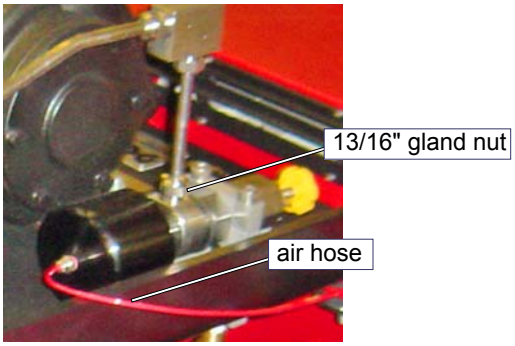


Figure 7-3

6. Remove air hose from the top of the on/off valve air actuator.
7. Remove drain hose beneath the ADO using the 7/8" open-end wrench (Figure 7-4)

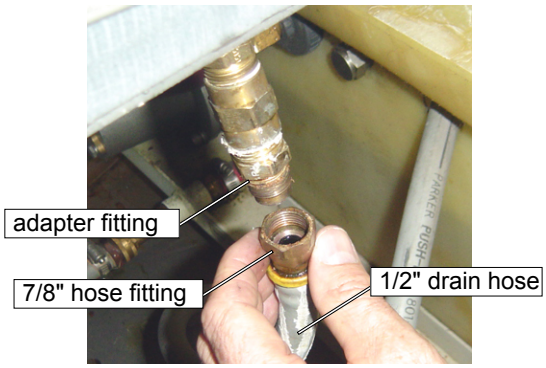


Figure 7-4

8. Remove two mounting clamp screws that secure the ADO to the pump chassis (8mm Allen wrench).

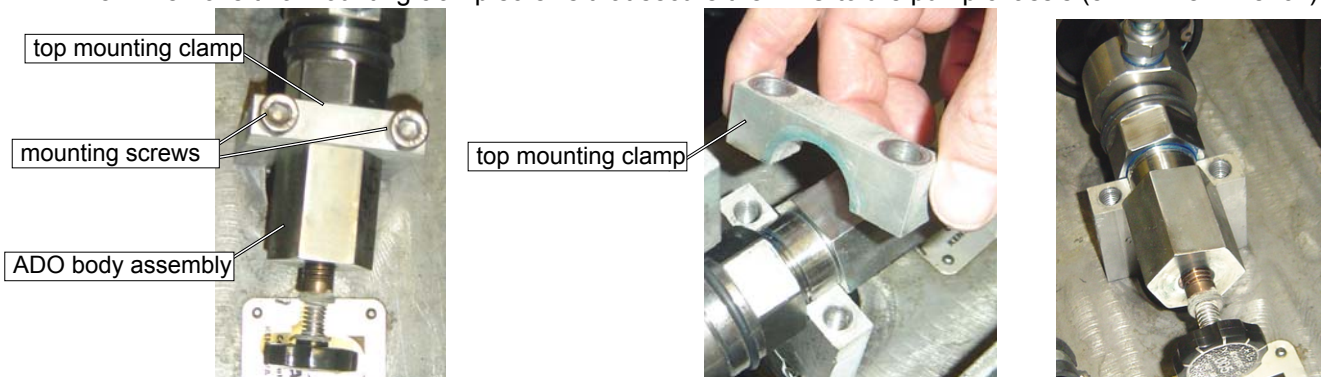


Figure 7-5

9. Lift ADO from its mount and place on a workbench for disassembly.

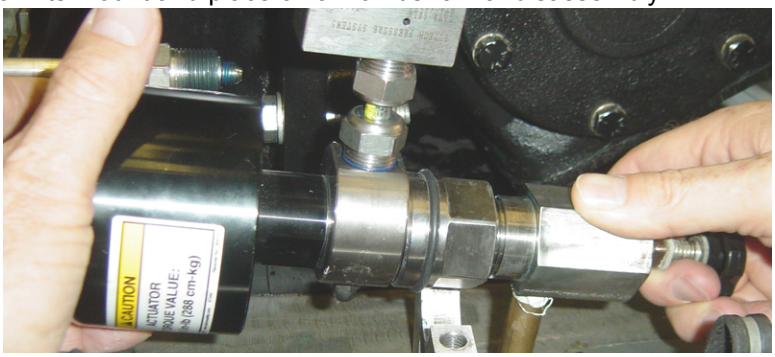


Figure 7-6

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. See Figure* 7-1 for components:

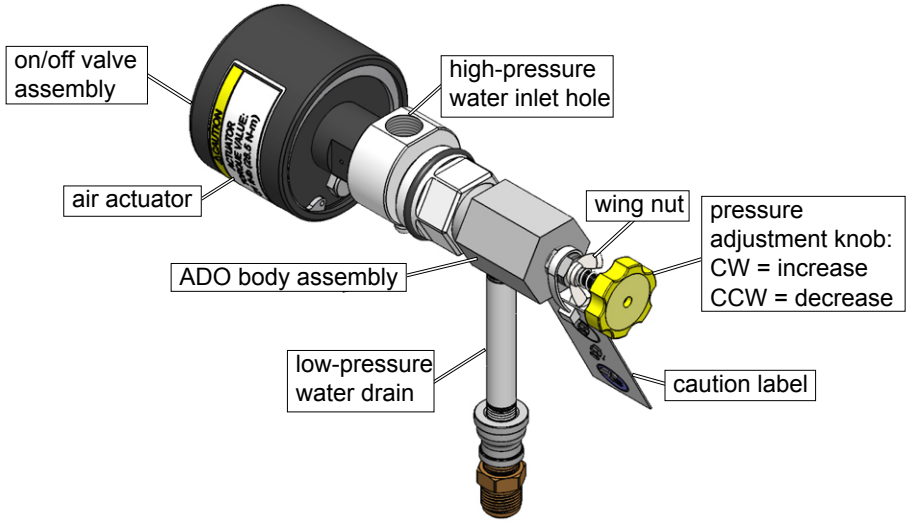


Figure 7-7

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

1. With the ADO assembly on a workbench, remove the body assembly using a 1-1/2" wrench on the on/off valve and a 1-1/2" wrench on the body assembly:

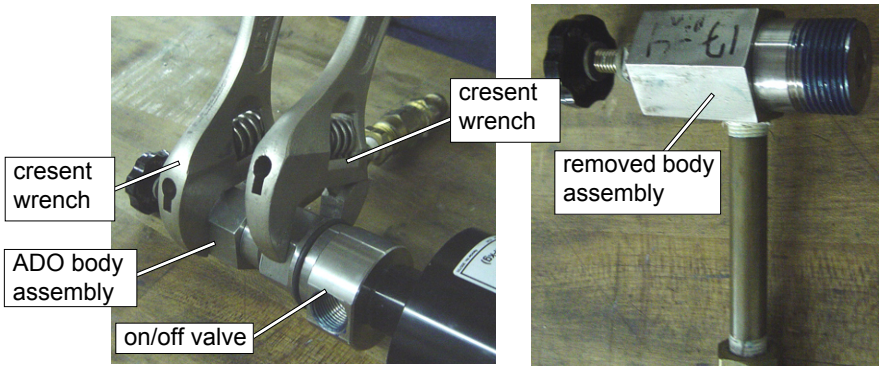


Figure 7-8

2. Unscrew the stem adjuster from the body assembly using a 1/2" open-end wrench.

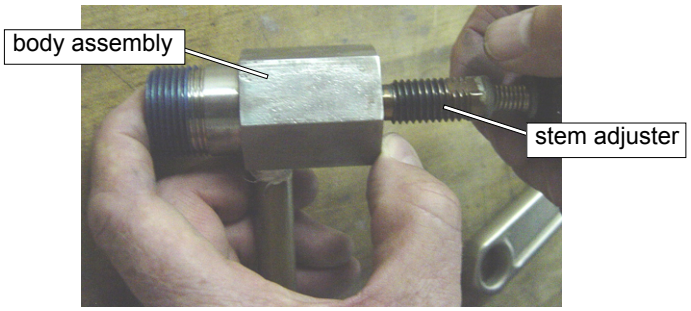


Figure 7-9

3. Pull the stem adjuster from the body assembly along with the tapered stem and attached seals.
4. Using a thin diameter tool such as a small Allen wrench, push out the tapered seat and erosion shield from the body assembly. See Figure 7-10:

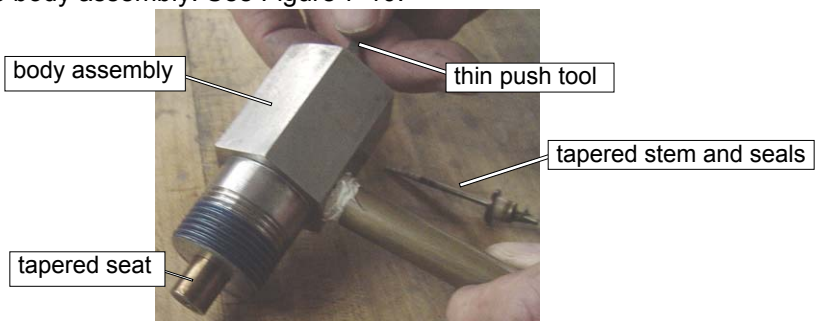


Figure 7-10

5. Remove and discard each seal component identified below (Figure 7-11), replacing them with parts provided in the ADO rebuild kit (see Figure 7-1).

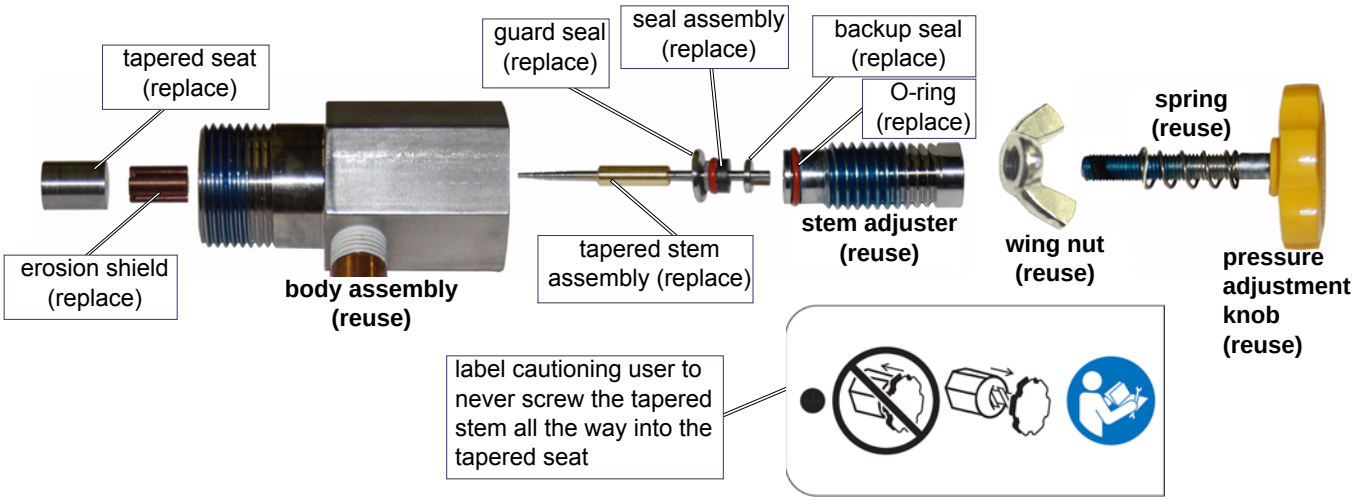


Figure 7-11

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. See Figure 7-12:***

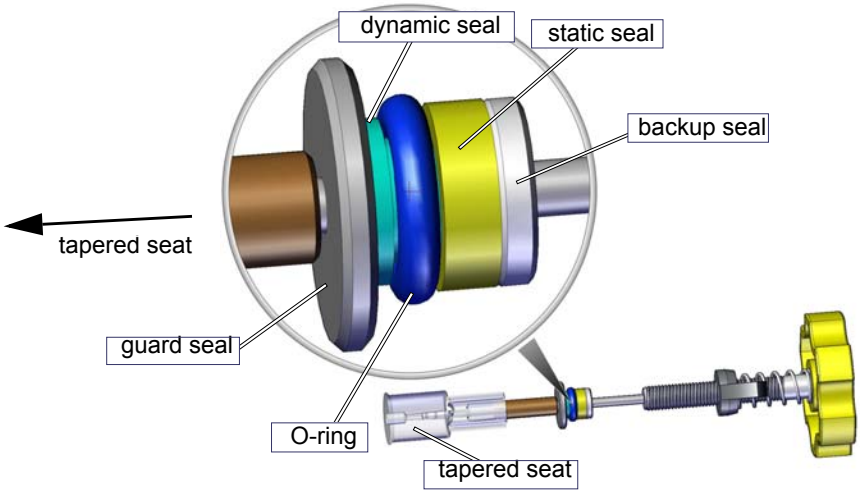


Figure 7-12

6. Install the new erosion shield into the body assembly, inserting the large diameter bore end in first (Figure 7-13).

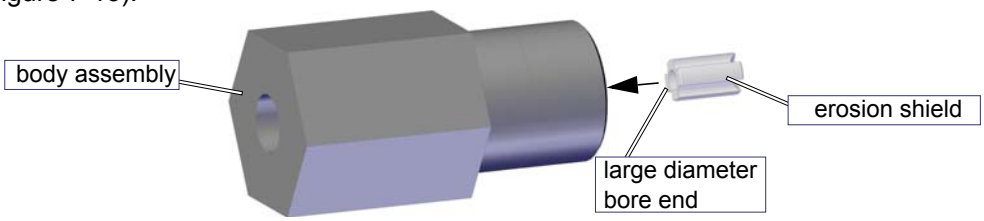


Figure 7-13

7. Apply a thin film of Extreme Pressure Lube to the outside diameter of the tapered seat (Figure7-13).
8. Place seat in the body assembly.

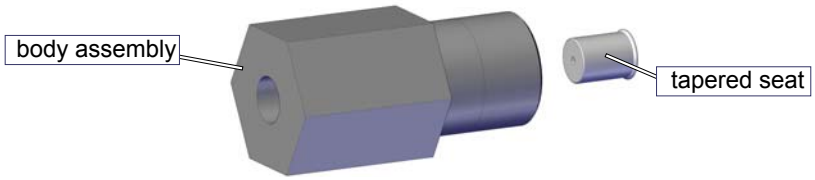


Figure 7-14

9. Place guard seal on stem assembly (Figure7-15).

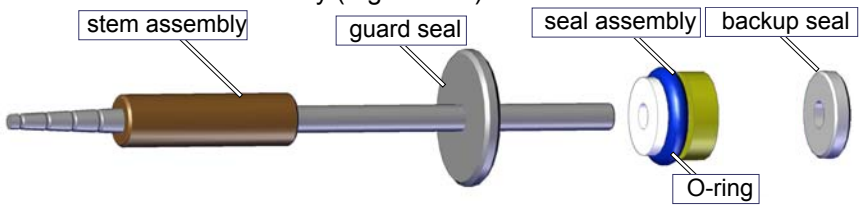


Figure 7-15

10. Apply a light film of Lubriplate on the stem assembly and carefully slide on the seal assembly with the white end toward the guard seal (Figure7-15).
11. Place backup seal on the stem assembly.
12. Apply a thin film of Lubriplate on seal assembly.
13. Carefully push tapered stem assembly and components in the stem adjuster until the brass sleeve and guard seal contact the bottom of the stem adjuster.

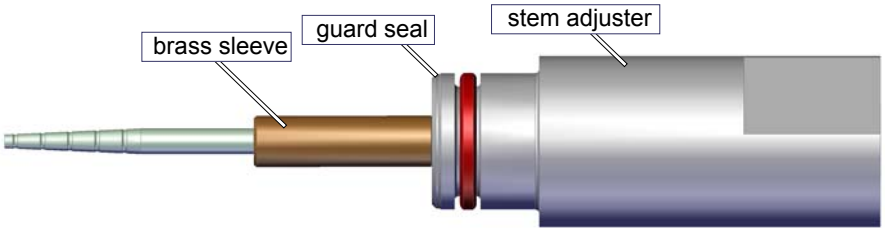


Figure 7-16

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

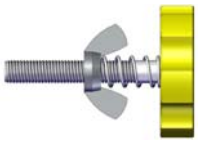


Figure 7-17

15. Apply a light film of anti-seize lubricant to threads of the adjustment knob and screw into stem adjuster until a 0.03" gap opens between the guard seal and stem adjuster.

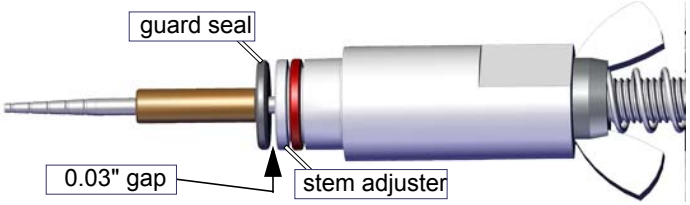


Figure 7-18

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

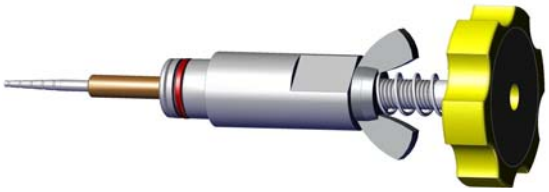


Figure 7-19

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

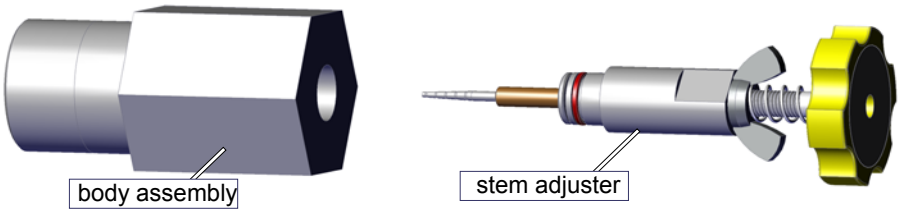


Figure 7-20

18. With a 1/2" open-end wrench, lightly tighten stem adjuster (about 20 ft-lb).

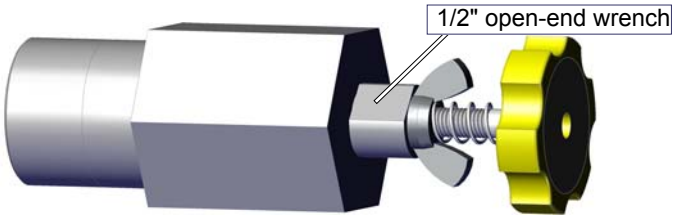


Figure 7-21

Caution: ***Never close the ADO valve 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 seat causing the pump to dead head and requiring 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 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 7-22). 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. Refer to Figure* 7-7. This alignment enables later installation of the nipple ring (*Figure* 7-25).

Note: *For additional information, refer to ADO NIpple Alignment DVD, P/N 307811.*

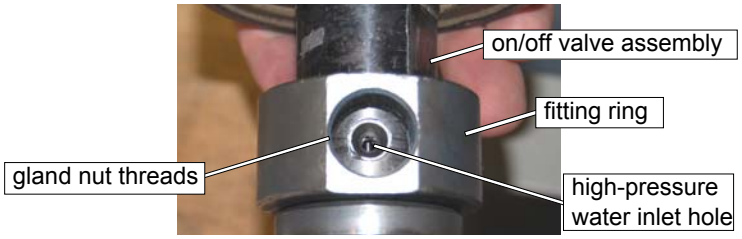


Figure 7-22

2. Once water inlet hole and fitting ring are aligned 180 degrees opposite the body assembly's brass nipple, place the 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 in alignment while tightening.***

3. Place the ADO assembly back onto the mounting clamp as illustrated in Figure 7-23 with on/off valve pointing towards the safety valve (Figure 7-25) and the brass nipple inserted into the chassis hole:

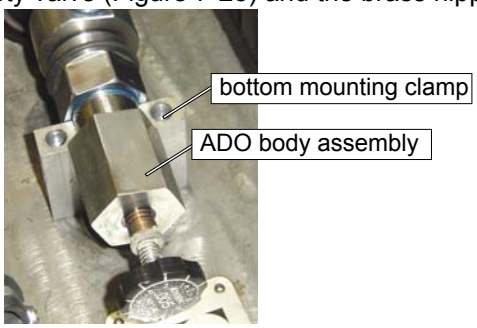


Figure 7-23

4. Place the top mounting clamp over the body assembly, insert the two M10 screws, and hand tighten both securely (8 mm Allen wrench).

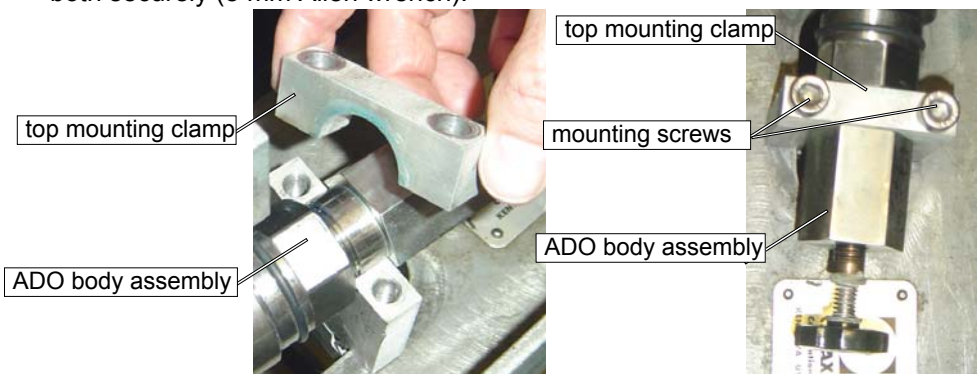


Figure 7-24

5. Insert the nipple assembly's gland nut into the fitting ring in the on/off valve. Finger tighten only at this time. Refer to Figure 7-25.

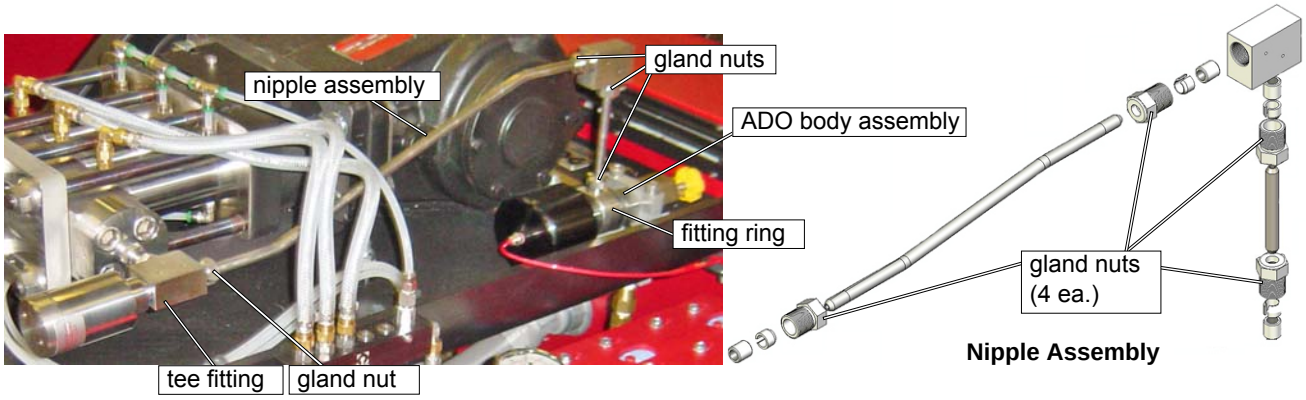


Figure 7-25

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

6. Tighten the gland nut on the fitting ring by placing a 13/16" open-end wrench on the gland nut and a 1" open-end wrench on the fitting ring.
7. Tighten the two ADO mounting screws (Figure 7-24).
8. Connect air hose removed earlier to air fitting located on top of the air actuator.
9. Connect 1/2" water hose using a 7/8" open wrench to the adapter fitting beneath the ADO (Figure 7-26).

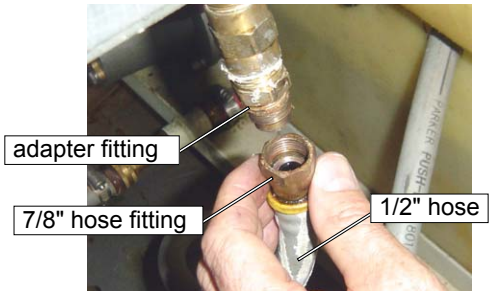


Figure 7-26

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

Adjusting ADO Pressure

ADO pressure requires adjusting anytime a different sized orifice is installed in the nozzle, or a defective or worn jewel is replaced. Refer to *Setting Up the Hardware* on page 3-7.

Correcting Water Leaks in the ADO Assembly

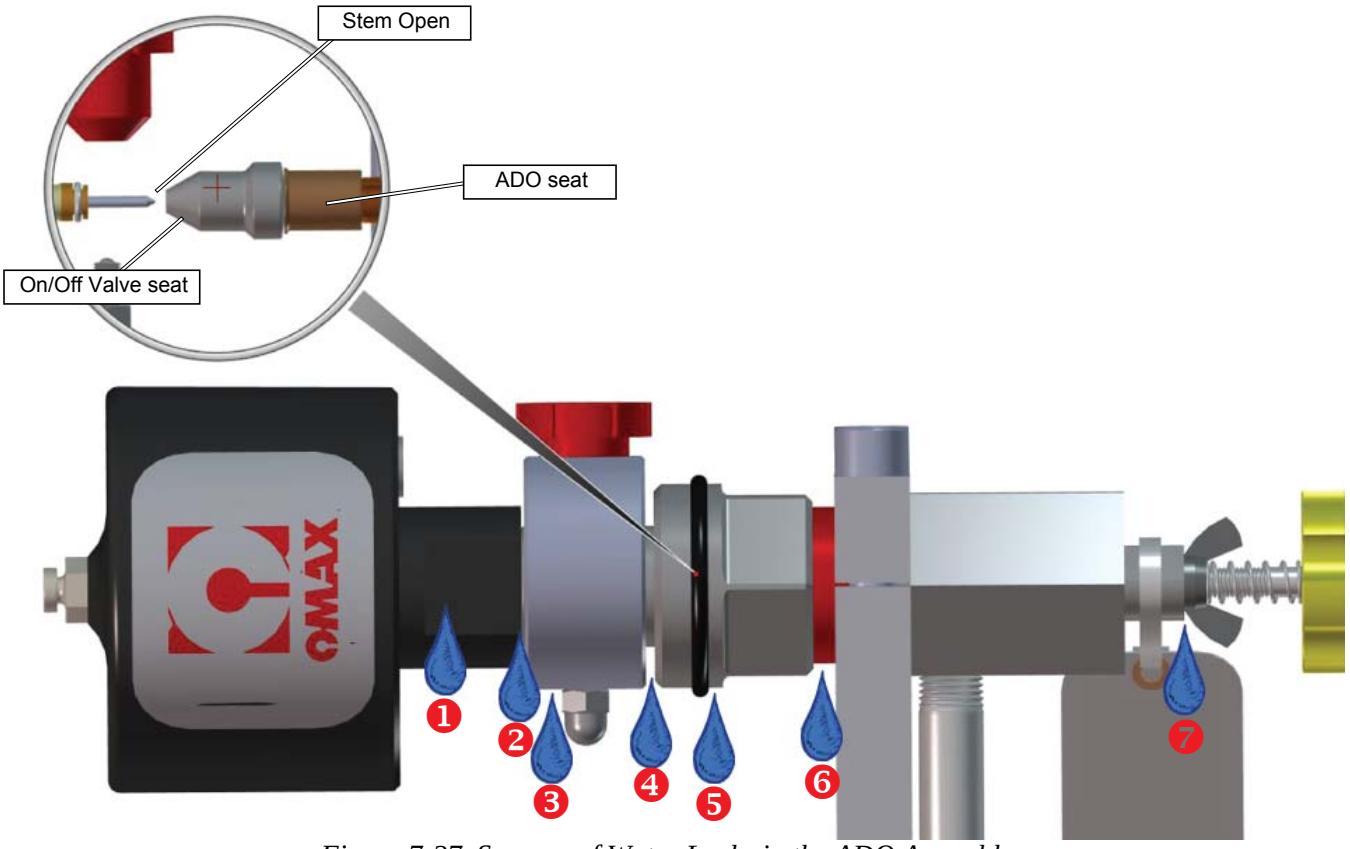


Figure 7-27 Sources of Water Leaks in the ADO Assembly

Troubleshooting Leaks in the ADO Assembly

Leak Point	Leak/Other Point Description	Suspected Causes	Recommended Action
1	air actuator weep hole	• leaky seal • cracked body	• Verify air actuator torqued at 250 in-lb (28.2 N·m); replace seal • check valve body for cracks
2	leak between air actuator and fitting ring	• leaky seal • cracked body	• replace seal • check valve body for cracks
3	leak 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	leak from weep hole between collar and nut	• cracked body; loose nut • failed seat or seal	replace defective component; tighten nut
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
6	if leaks between gland nut and ADO body, a low pressure leak	normal wear leakage	low pressure leaks fixed during regular scheduled maintenance.
7	leak at ADO wing nut	normal wear leakage	rebuild with ADO kit

Note: *Diagram shows both the ADO and On/Off valve. Troubleshoot each component separately.*

Troubleshooting ADO Assembly Leaks

If you see leaks at the weep hole between collar and nut (item 4 on page 7-10 or at item 5 on page 7-10), troubleshoot with these tests.

1. In OMAX **Make**, click **Test**, then click **Pump Only (Dump valve open)**.
2. If leak occurs at item 4 or 5:
   a. On/Off valve seat is defective, or
   b. On/Off valve body is cracked.
3. In OMAX **Make**, click **Test**, then click **Water Only (Pump is active)**.
4. If leak occurs at item 4 or 5:
   a. leak is between On/Off valve seat and ADO seat
   b. repair with On/Off valve repair kit first, or ADO repair kit.