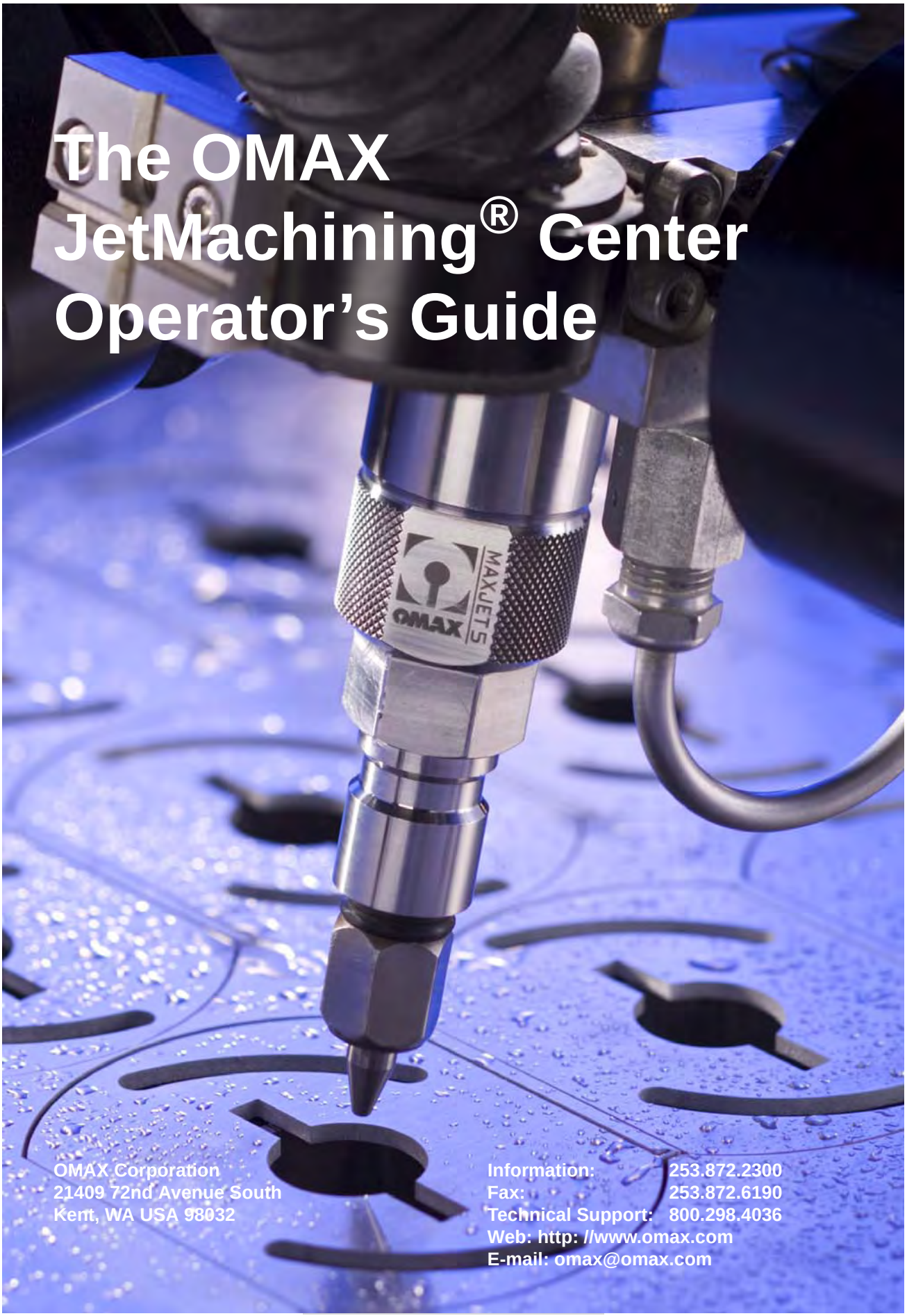
The OMAX JetMachining® Center Operator's Guide



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OMAX Corporation believes the information described in this manual is accurate and reliable. From time to time, design improvements will be made to the JetMachining Center. Photographs, text, and sketches within the body of this manual may not exactly represent your equipment. In general, this manual contains the most up-to-date information available. However, OMAX Corporation cannot accept any responsibility, financial or otherwise, for any consequences arising out of the use of this material. The information contained herein is subject to change, and revisions may be issued to advise of such changes or additions.

OMAX strives to continually improve their user documentation. If you have any questions or concerns about the content of this operator's guide, we want to hear from you. Please email us at tech_writing@omax.com or contact us by mail at:

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OMAX Corporation is continually improving the OMAX JetMachining® System to bring you the best in abrasivejet machining technology. For that reason, your OMAX JetMachining System may differ slightly from what is described in this document. If you have any questions, please feel free to contact us at 1 800-838-0343 or at email techsupport@omax.com.

You can also receive technical support on-line at: http://www.omax.com/support (user name and password required for access)

The OMAX Machine tool apparatus and linear motion track are covered by U.S. patent number 5,472,367. Other patents pending.

The OMAX motion control with precompilation is covered by U.S. patent number 5,508,596.

January 2009

About this Manual

Purpose

This manual describes the OMAX® JetMachining® Center and provides instructions for the care and safe operation of OMAX Models 2626, 2626*xp*, 2652, 5555, 55100, 80160, 60120, and 80X.

Audience

This manual assumes the reader has a basic understanding of the Windows operating system, can perform simple computer operations such as launching programs, copying and moving files, etc., and has participated in the operator training classes provided by OMAX as part of the original equipment purchase and installation.

Supporting Documentation

In addition to this operator's manual, the following documentation is included with your OMAX equipment:

- The OMAX JetMachining Center Service and Maintenance Guide
- Computer Manuals
- Pump Rebuild DVD
- Nozzle Rebuild DVD

Organization

This operator's guide for the OMAX JetMachining Center provides the following information:

Chapter 1: Safety First

- Identifies equipment labels designed to support safe equipment operation, shows their location on the equipment, and explains their meaning.
- Lists important safety "do's and don'ts" to follow that are essential in ensuring safe equipment operation.
- Explains the safety devices built into the OMAX equipment.
- Safety checklist form.

Chapter 2: Introduction

- Identifies the major components of the JetMachining Center and breaks each down into their individual pieces, providing names and descriptions.
- Shows the location and explains operator control devices.
- Lists accessories currently available for your JetMachining Center.

Chapter 3: Operation

- Explains how the pump and abrasivejet system work.
- Provides instructions on starting and stopping the system, including an emergency shut-down.
- Discusses the JetMachining software.
- Explains important tasks performed in the material cutting process.
- Lists tips for effective use of your equipment.
- Provides procedures that cover the entire cutting process from equipment power-up to power-down

Note: This manual does not provide detailed information on the operation of the OMAX software, *Make* and *Layout*. For instructions on using this software, refer to the OMAX Interactive Reference (the software help screens), and the online training videos (http://www.omax.com/support/customers/videos.asp).

Chapter 4: Maintenance

- Lists maintenance requirements for the pump and JetMachining Center.
- Explains routine operator maintenance activities.
- Provides procedures for troubleshooting equipment problems.
- Provides nozzle repair/rebuild instructions.

- Lists replaceable items normally consumed during equipment operation.
- Contains maintenance information for the pump dump valve.

Chapter 5: Customer Support

- Provides OMAX customer support contact information.
- Explains how to order and return parts for your JetMachining Center.

Chapter 6: OMAX Glossary

- Definitions of terms specific to OMAX and the waterjet industry.

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Chapter 1

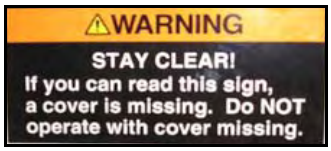
Safety First

This chapter describes the safety labels appearing on the OMAX JetMachining Centers and identifies where each are located. These labels provide information essential for safe equipment operation. This chapter also emphasizes important safety precautions that must be observed while operating or servicing and maintaining this equipment, and identifies the safety devices built into this equipment.

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

Safety Labels

Safety Label	Description
	**Wear Gloves** Since bacteria in the tank water can build up, even a seemingly minor break in the skin can introduce harmful bacteria into a wound. Always wear protective gloves if you have cuts or open wounds on your hands. When setting up material for cutting, always 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 do maintenance on the OMAX equipment with the main AC 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 OMAX pump off at its source.
	**Eye Protection** Always wear approved safety goggles whenever cutting. **Regular glasses are not sufficient eye protection!**
	**Ear Protection** Always wear hearing protection while in the vicinity of the OMAX. When cutting in air, noise levels can exceed 120 dB.
	**Flying Debris/Loud Noise** Eye and ear protection are always required during operation.
	**Emergency Stop Switch** Pushing the emergency stop switch in immediately shuts down water pump and abrasivejet operation. The emergency stop switch should be used only for real emergencies. When pressed, the OMAX loses important machine position. The equipment cannot be restarted until the emergency stop switch is reset.

Safety Label	Description
	Never operate the OMAX with any of its protective guards or covers removed or rendered inoperative. Never make unauthorized alterations to the equipment or components.
	Never operate the OMAX 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.
	Never operate the equipment with the protective covers missing, exposing yourself to dangerous mechanical and electrical hazards.
	Removing the abrasive feed hose from the nozzle while still under pressure will blow abrasive particles into the room air, getting into eyes and contaminating tools and machines.
	Don't spray the identified area with water or compressed air. Read the service and maintenance guide for additional information.

Placement of Safety Labels

Figure 1-1: Safety Labels for the OMAX Models 2626, 2626|xp, 2652, 5555, and 55100

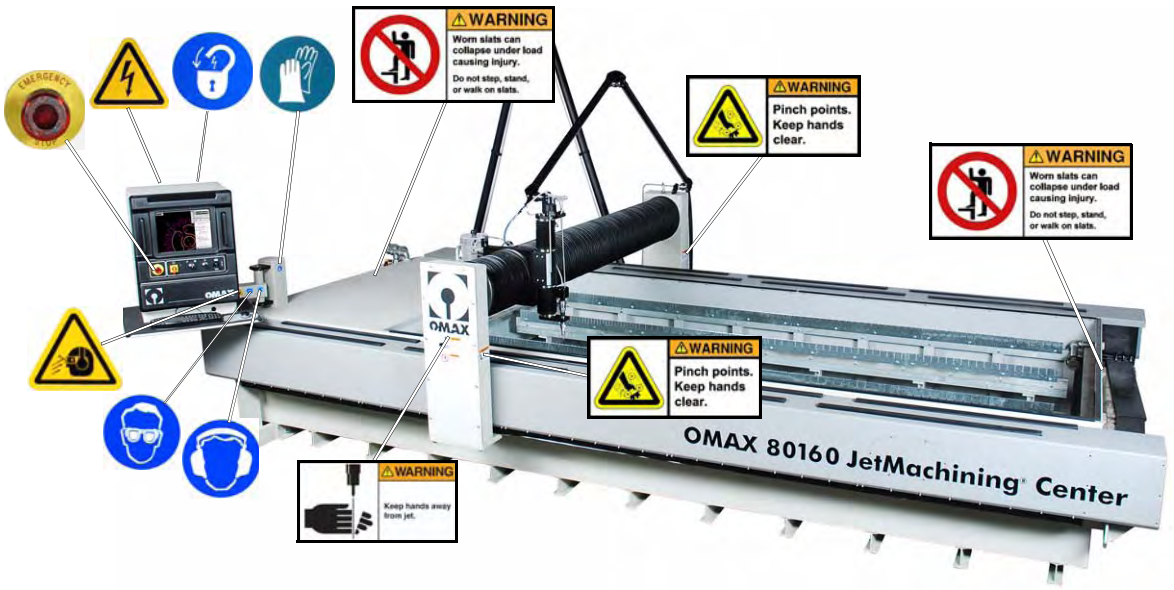


Figure 1-2: Safety Labels for the OMAX 80160

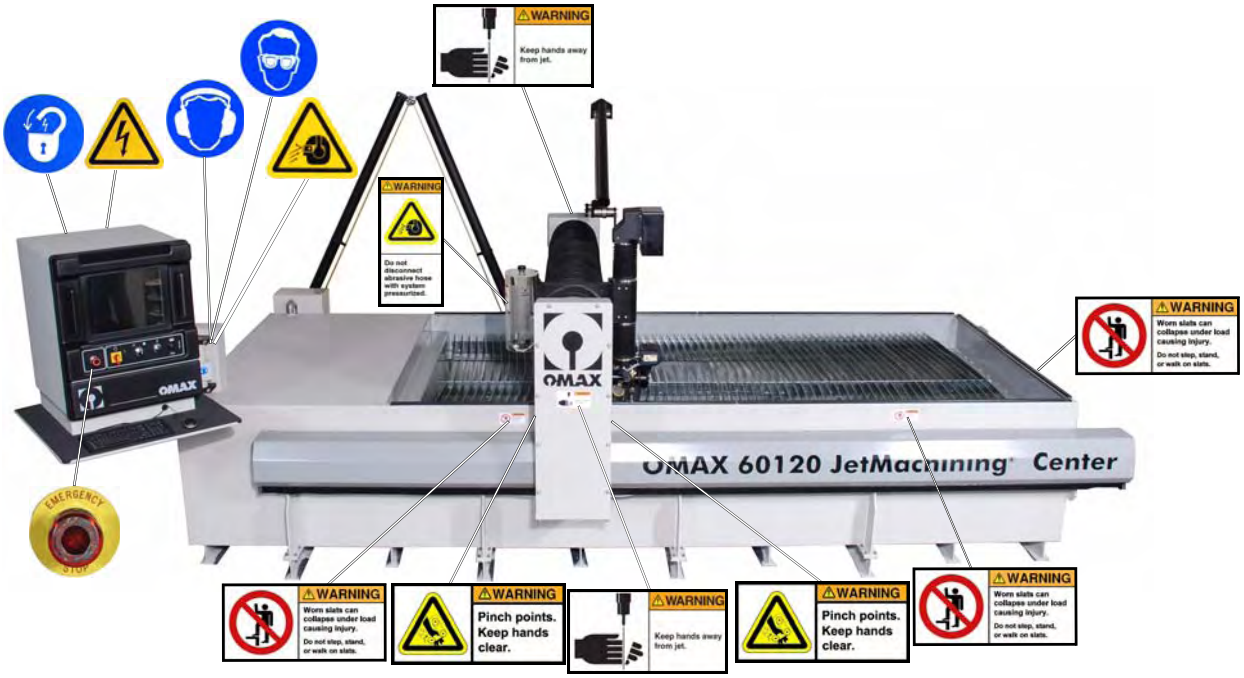


Figure 1-3: Safety Labels for the OMAX 60120

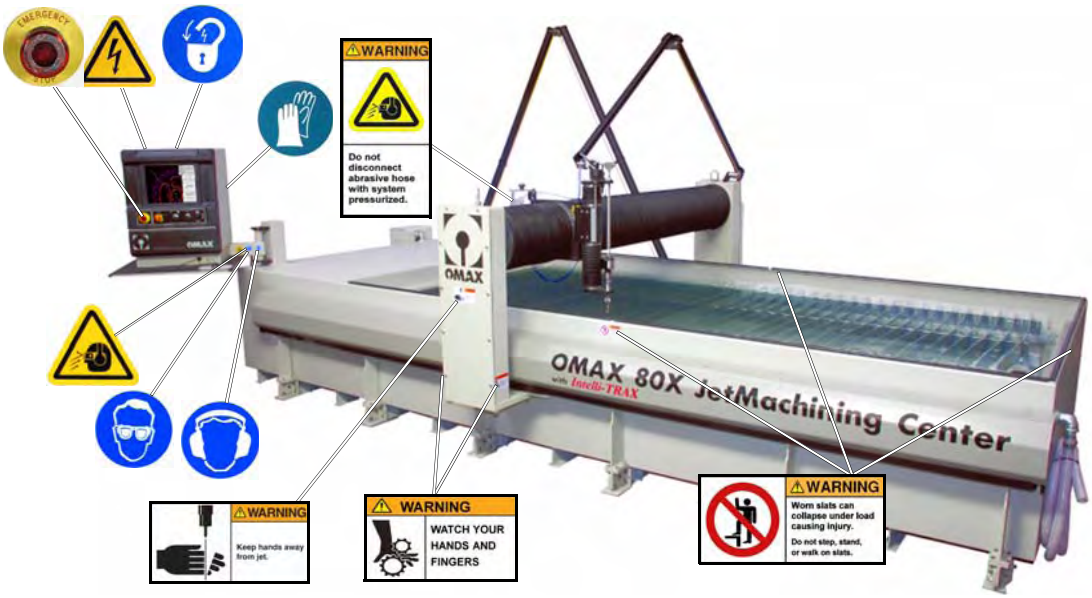


Figure 1-4: Safety Labels for the OMAX 80X

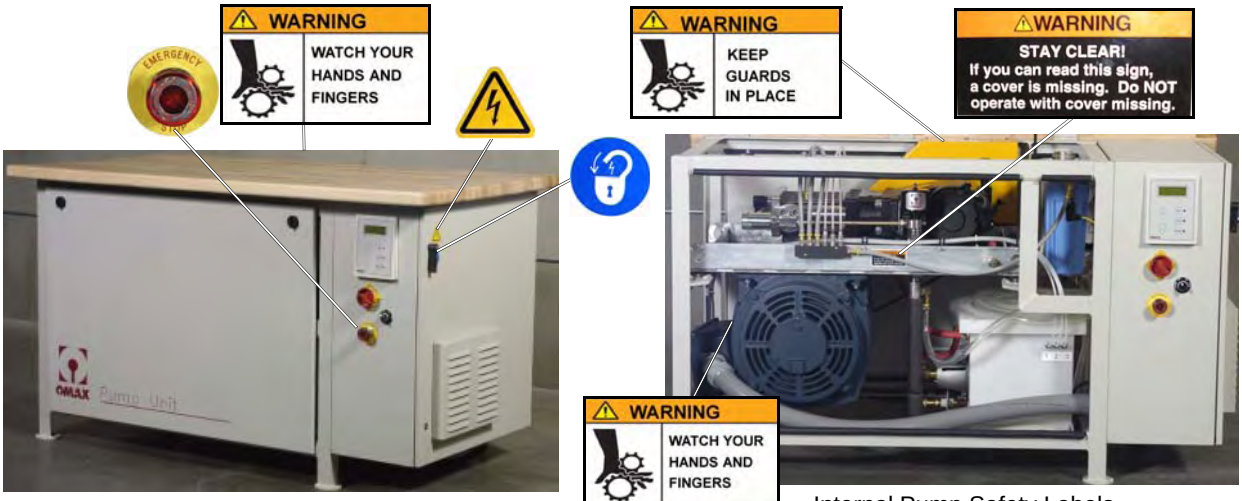


Figure 1-5: Safety Labels for the OMAX High-pressure Pump

Safety Precautions

Always observe the following safety precautions while operating your OMAX equipment. Carefully operated, the OMAX is a safe, productive tool. When operated carelessly, serious injury can easily 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.
- Wear hearing protection while in the vicinity of the OMAX. When cutting in air, noise levels can exceed 120 dB.
- Cut under water whenever possible. When water covers both the material being cut and the nozzle tip, the noise level measured in the operator's area drops to approximately 80 dB (refer to Figure 1-6).
- Wear approved safety goggles whenever cutting. Regular glasses are not sufficient eye protection!
- Have an eyewash station located near the OMAX in the event abrasive spray splashes into your eyes. The garnet abrasive is not a chemical irritant, but if not quickly washed out, it can injure an eye just as any sand would. In addition, tank water could contain chemicals irritants.
- 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 (exception is with EBBCO Closed Loop) 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.
- When setting up material for cutting, wear gloves that provide protection against sharp metal edges and waterborne microorganisms.
- Dispose of cutting wastes properly and in accordance with all local and federal regulations. The OMAX 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 kerf material 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. Never climb on or around the equipment using makeshift devices.
- Always use the muff on the abrasivejet nozzle. It helps keep the noise level low during machining and reduces splashing of water and abrasive.
- Always use proper lifting equipment to handle heavy work materials.
- Always remove power from the equipment when finished using the JetMachining Center for the day.

Don't

- Don't operate the OMAX JetMachining Center without first being adequately trained on how to operate it correctly and safely.
- Don't allow nozzle movement while handling material in the tank. Stop the abrasivejet before making any adjustments. Nozzle movement can exert up to 1,000 lbs (4.4 kN) of force, easily crushing any hands or fingers caught between it and another object.
  Note: It's possible that the nozzle may move or become active during machine adjustments while power is still applied.
- Don't stand on the support slats. They are weakened by continued cutting and may not support your weight.
- Don't operate the OMAX with any of its protective guards or covers removed or rendered inoperative.
- Don't operate the OMAX 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 OMAX.
- Don't allow unauthorized personnel access to the machining area without providing proper supervision.
- Don't switch tank chemicals for bacterial control without first reading the manufacturing warnings on the labels. Mixing different chemicals can create a hazardous situation.
- Don't use silica sand as a cutting abrasive. Fine silica dust produced by the cutting process can lead to silicosis, a serious lung disease.
- Don't operate the machine in close proximity to other machines or electrical equipment as water can spray or splash out of the cutting table area.

Pump Safety Requirements

Do

- Operate the OMAX pump only after reading this manual and receiving instruction from a qualified operator.
- Stay in a location within easy reach of the emergency stop switch.
- Start the pump only when all side panels are securely in place.
- Maintain all protective guards and shutdown devices around the OMAX pump.
- Immediately notify responsible repair personnel whenever leaks are detected in high-pressure 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.
- At the conclusion of maintenance activities, clear all tools and rags from around the OMAX pump before operating the equipment.

Don't

- Don't start the OMAX pump unless you know how to stop it.
- Never open or do maintenance on the OMAX pump with the main disconnect ON or unlocked, or while the pump unit is operating. Always follow standard lockout/tag-out procedures.
- Don't apply power to this pump while maintenance work is in progress. Always lock the main power to the OMAX pump off at its source.
- Don't make unauthorized alterations to the equipment or components.

- Don't operate the abrasive waterjet for more than a few seconds when the standoff distance between the water level and nozzle tip is greater than 1.5 inches. Above this height, the entrapped air can allow the jet stream to easily travel through the water and strike the tank bottom with sufficient force to cut through it.

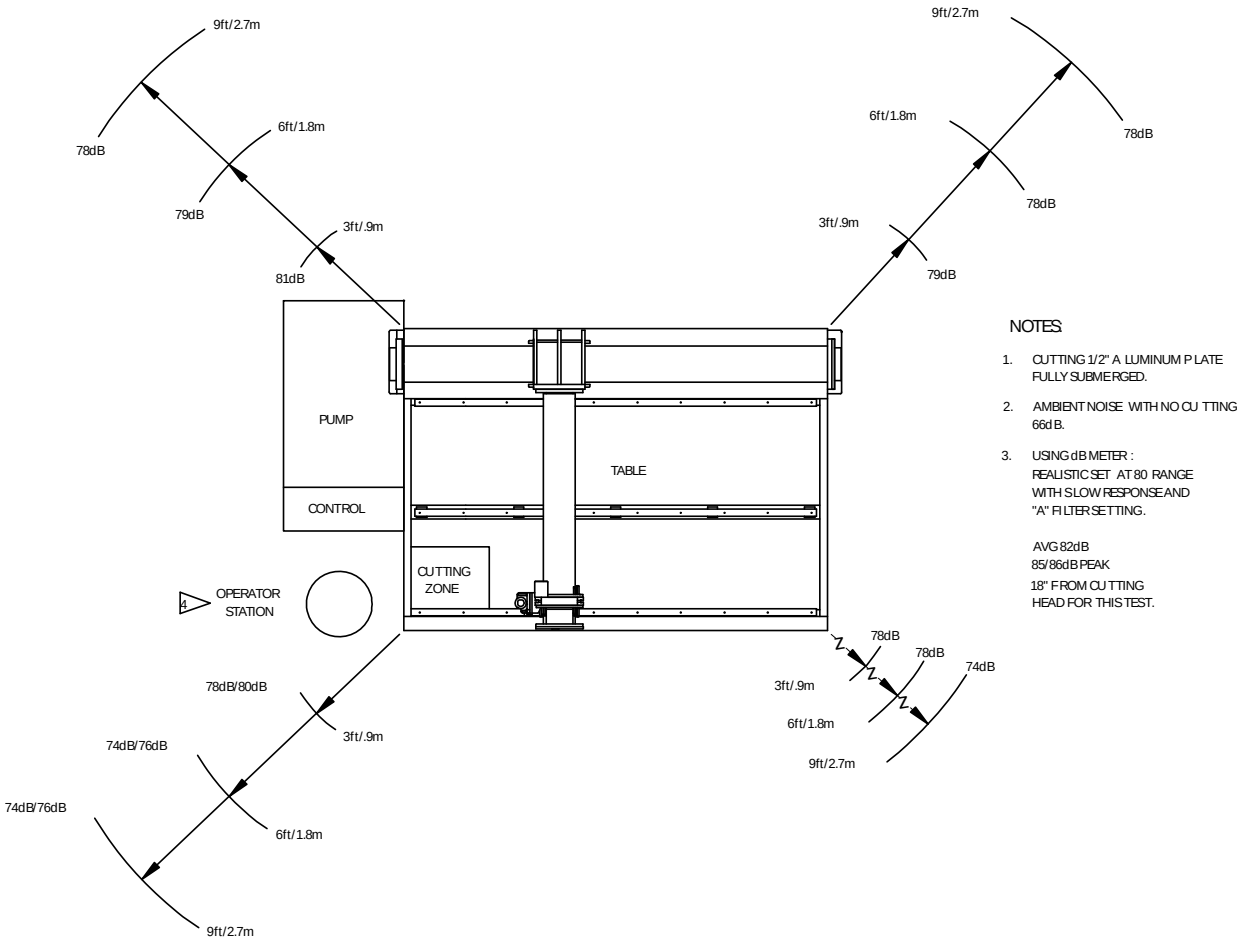


Figure 1-6: Sound Level Map of OMAX JetMachining Center

Equipment Safety Features

The OMAX equipment provides several built-in safety features:

1. **Emergency Stop Switch**: Both the pump unit and controller are equipped with an emergency stop switch. Push in the emergency stop switch to immediate shut down both the pump unit and the abrasivejet.
2. **Overpressure Protection**: The pump has two types of overpressure protection. A factory set mechanical safety valve provides a hard-plumbed, overpressure limit. The electronics for controlling the pump also monitor system water pressure. Whenever it detects that the system pressure has exceeded the factory set pressure limit, it stops the pump and displays 'Dead head of Pump' on the pump display panel.
3. **Electrical Protection**: The variable frequency drive (VFD) provides electrical protection as well as speed control for the pump's main drive motor. A circuit breaker provides short circuit protection for the charge pump motor. Circuit breakers protect the internal transformer and a 0.5 Amp fuse protects the pump keypad.
4. **Access Control Circuit**: An optional OMAX Access Control Circuit (ACC) is available for all OMAX tables. The ACC creates a designated safety zone around the OMAX JetMachining Center that protects operators from injury when using the OMAX equipment. The access control circuitry continually monitors two external switch contacts. Opening either switch immediately disables the cutting process.

OMAX JetMachining Center Safety Checklist

	Safety Checklist Topics
Safety Labels and what they mean	
	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
	Cutting under water
	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
	Start pump only when all side panels are in place
	Maintain protective guards and shutdown devices on/around pump
	Immediately notify repair personnel if leaks are found in pump fittings or connections
	Follow manufacturer's recommendations for servicing and use only original manufacturer replacement parts
	Follow periodic maintenance schedule that ensures proper equipment operation
	Following maintenance activities, clear all tools and rags from around the equipment before starting
Safety Precautions (Don't)	
	Don't start equipment unless you know how to stop it
	Never open or do maintenance on the equipment with the main disconnect ON or while the pump is operating. Always follow lockout/tag-out procedures
	Don't make unauthorized alterations to the equipment or components
Equipment Safety Features	
	Emergency (E-Stop) Switch (PC Controller and Pump)
	Overpressure Protection safety valve and software shutdown
	Electrical Protection
	VFD / DIN rail mounted contactor and circuit breaker (short circuit protection to the charge pump motor)/ Circuit breakers protect internal transformer/ 0.5 Amp fuse protects pump keypad

Date_____

Students Name_____Signature[1]_____

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

Chapter 2

Introduction

This chapter identifies the major components of the JetMachining® Center, locates each operator control explaining their function, and lists the accessories currently available for the JetMachining Center.

OMAX High-pressure Pump

The OMAX variable speed, high-pressure pump is an electrically driven, variable speed, positive displacement, crankshaft drive triplex pump designed for use with the OMAX Precision JetMachining system and other applications requiring high-pressure water. This pump provides the high-pressure water required by the OMAX JetMachining System to operate.

Figure 2-1: OMAX High-Pressure Water Pump

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 drive for the high-pressure pump. The electronic VFD varies the electric motor speed, and therefore the pump speed. The variable frequency drive accommodates slight variations in nozzle flow characteristics, produces surge free starting, and provides high power factors and VFD/motor efficiencies throughout the useful power range.

Pump components are mounted in a compact enclosure that occupies only 15 square feet (1.4 square meters) of floor space. All electrical control components and the VFD are located in the electrical enclosure mounted on the end of the pump unit (Figure 2-8).

The main electric drive motor, belt drive, and OMAX high-pressure crankshaft are mounted on a welded steel tray that is mounted in the steel pump frame with anti-vibration mounts. A water module is mounted on a steel tray and consists of a water tank and charge pump.

Removable covers are provided on the front and back, and on the left-end of the pump unit. The pump's laminated wood top can be raised, allowing easy access to the water filters and pump high-pressure wet-end.

A charge pump is responsible for the pre-circulation of water through the pump's white water tank and cooling lines. This flow purges warm water from the water tank and the pump cooling lines before the high-pressure pump starts. Cooler water increases the life of the high-pressure pump seals. This water is then recycled back to the white water tank.

Pump Components

Front and Right Side Views

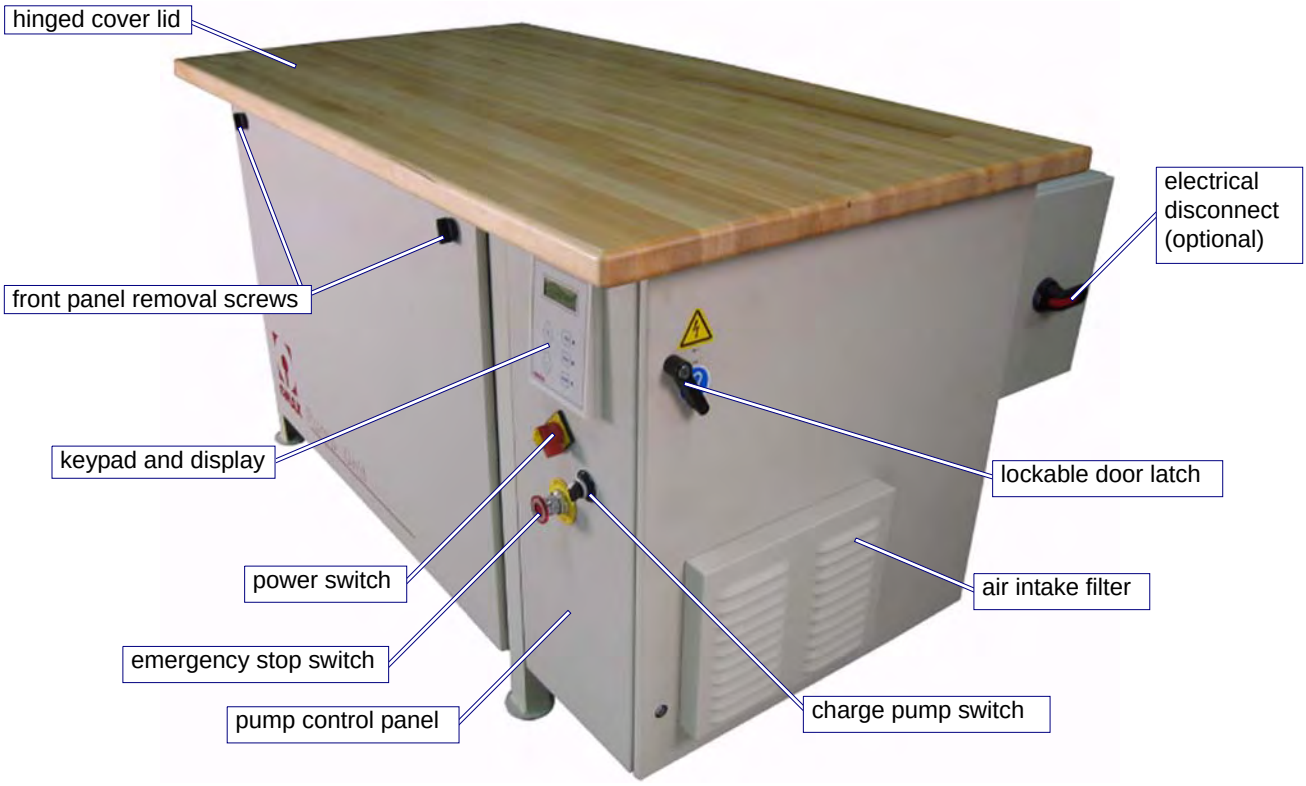


Figure 2-2: OMAX Variable Speed High-Pressure Pump Front View

Pump Control Panel

The pump control panel is located on the right side of the front panel (Figure 2-3). It provides a keypad, a display screen, and the pump's start/stop controls. When the pump is attached to an OMAX JetMachining Center, control is shared between the JetMachining Center Controller and the pump keypad.

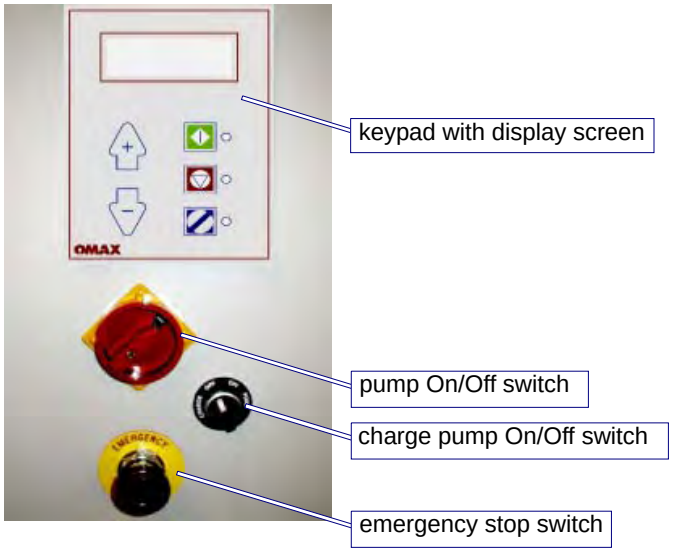


Figure 2-3: Pump Control Panel Components

Operator Keypad and Display Screen

The keypad provides function buttons and a display screen for operator messages. See Figure 2-4 for an illustration.

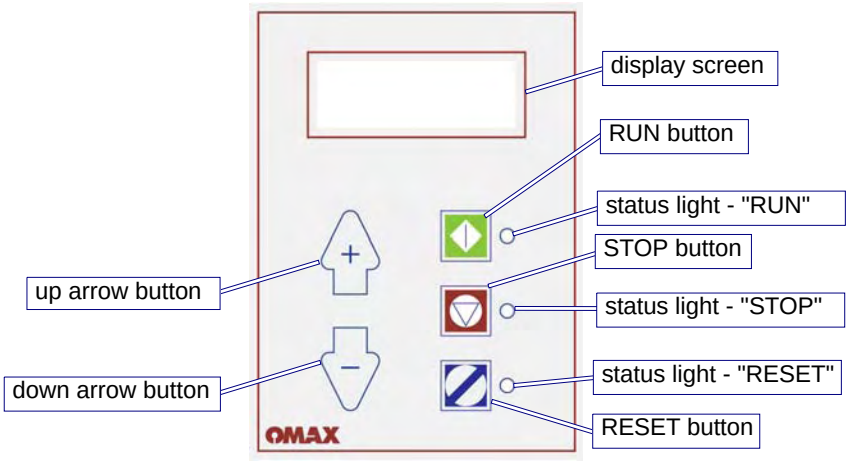


Figure 2-4: Front Panel Keypad and Display Screen

Display Screen

When the pump is operating normally, these four lines of text appear:

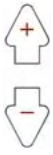
Water Pres	**xx.x KSI**	pump output pressure in KSI
High PreSet	**xxxx RPM**	preset drive motor high RPM
Low PreSet	**xxxx RPM**	preset drive motor low RPM
RunTime	**xxx HRS**	accumulative number of pump run hours

Note: A "**T**" appears with the water pressure reading ("Water Pres") if the pressure transducer is connected and recognized by the pump control card.

Run Button
When started, the motor RPM (pump pressure) returns to the last value of "Hi Pre-Set." The red status light to the right of this button is lit when the pump is in "run" mode.

Stop Button
Stops pump operation whenever pressed. When held down for 3 seconds, displays the pump's operational mode, model number, and software version. The red status light to the right of this button is lit when the pump is stopped.

Reset Button
Press the reset button to clear a pump fault condition. Pressing either the **up** or **down arrow** while also pressing the **Reset** button, sets the Low Pre-Set pump motor RPM (low pressure). The red status light to the right of this button is lit whenever the pump is in a fault condition. If a fault condition is present, you must press the **Reset** button to continuing machine operation.



Up/down Arrow Buttons
Pressing the **Up Arrow** increases the pump's RPM and water pressure. Neither pressure nor RPM can be increased above their maximum allowable limits. Pressing the **Down Arrow** at any time decreases pump RPM and water pressure.

Control Panel Switches

The front panel includes a main power switch, a power switch for the charge pump, and an emergency stop switch (E-Stop):

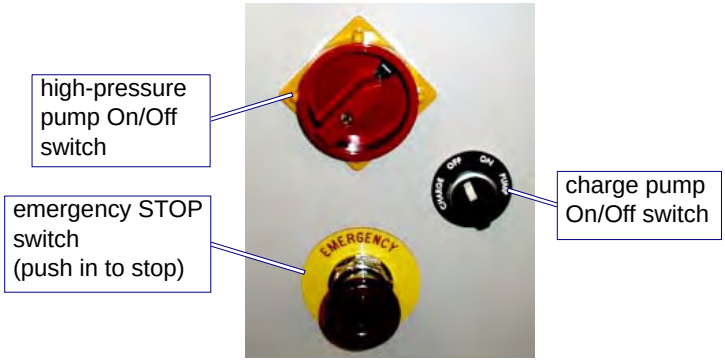


Figure 2-5: Pump Control Switches

Main Pump Power Switch

This switch applies AC power to the pump and the table. When switched OFF, the pump and table immediately stop. When switched ON, power is enabled for the pump; the pump is enabled but starts only when commanded by the OMAX JetMachining Center.

WARNING! ***The pump On/Off switch will not remain in the On position unless power to the pump unit is received from the AC main power disconnect. Whenever power at the main disconnect is On, there is always live AC power on the DIN rail and at the terminals inside the pump electrical enclosure even when the pump On/Off switch is Off.***

Emergency Stop Switch

Pushing the emergency stop switch in immediately shuts down the pump and JetMachining Center. The emergency stop switch is disengaged (reset) by manually pulling it back to its original position. The pump and JetMachining Center cannot be restarted until the emergency stop switch is reset.

Note: *Pushing the emergency stop switch in (either the emergency stop switch on the pump, or the emergency stop switch on the JetMachining Center) immediately shuts down both the pump and the JetMachining Center. If the JetMachining Center is being powered from a 115 VAC source other than that of the OMAX pump, the pump's emergency stop switch will not stop the JetMachining Center.*

Charge Pump On/Off Switch

The charge pump boosts incoming water pressure and circulates water through the cooling lines. Cooler water increases the life of the high-pressure pump seals.

The charge pump power switch controls only the charge pump. The charge pump must be running for the high-pressure pump to start. If an attempt is made to start the high-pressure pump without the charge pump running, the high-pressure pump will not start and an error message appears on its front panel display.

Front View With Front Panel Removed

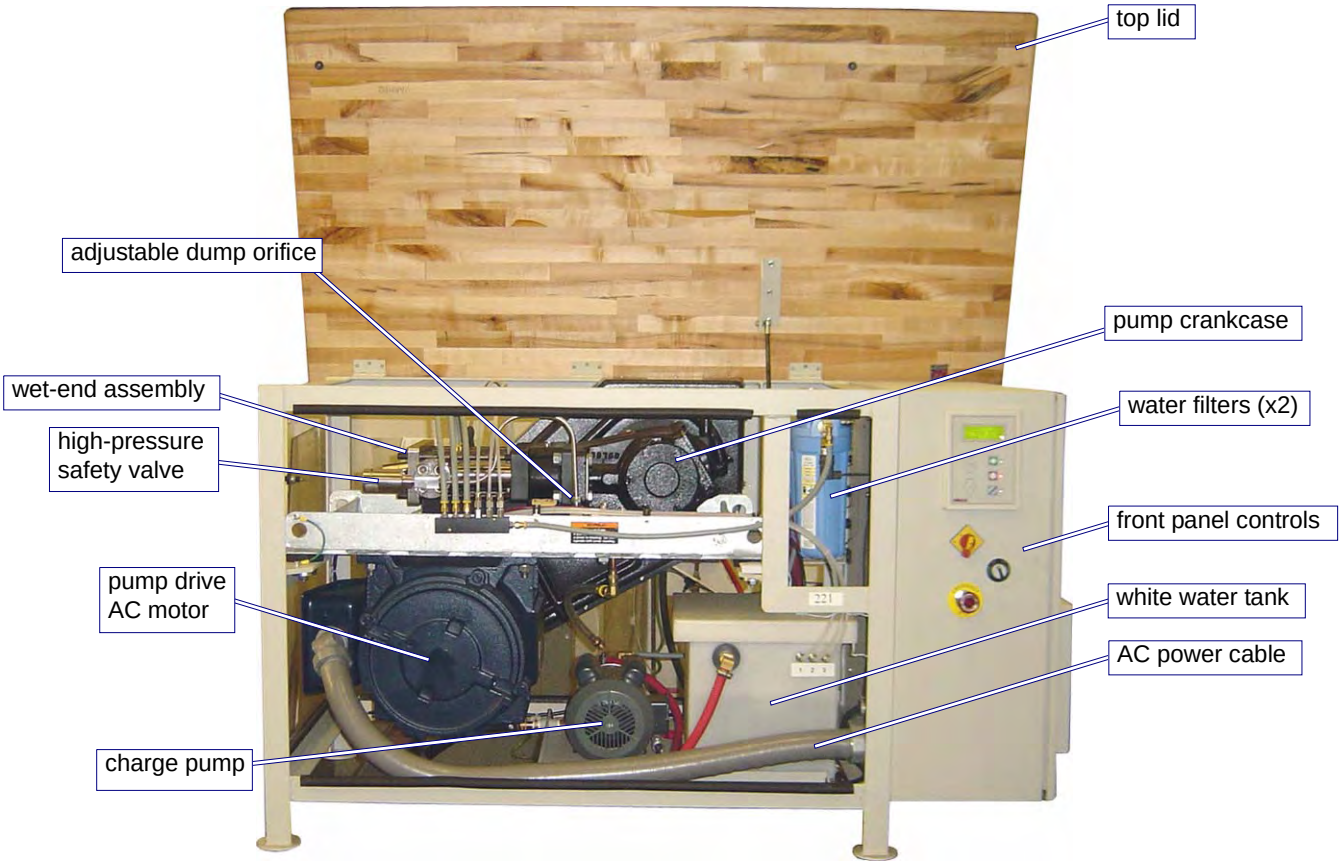


Figure 2-6: Pump with Top Lid Open and Front Panel Removed

Top View

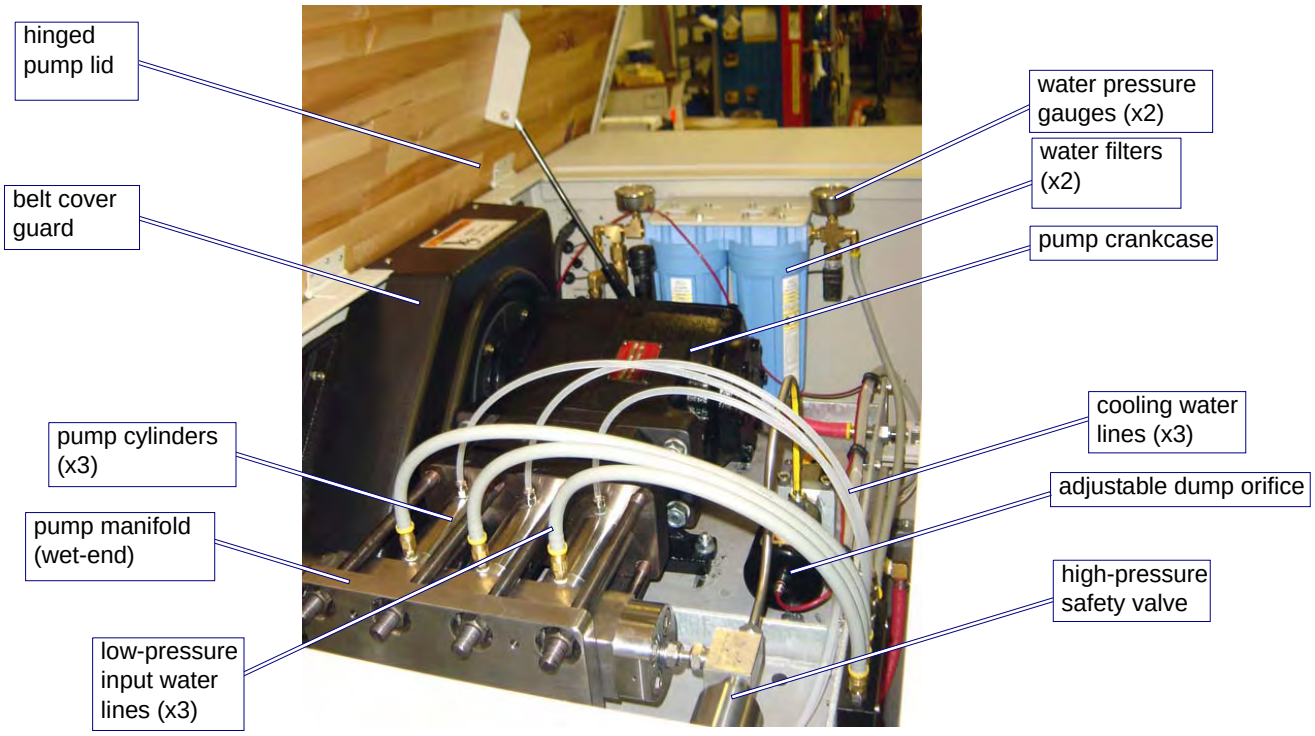


Figure 2-7: Pump Top View with Lid Open

Side View with End Panel Open

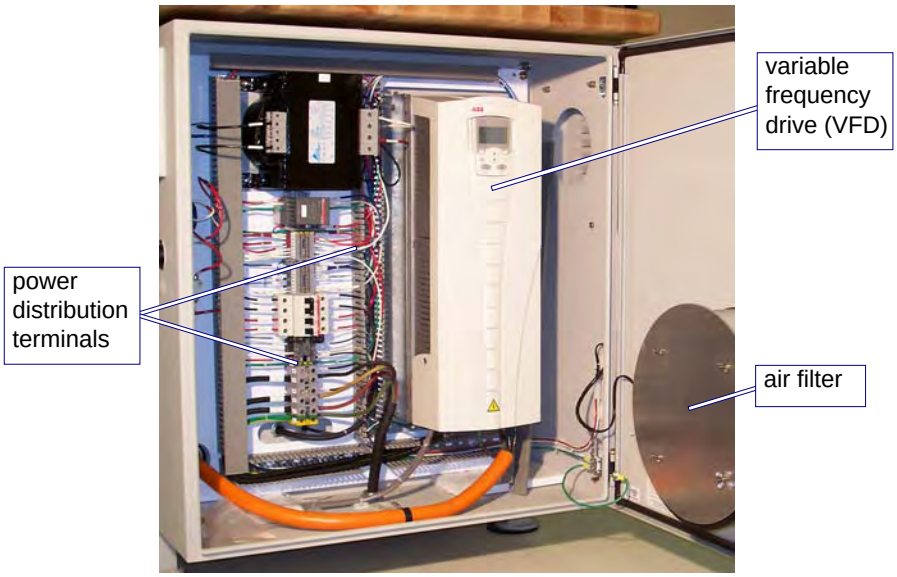


Figure 2-8: Pump Internal Components on Right Side

OMAX JetMachining Center

The JetMachining Center is a precision tool that cuts parts out of most materials including metal, plastic, glass, ceramics, stone and composites directly from a CAD drawing or DXF file. Eight versions of the OMAX JetMachining Center are currently available: the models 2626, 2626|xp, 2652, 5555, 55100, 60120, 80160, and 80X.

Figure 2-9: OMAX 80160 JetMachining Center

Major Components of the JetMachining Centers

Four major components make up the OMAX JetMachining® System (see Figure 2-10):

- **Controller**

  The OMAX is controlled using a personal computer (PC) running the OMAX software. The Controller starts and stops the pump, turns the water and abrasive On and Off, and guides the abrasivejet on its precise tool path. Refer to Figure 2-11, page 2-8.

- **High-pressure Water Pump**

  The high-pressure water pump pressurizes the water used by the OMAX abrasivejet nozzle. Refer to Figure 2-2, page 2-2.

- **X-Y Table**

  The X-Y table moves the abrasivejet nozzle above a large catcher tank containing water from the cutting process and providing a settling tank for spent abrasive and work piece particles. Pressurized air is required on all units for on/off valve and abrasive valve operation, and to control tank water level.

- **Abrasivejet System**

  In the abrasivejet nozzle, high-pressure water is forced through an orifice to form a narrow stream moving at speeds up to 2500 feet per second (760 m/s). This stream causes a suction that draws air and abrasive through the abrasive feed tube. The abrasivejet system consists of the high-pressure nozzle and garnet feed system (hopper). Refer to Figure 2-10, page 2-8.

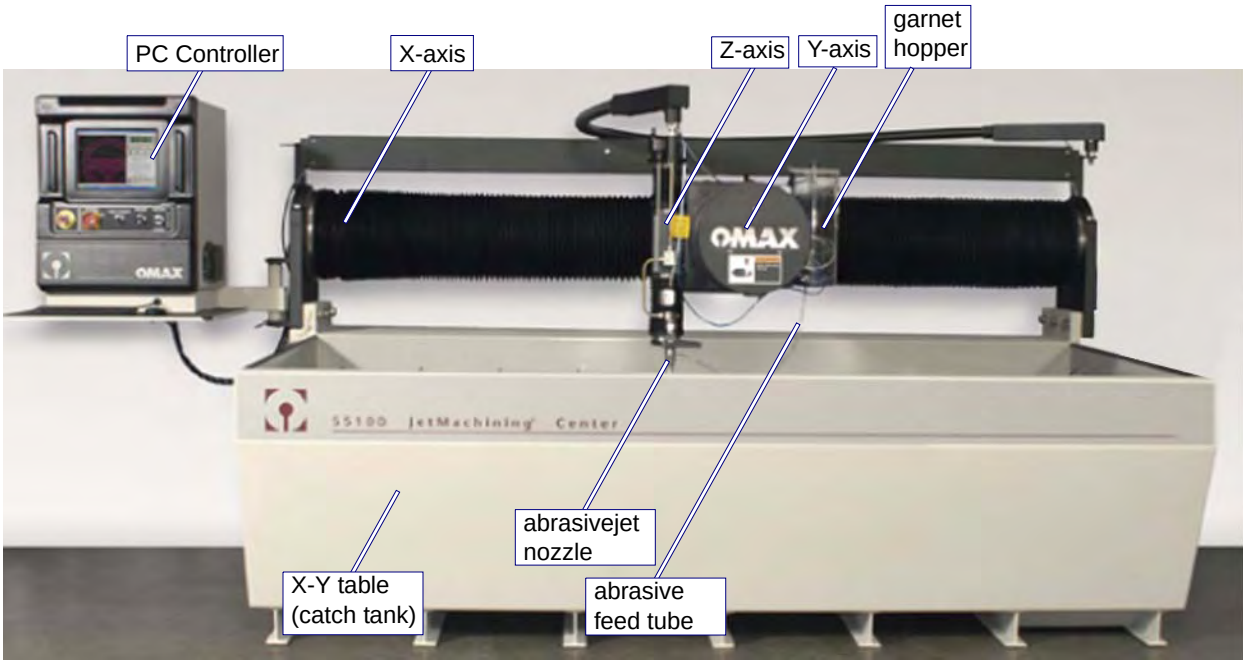


Figure 2-10: The Model 55100 OMAX JetMachining® Center

PC Controller

Software for the JetMachining Center runs on a personal computer mounted inside the controller cabinet. When supplied with your OMAX, it is already configured and ready to run upon installation. This personal computer is accessible by lifting up the computer access panel. The controller's hinged arm allows you to position the cabinet according to your viewing requirements. The keyboard and mouse are water-resistant for reliable operation in an abrasivejet environment.

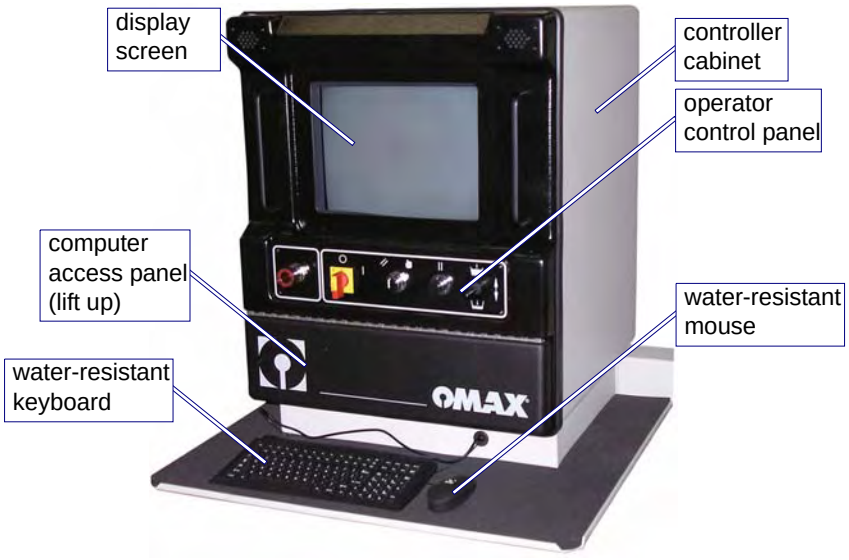


Figure 2-11: The JetMachining Center PC Controller

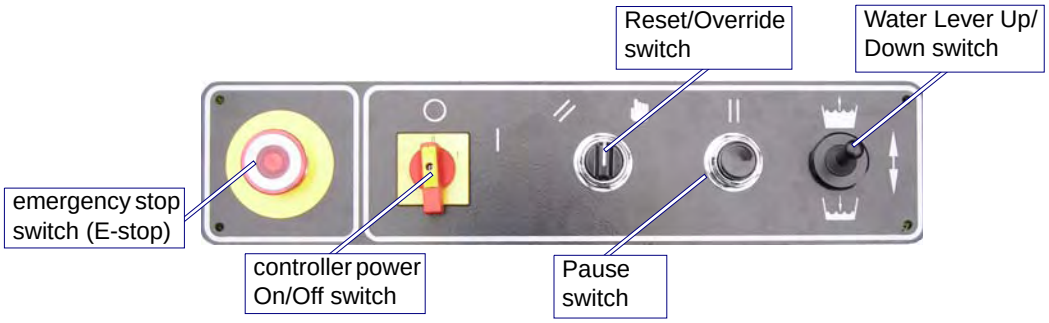


Figure 2-12: Control Panel Operator Switches

Control Panel Switches

Water Level
Raises (↑) and lowers (↓) the water in the catcher tank to cover/uncover the material being cut.

Emergency Stop
Immediately shuts down the water pump and abrasivejet operation. The emergency stop (E-stop) should be used only for real emergencies. When pressed, the OMAX loses important machine positioning information.

Caution: ***The abrasive feed line must always be cleaned out after using the Emergency stop switch!***

Pause
Pauses motion and shuts down the abrasivejet nozzle. Machining can be restarted without any loss of machine positioning information.

Power On/Off
Turning this switch to its On (|) position after the pump has been powered up, automatically starts the computer.

Reset
Reset disables all servo motors and resets any faulted drive.

Servo Motor Override
This override function is for diagnostic purposes only and is **not for normal operation**.

X-Y Table

The X-Y table on OMAX models 2626, 2626|xp, 2652, 5555, and 55100 consists of a bridge X-axis and a cantilever Y-axis rigidly mounted to the cutting table. A series of steel slats provide vertical support for the parts being machined.

The 80160 X-Y table consists of a Y-axis bridge attached to dual X-axis rails rigidly mounted to the catcher tank. The Y beam is connected to the carriage that moves along the X beam. Both the X and Y

carriages ride on rigidly mounted linear rolling bearings. The carriages are moved by preloaded ball screws driven by steel reinforced timing belts from digital servo motors.

On the 80X and 60120, the X-beams are not connected to the catcher tank, and a traction drive with a linear encoder is used rather than a ball screw for X-axis movement.

The entire bearing and drive mechanisms are surrounded and sealed using bellows or steel housings to keep water and abrasive particles out of the table's bearings and slides. The motors are brushless with positioning feedback. Each command to the servo amplifier causes the carriage to move approximately 0.0005" (0.01 mm).

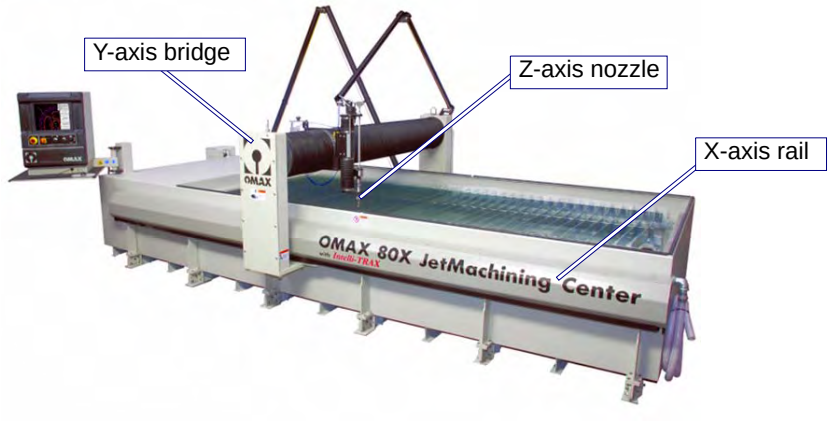


Figure 2-13: The OMAX 80X JetMachining Center

Accessories for the OMAX JetMachining Center

A number of optional accessories are available for your OMAX JetMachining Center. For current prices and ordering information, contact your OMAX distributor. For a complete list of OMAX accessories refer to http://www.omax.com/accessories.php.

Tilt-A-Jet

The Tilt-A-Jet® replaces the Z-axis with a mechanism that precisely tilts the nozzle to offset the taper naturally caused by the abrasivejet stream. The Tilt-A-Jet is ideal for operations requiring the cutting of high precision parts.

Figure 2-14: OMAX Tilt-A-Jet

Precision Optical Locator

The Precision Optical Locator (POL) uses a high-resolution digital camera attached to a Tilt-A-Jet or motorized Z-axis to precisely determine the position of a piece of material and enabling secondary machining operations.

Figure 2-15: OMAX Precision Optical Locator

Waterjet Brick

The waterjet brick replaces the normal tank slats to better support thin materials, prevents small parts from falling into the tank, and reduces back splash on materials being cut.

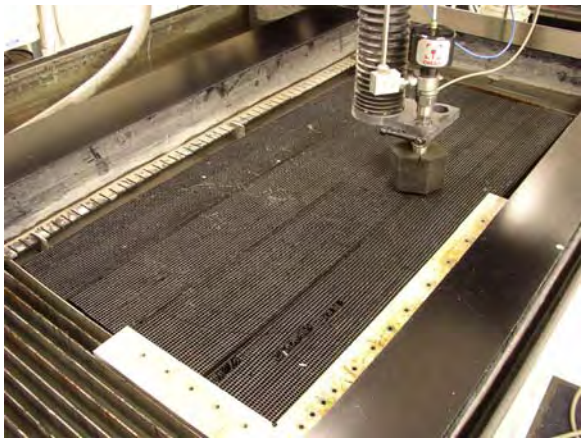


Figure 2-16: Waterjet Brick

MaxJet® 5 MiniJet Nozzle

The MiniJet Nozzle provides a thin stream that produces a narrow, precise cut with less taper than the standard MaxJet 5 nozzle. The MiniJet easily switches place with the MaxJet 5 and is ideal for making very small parts with intricate detail, or for working with expensive materials such as precious metals.

Solids Removal System

This optional garnet removal system automatically removes the garnet and kerf material from the tank, reducing the downtime necessary for manual removal.

Figure 2-17: OMAX Solids Removal System

Chiller

High-pressure pumps last longer when the inlet water temperature is always kept less than 70° F (21° C). The Chiller maintains low water input temperatures, preventing costly maintenance and equipment rebuilds.

Figure 2-18: OMAX Inlet Water Chiller

Drill Head Attachment

The Drill Head Attachment mounts on the nozzle of the JetMachining Center to drill start holes for composites and laminates. This drill operates under software control. When the drill head attachment is activated, pierces that are normally done with the jet can be done using a drill bit.

Figure 2-19: OMAX Drill Head Attachment

Closed Loop Water Recycling System

This closed loop system recycles waste water so that only a small amount of water is needed when operating the OMAX. This reduces the load on the water drain system, and also helps maintains water quality.

Figure 2-20: Closed Loop Water Recycling System

Terrain Follower

The OMAX Terrain Follower allows your JetMachining Center to cut parts from materials having irregular, bent, or wavy surfaces without a need for special programming. Material that is warped and uneven makes it difficult to machine accurately and quickly. The OMAX Terrain Follower solves this problem by always keeping the nozzle at a constant distance above the surface of the material being cut.

The Terrain Follower can be retrofitted to any OMAX JetMachining Center having a motorized Z-axis or Tilt-A-Jet. It attaches directly to the machine's Z-axis and uses a sensing foot that maintains contact with the surface of a material as it's being cut. Changes in the material's height are detected and communicated to the Z-axis controller which makes the required nozzle height adjustments, accurately maintaining the optimum stand-off distance for cutting.

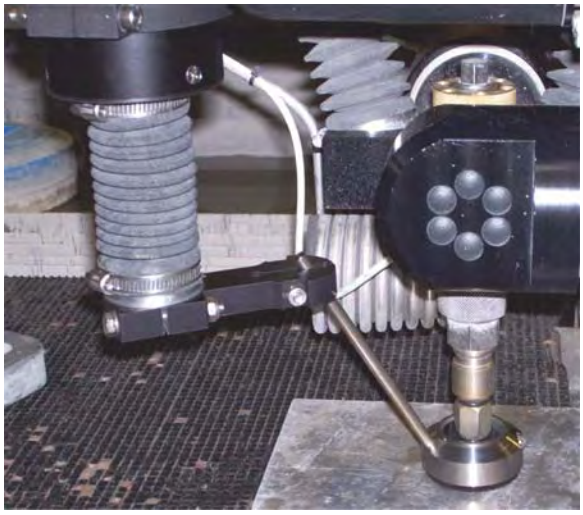


Figure 2-21: OMAX Terrain Follower Attached to a Tilt-A-Jet

Chapter 3
Operation

This chapter provides information and instructions supporting operation of the OMAX JetMachining Center. It explains how the pump and abrasivejet system work and provides instructions on starting and stopping the system and doing an emergency shut-down. It also discusses the JetMachining software, explains important tasks to be performed in configuring the machine prior to cutting, lists tips for effective use of your equipment, and outlines the steps involved in the cutting process from equipment power-up to power-down.

Note: *This manual does not provide detailed information on the operation of the OMAX Make and Layout software. For instructions on using this software, refer to the OMAX Interactive Reference (the software help screens), and software training videos available on the OMAX web site at http://www.omax.com/support/customers/videos.asp.*

Operating the 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.***

When attached to an OMAX JetMachining Center, control is shared between the JetMachining Center Controller and the pump keypad. The JetMachining Center turns the high-pressure pump ON to begin a cut and turns it OFF between cuttings.

Before starting the pump unit:

1. Check the pump's maintenance log and other records for any ongoing service activities. Verify that no "Out of Service" tags are posted on the pump's main electrical disconnect or on its On/Off switch. If service is scheduled and necessary, have it completed before resuming pump operation.

WARNING! ***Before powering the pump for operation, verify that any equipment service is not in progress.***

2. Visually inspect the pump components for damaged parts, leaks, and other conditions that could prevent safe and proper operation. Ensure that the area around the pump is clear of tools and other objects that could obstruct immediate access to controls functions, hindering safety.
3. Verify that the oil level in the pump crankcase is sufficient for operation.
4. Ensure that all pump side panels and enclosures are in place and properly secured.
5. Familiarize yourself with the location and function of the controls identified previously in Figures 2-4 and 2-5.

Starting the Pump

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

1. Open the building's inlet valve that provides water to the pump.
2. Place the main electrical disconnect in the **ON** position.
3. Turn the pump On/Off switch to the **ON** position ("I").
4. Turn the charge pump On/Off switch to the **On** position.

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

Caution: ***It is essential that the cylinders surrounding the dynamic seals stay beneath 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 water temperature in the white water tank to that of the inlet water temperature prior to resuming cutting.***

5. Verify that the PC Controller starts and stops the pump as required for operation.
6. Once the pump starts, verify that the red LED next to the **Run** button on the keypad is lit (see Figure 2-4), and the RPM reading on the display achieves the "Hi PreSet" value.

Stopping the Pump

1. Press the keypad's **Stop** button.
2. If the pump is connected to an OMAX JetMachining Center, the PC Controller automatically starts and stops the pump as required during operation.

Note: *The pump may be stopped at any time by pressing the **emergency stop switch**, either on the pump or on the JetMachining Center controller.*

3. When the pump stops, verify that the red LED next to the keypad's **Stop** button is lit (see Figure 2-4).
4. Turn the charge pump switch to its **OFF** position.
5. Turn the pump On/Off switch to its **OFF** position.

Emergency Shutdown Procedures

Pushing the emergency stop switch in, immediately shuts down both the pump and the JetMachining Center. The emergency stop switch is reset by manually pulling it back to its original position. The pump cannot be restarted until the emergency stop switch is reset.

Note: *If the pump is connected to an OMAX JetMachining Center, pushing the emergency stop switch in at any time (either the emergency stop switch on the pump itself, or the emergency stop switch on the JetMachining Center) immediately shuts down both the pump and the JetMachining Center.*

Setting the Pump RPM

The pump RPM, which determines cutting pressure, may be adjusted up or down using the keypad's **arrow** buttons while the pump is either running or not running. Generally, both the high and low operating pressures are preset with the pump operating in a test mode.

1. To increase the high-pressure value, press the keypad's **up** arrow.
   The "Hi PreSet" RPM value will increase. If the pump is running when this arrow button is pressed, the pressure shown on the keypad display also increases. When the pump is running and the "Hi PreSet" RPM results in an output pressure greater than the maximum allowed, the RPM value decreases to conform to the maximum allowable pressure. The display screen will then repeatedly flash the message "@MAX".
2. To decrease the high-pressure value, press the keypad's **down** arrow.
   The "Hi PreSet" RPM value decreases. If the pump is running when this arrow button is pressed, the pressure shown on the keypad display also decreases.

3. The pump control has a "Low PreSet" RPM mode for low pressure operations with the OMAX JetMachining Center. This is useful for piercing brittle materials or etching and scribing materials at reduced pressure.
4. The "Low PreSet" RPM value is set by pressing and holding the keypad's **Reset** button while also pressing either the **up** or **down** arrow button. Attempts to set the RPM lower than 700 RPM causes the display to repeatedly flash the message "@MIN". The low RPM mode can be activated only by a signal from the JetMachining Center controller.

Pump Operating Characteristics

1. The electric motor should always be operated at or above the minimum RPM to ensure sufficient lubrication of the pump crank within the crankcase. The pump control will not permit sustained operation below the minimum RPM.
2. The maximum design output pressure is limited to 40,000, 50,000, or 55,000 psi, depending on the specific pump model. The pump control does not allow sustained operation above these limits.
3. **Low PreSet** is the factory set value of motor RPM for low-pressure operation and can be changed at anytime by the user. When operating with the OMAX JetMachining Center, this is the operating pressure for piercing and etching and is activated from the JetMachining controller.
4. **Hi PreSet** is the factory set motor RPM value for high-pressure operation and also can be changed at anytime by the user until the maximum allowed output pressure of the pump is reached. The Hi PreSet value can be adjusted up to, but not above, the Operating Point output pressure value, or a maximum of 2000 RPM. Hi PreSet is the motor RPM value that the pump normally returns to when started. When operated with the JetMachining Center, it is the high-pressure mode.
5. **Operating Point** is the motor RPM corresponding to maximum performance and maximum horsepower available.

OMAX JetMachining Center Overview

About Abrasivejet Machining

Industrial abrasivejets have been in use since 1982. An abrasivejet uses water that is pressurized to more than 40,000 pounds per square inch (psi) (2760 bar). 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). Forcing the water through the hole in the jewel accelerates the stream of water up to 2500 feet per second (760 m/s). 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. The abrasive is stored in a hopper on the moving head of the X-Y table. An air-controlled valve in the Bimba valve releases a stream of abrasive into a feed tube where it flows to the nozzle. This stream then moves into the mixing tube. The mixing tube has a small hole through the center that serves to contain the water and abrasive as they mix to form an abrasivejet. The mixing tube is made from a hard, brittle material designed to resist abrasion. 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 onto the material being machined.

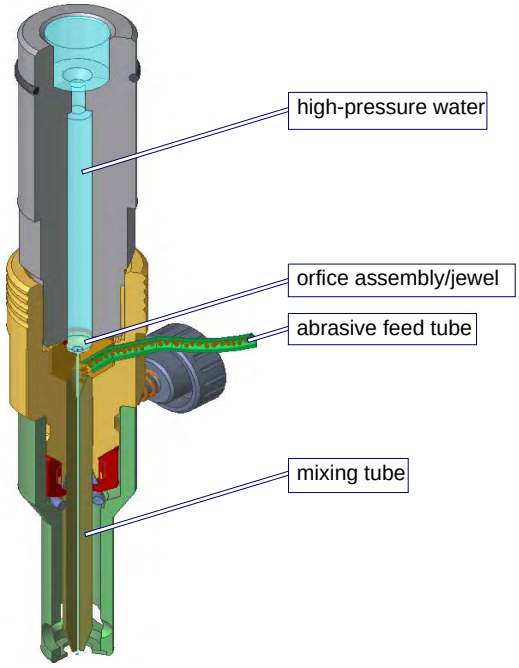


Figure 3-1: The Abrasivejet Nozzle

WARNING! ***Keep your hands away from the nozzle whenever it is moving or cutting. The abrasivejet's high-pressure stream can cause serious injury. In addition, nozzle movement can crush fingers and hands caught between it and another object. Cutting with the nozzle out of water is extremely noisy and can damage your hearing! Always wear ear and eye protection when cutting.***

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 (38.1 mm). 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 cutting is done either under water or with the water level immediately below the work piece.***

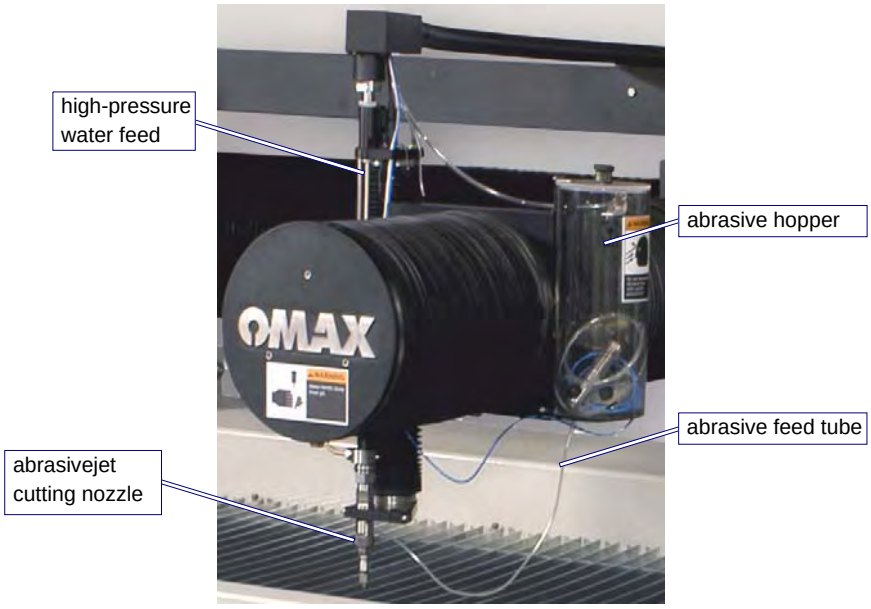


Figure 3-2: The Abrasive Waterjet System

The OMAX Software

OMAX software is used to create part drawings (OMAX *Layout*) and to cut the part (OMAX *Make*). The OMAX software completely controls the operation of the JetMachining Center.

In addition to OMAX Layout and Make, many other useful utilities are supplied with your OMAX software. Consult the online OMAX Interactive Reference (online help files).

OMAX Layout Program

The OMAX CAD module called *Layout* creates parts for cutting. This drawing software includes a full range of drawing and editing tools. DXF files from other CAD programs can be imported into Layout. In addition, DXF files can be exported from Layout to other CAD programs. The end result of Layout will be the creation of an OMAX Routed Data file (.ORD), which also contains the machine cutting instructions.

OMAX Make Program

The OMAX *Make* software prepares the Layout drawing for the cutting process. It calculates the speed of the abrasivejet for optimum results and controls all machining operations. Make can calculate how much time and abrasive material will be required to machine the part, and allows you to review the exact path of the abrasivejet, even when not connected to the OMAX JetMachining Center.

OMAX Interactive Reference

The OMAX Interactive Reference (OIR) is an extensive set of Help files that document all the features of Layout and Make. The OIR provides a wealth of information—not only about the commands in the software, but also practical, real-world tips on how to effectively use your OMAX.

There are several ways to access the OIR:

1. Click the **Help** button when using a command.
   Many Layout and Make commands provide a Help button that starts the OIR and opens the page describing that command.
2. Press the **F1** key while in either Layout or Make.
3. Double-click the desktop **OIR** icon ("OMAX Reference").
4. Click **HELP** in the Layout or Make main menu.

Drawing the 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.

Layout can open files from other drawing programs. Drawings in the DXF format can be imported. Parts can also be created from photographs and other drawing sources using Layout's tracing capabilities.

Setting the Tool Path

After a part's drawing is created, Layout's **Generate Tool Path** command creates a tool path that defines how the part will be cut. In most cases, this command creates the exact tool path wanted, but you can always modify the path manually when needed.

Making the Part

Once the tool path is created, the Make software can control movement of the abrasivejet and the cutting of your 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.

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. At the highest quality (5), the abrasivejet nozzle moves the slowest. Quality also takes into account the material being cut. When working with a softer material such as polypropylene, for example, a quality of 5 moves the abrasivejet nozzle much faster than a quality of 5 would while working with steel. Quality is always relative to the machinability of the material.

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 and less smooth.

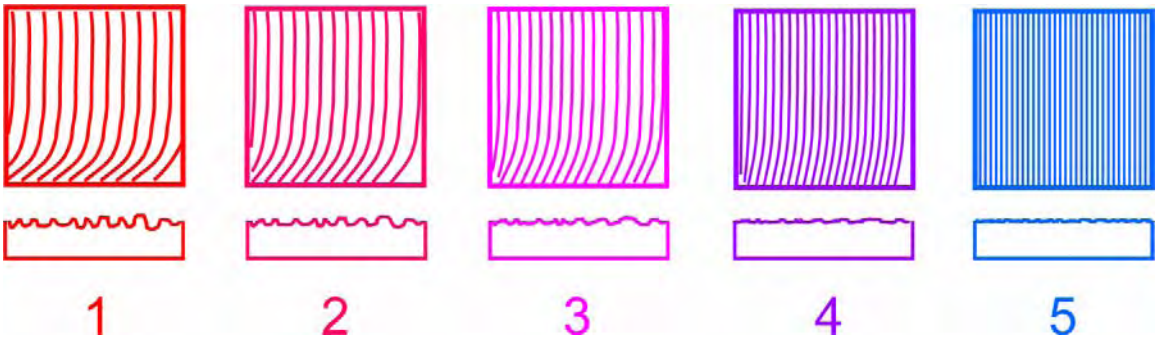


Figure 3-3: Quality Examples

In most cases, setting the cutting quality is a compromise between achieving the best surface finish in the least amount of time. When deciding which quality to use on a new material, a quality of 3 is a good choice. If the finish is too rough, increase the quality number. If the finish is acceptable, try lowering the quality to see if the part can be made in less time.

Four of the available types of qualities—Etch, Scribe, Water Only, and Lead—are different types of qualities. Etch and Scribe are designed to mark the surface of a material (to add a part number, for example). Water Only is designed for materials that can be machined without add an abrasive. Lead is assigned to a cutting path's lead-ins and lead-outs.

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. One of the primary causes for out-of-tolerance parts is allowing the material to move while being cut.

WARNING! ***Always be careful when handling material in the OMAX tank. During normal usage, 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 the frame or tank. Never clamp material to the slats themselves. Slats can sway back and forth slightly, moving the material with them. Use the 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: *The size of the high-pressure water pump also affects the clamping required. If the pump power is doubled, the amount of force exerted on the material will also double.*

WARNING! ***Always use the proper lifting equipment when handling heavy materials.***

Using Tabs for Holding Small Parts

When cutting small parts, design them using small holding tabs that prevent the part from detaching and slipping past the slats and down into the tank. Slats in the OMAX are spaced 1" (2.5 cm) apart. Small parts can easily slip between these slats once cut free. Designing tabs to hold a part to the cutting material prevents this. After the cut is complete, it can be broken free and the tab filed smooth. Tabs can be as thin as 0.030" (0.8 mm), depending on the material being used. Several tabs may be used on small parts to hold them steady if the part requires intricate detail work.

Note: *Using Waterjet Brick for holding small parts is an effective alternative to designing tabs.*

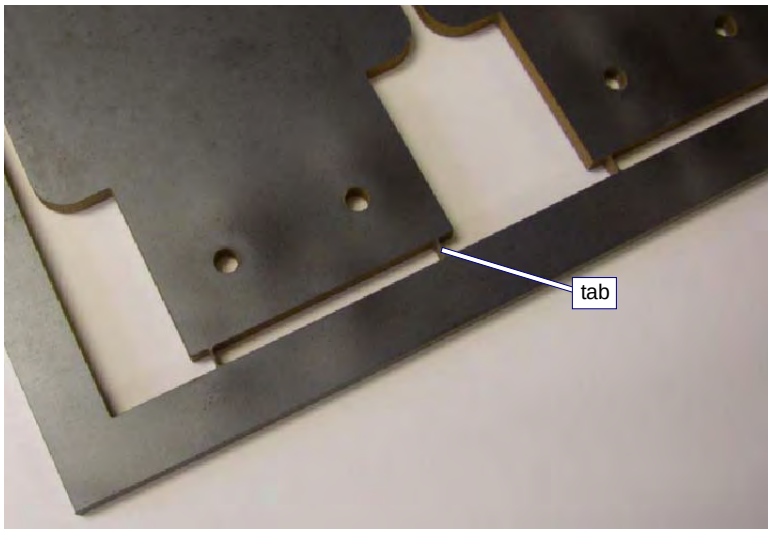


Figure 3-4: Using Tabs Prevents Small Parts from Falling in the Tank

WARNING! ***Never place your hands in the tank for any reason while the nozzle is operating. Never hold a part with your fingers while the nozzle is operating!***

Ensuring Clean and Quiet Machining

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

Keep the Abrasivejet Nozzle Under Water

Machining under water is significantly quieter than machining with the nozzle above water. There is also less spray from the abrasivejet when under water. Keep the abrasivejet nozzle under ¼" to 2" (6 to 51 mm) of water during machining.

Note: *Raising the abrasivejet nozzle above the water once machining in finished, prevents the water and abrasive mix from being drawn into the mixing tube and plugging it.*

When working with a highly buoyant material such as wood or paper products, it may not be possible to keep the abrasivejet nozzle under water. In this situation, always wear hearing protection and be prepared for the additional over-spray during machining.

Place a Muff on the Abrasivejet Nozzle

The OMAX is shipped with a sponge muff that fits over the abrasivejet nozzle. This muff serves several purposes. It keeps the noise level low during machining, reduces splashing and spraying, and protects the Z-axis and cutting head components. Always place a muff on the abrasivejet nozzle when machining.

This muff will eventually wear out. Included with the OMAX software is a file called "Muff" in the `\SAMPLES\USEFUL_TOOLS` directory that contains the pattern needed for making additional muffs. Use sponge material at least 1" (2.5 cm) thick for the muff. Muffs may also be ordered from OMAX.

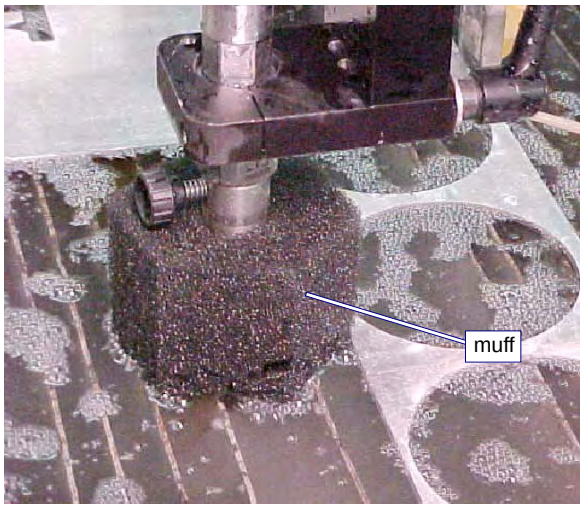


Figure 3-5: Cutting Nozzle with a Muff Attached

Keep Extra Sponges on Hand

Extra sponges should always be available. Set the sponges in the tank around the material being machined. When the abrasivejet stream strikes one of the support slats, often the stream is deflected and water sprays. The sponges reduce the spray and are also handy for wiping down the work surface.

Washing Heavy Garnet Deposits from Parts

Garnet will be deposited on the surface a part while being machined. Because the abrasivejet nozzle moves slowly and has time to stir up more sediment, this is most noticeable when working with thick materials. When too much spent abrasive has accumulated, the abrasivejet nozzle will need to plow through it, causing the material to shift and reduce the accuracy of the cut.

If too much garnet accumulates on a part while machining, wash away the deposits with a hose while the OMAX makes the cut.You should also consider purchasing the OMAX Solids Removal System. For more information on this product, contact your OMAX distributor.

Tips for Effective Cutting

- **Use an abrasivejet nozzle standoff of less than 0.060" (1.5 mm)**
  The closer the abrasivejet nozzle is to the material being cut, the less the taper. The ideal distance from the end of the nozzle to the material (standoff) is as close as possible without actually touching. Increasing this standoff increases the taper. Lower standoff distances increase the likelihood of plugging the nozzle during piercing. You can avoid this problem by pre-piercing holes using a higher standoff.

Note: *The default standoff is set for 0.060" (1.524 mm). The software uses this value to determine how to cut a part. If a different standoff value is used, change it using "Motion Preferences" (Setup/Motion Preferences...).*

- **Keep contaminants out of the abrasive**
  Contaminants in the abrasive material clog the mixing tube. Contaminants include drops of water, bits of paper, metal shavings, dirt, 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.
- **Make sure the 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 and to the tank bottom.
- **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**
- **Position parts with the longest dimension perpendicular to the slats**
  This minimizes the risk of tilting.
- **Be wary of parts with heavy ends that may tilt even when supported by many slats**
- **Raise the nozzle before running Auto Home**
  If your OMAX machine is equipped with X- and Y-axis hard stops, you can use the Auto Home feature to automatically set the home position. Before you do this, make sure you raise the nozzle high enough to avoid hitting anything (such as fixturing). In general, it's a good idea to move the nozzle close to the home position, both to avoid collisions and to speed up the Auto Home process.
- **Reposition weights during a traverse**
  Wait until the OMAX reaches a rapid traverse (green line on tool path) 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.
- **Draw parts to start in a consistent position**
  Always design parts so that the starting position is in the same place (such as the upper left-hand corner). This allows consistent positioning of the abrasivejet nozzle when making parts.
- **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 your parts in different areas of the table to even slat wear.
- **Place a rod inside tubing when cutting**
  When cutting hollow tubing or pipe, place a solid rod inside the tube. In a hollow tube, the abrasivejet stream spreads out when it strikes the air inside the tube, causing the far end of the cut to be wider with a ragged edge.
- **The top surface may be used for tooling**
  The top surface of the OMAX frame is flat and is exactly parallel to the X and Y motion of the abrasivejet nozzle. This surface may be used for any special fixturing installed.

Note: *For additional tips on effective cutting, consult the OMAX Interactive Reference where an entire section is devoted to tips.*

Setting Soft Limits

In the OMAX, 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 maximum cutting area that is available on a particular table. These are hardware limits that are set using physical stops installed on the ends of the ball screw threads for both the X- and Y-axis (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 ever 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 cutting 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 pops-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 Your 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 other defined homes and soft limits are points that are relative to the Absolute Home location. To ensure positioning accuracy, Absolute Home must always be re-zeroed before another home is created. **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 PC Controller.** Absolute Home is usually in the front corner of your machine. For the 80160, Absolute Home is in the rear, far corner of the machine.

To Auto Home your OMAX:

1. Move the cutting head to about 10 inches for each axis from the Home corner.
2. In **Make**, click **Homes**/**Advanced**/**Auto Home...**

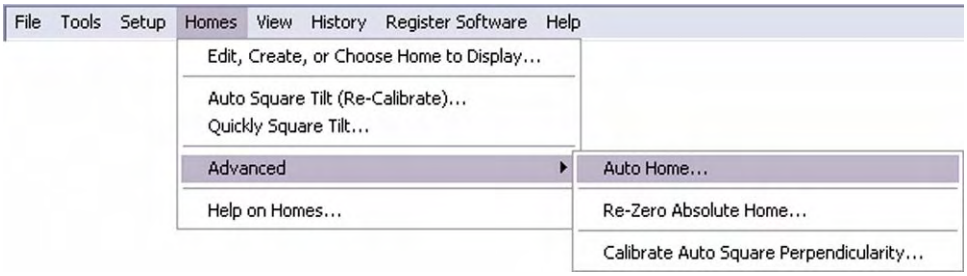


Figure 3-6: Selecting Auto Home in OMAX Make

3. When the warning message appears, if appropriate, click **OK**.

Note: *The machine will now move in the X-axis direction until it gently contacts the X-axis hard stop. It then moves in the Y-axis direction until it gently contacts the Y-axis hard stop.*

4. When prompted to re-zero Absolute Home, select **Yes**.

   Your OMAX should now be accurately aligned and ready for use.

Operating the JetMachining Center

Note: *The following guidelines for operating the JetMachining Center assume that the OMAX operator has received the factory training provided as part of the original equipment purchase and installation.*

Configuring Your Drawing

1. Import your part file (.dxf) into **Layout**, the OMAX drawing tool.
2. Use the **Clean** command to clean up the drawing file by removing any unnecessary dots, closing any gaps, and removing any duplicate entities.
3. Define the quality of the cut needed for each part entity (see Determining Quality on page 3-6):
   - Quality 1 is the lowest quality cut and the fastest.
   - Quality 5 is the highest quality cut and 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 your lead-in/outs determines whether the nozzle cuts 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 your 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.
5. Save the completed version of your .dxf file.

6. Use the Layout Path Special Tool to specify the machine path.
   - Configure the path either manually or automatically.
   - Render as a Solid to verify the outcome.
   - Run collision detection and correct any found.
7. Save your final path drawing. Layout automatically saves it as an OMAX .ord file.

Note: Consult the OMAX Interactive Reference for a detailed Layout tutorial and any additional drawing information.

Cutting Parts

WARNING! ***Safe operation of this equipment requires that you have read and can practice all the safety "dos" and "don'ts" presented in "Chapter 1: Safety First."***

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 rubber gloves).
2. Switch the main power breaker **On** for your OMAX equipment.
3. If installed, close the bleed valves on the bulk hopper and common water air tank.
4. Switch the air supply valve **On**.
5. Switch the water supply valve **On**.
6. Check the white water tank inside the pump (Figure 3-7) to verify the water level is between one-half and three-fourths full.
7. Power up the OMAX high-pressure pump as follows:
   a. Turn the pump control panel switch **On**. Verify pump operation by checking for valid RPM and KSI readings on the pump's LCD screen.
   b. Turn the charge pump control panel switch **ON**. Inspect the cooling flow from the three hoses in the white water tank for a similar flow from each. When holding each horizontally, the water should stream out 2-4 inches before dropping.

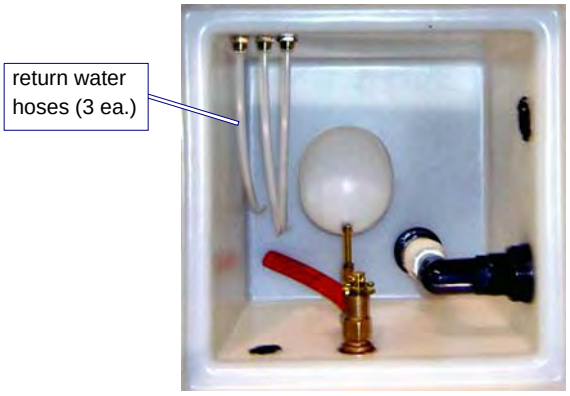


Figure 3-7: White Water Tank Internal View

WARNING! ***Always run the charge pump for approximately 15 minutes following its initial power up and when the pump has been inactive for 30 minutes or more. This allows cool water to circulate and cool off the dynamic seal area of the pump, ensuring that pump seals are cooled down prior to high-pressure operation.***

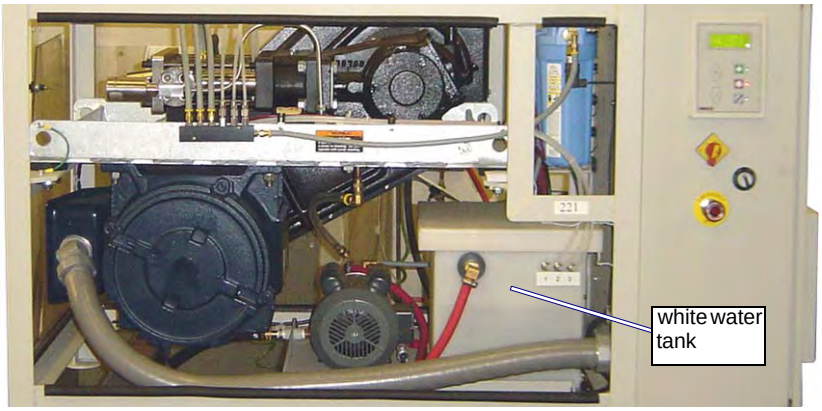


Figure 3-8: White Water Tank Location in OMAX Pump

c. After running the charge pump for 15 minutes, measure the water temperature of the white water tank. It must always be maintained below 70° F (21.1° C). The colder the better!

WARNING! ***If your inlet water is above 60° F (15.6° C), you may experience a shorter life from your 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 will need a rebuild.***

8. Power up the JetMachining Center by switching the PC Controller's power ON. Verify that the Windows operating system boots up without issues.
9. When applicable, also power ON any attached OMAX accessories (solids removal system, bulk feed hopper, chiller, etc.).
10. Verify the nozzle being used matches the size required for the part being cut. Change it to the correct size when required.

Caution: ***Changing the nozzle orifice size also requires adjustment of the dump orifice in the high-pressure water line of the OMAX pump. Correctly matching the orifice size in the nozzle with that in the pump minimizes water pressure difference in the high-pressure plumbing during nozzle Off and On conditions, thus reducing pressure spikes and premature plumbing failures. For pumps with the Adjustable Dump Orifice (ADO) (Figure 4-73) see page 4-35 for adjustment procedures. For pumps with interchangeable Dump Valve orifices (Figure 4-73), see page 4-39 for orifice replacement procedures.***

11. Ensure that your mixing tube has been installed properly using the nozzle/mixing tube gauge as illustrated below in Figure 3-9:

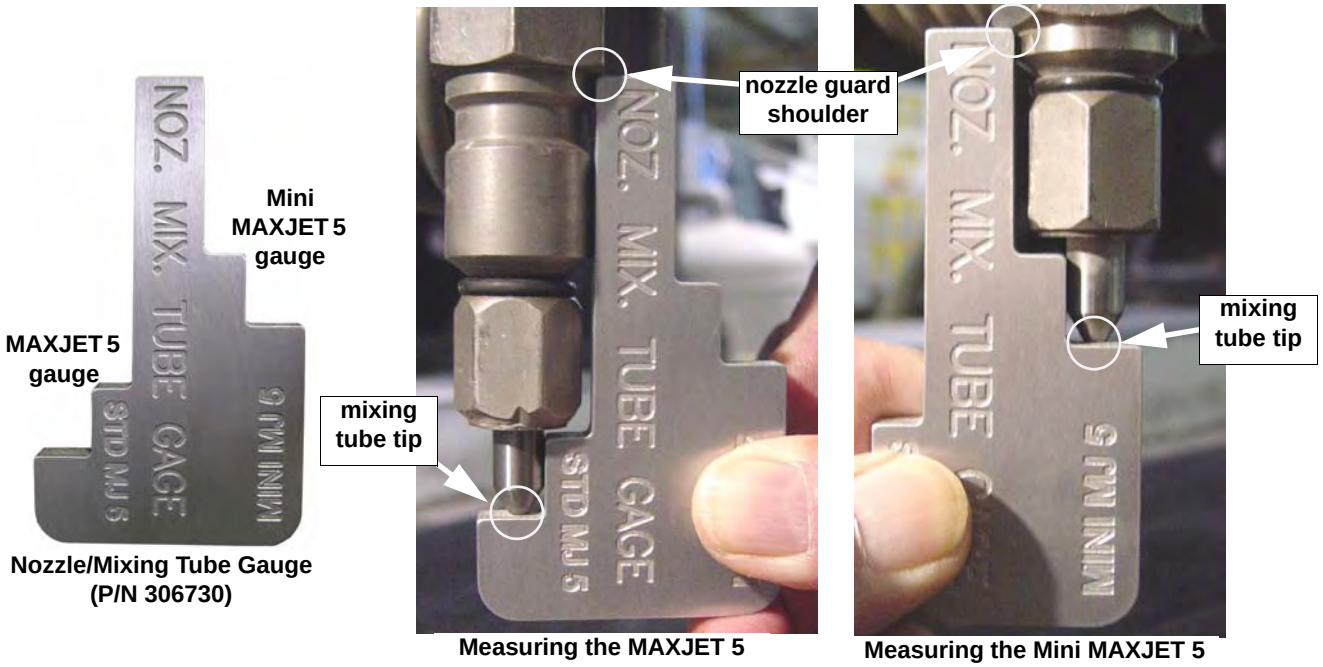


Figure 3-9: Verify Correct Mixing Tube Placement

- Verify that the gauge touches both the **mixing tube tip** and the **nozzle guard shoulder**.
- Verify that no gap exists at either location.

Note: *If a gap greater than 0.010" is seen at either location, it is recommended that you disassemble the nozzle, clean all the components, re-assemble the nozzle, ensure that the mixing tube is pushed in all the way, and recheck for correct mixing tube placement using the nozzle/mixing tube gauge.*

12. Pour the desired abrasive size (mesh) into your nozzle hopper. Ensure that the amount added will be sufficient to finish cutting the part.
13. Check the tank's water level. Make sure that the material being cut can be covered and also uncovered with tank water. Add or drain tank water as needed.
14. In Windows, click the OMAX **Make** icon to launch the cutting software.
15. Auto Home the machine to ensure that the machine's zero (absolute home) position is set (Figure 3-10).

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

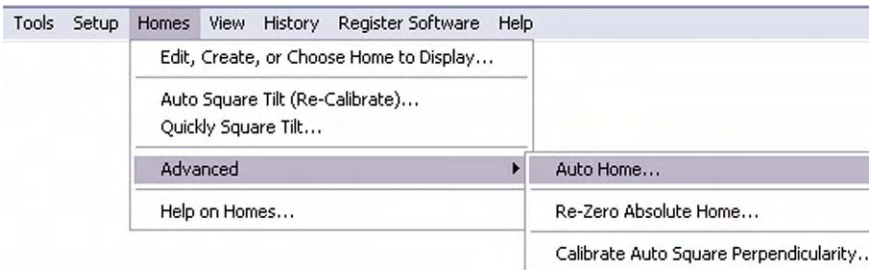


Figure 3-10: Use the Homes Menu Option to Initiate an Auto Home

16. Verify that the soft limits are enabled (**Setup/Advanced/Soft Limits** - see Figure 3-11):

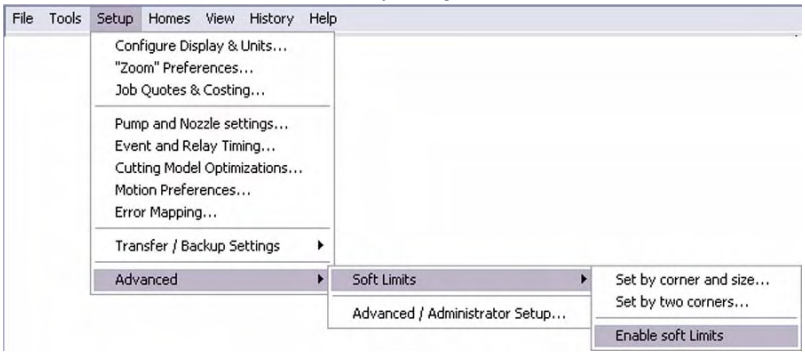


Figure 3-11: Use Setup to Enable the Soft Limits

17. 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 out of water.***

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

Figure 3-12: Pump and Nozzle Test Options

    b. Select **Low,** then click **Water** to begin the test (Figure 3-12).
    c. When the jet stream begins, remove the abrasive feed tube from the abrasive feed block on the Bimba valve (Figure 3-17) and block air flow through the feed tube by holding a finger against the tube opening. Then, examine the quality of the jet stream as illustrated below:

Figure 3-13: Example of Both Good and Poor Quality Jet Streams

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 3-14 to compare the effect that a damaged orifice and worn mixing tube have on the quality of a nozzle's jet stream.

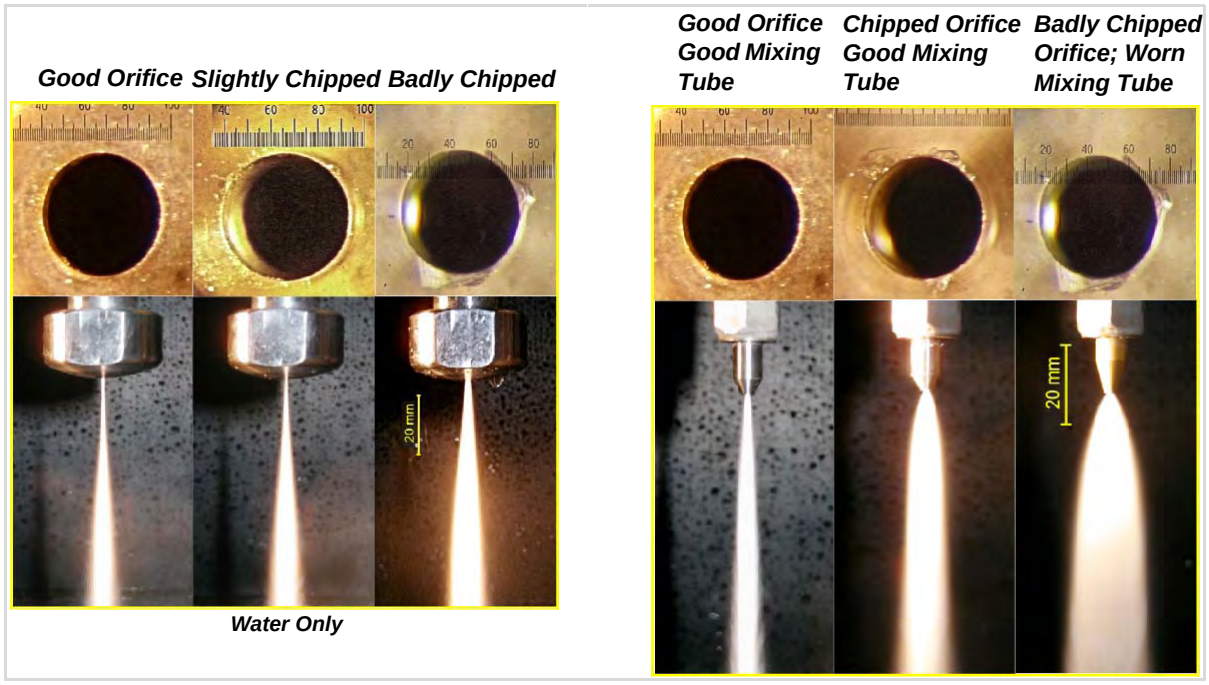


Figure 3-14: Comparison of Jet Streams with Different Jewel and Mixing Tube Conditions

e. Refer to Figure 3-15 to see how the shape of a jet stream's shape indicates the quality of its cutting performance.

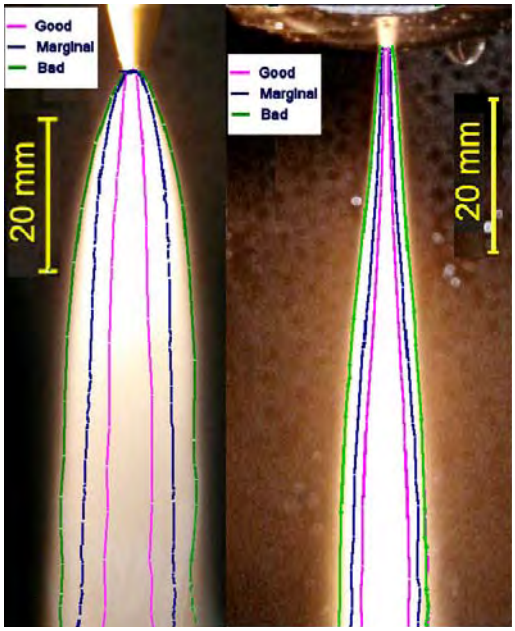


Figure 3-15: Comparison Spread of Waterjets and Abrasive-waterjets at Different Health States

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

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

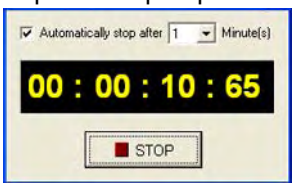


Figure 3-16: Nozzle Pressure Test Stop Button

19. 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 cutting is done either under water or with the water level immediately below the work piece.***

a. If necessary, click the **Test** button to again display the nozzle test options (refer back to Figure 3-12).

b. Select **High,** then click **Water** to begin the test (see Figure 3-12 for options).

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 3-13.

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

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

e. During this test, also check the **charge pressure** at full flow. The difference between the two pressure gauge readings must not exceed 20 pounds. If more than this, the water filters most likely require changing.

f. Click **Stop** to end the high-pressure pump test (Figure 3-16).

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

a. If necessary, click the **Test** button to display the nozzle test options (refer back to Figure 3-12).

b. Select **High,** then click **Water and Abrasive** to begin the test (see Figure 3-12).

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 3-16).

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

Note: *The abrasive flow rate should be measured each week (or sooner, whenever there are operational changes).*

a. Remove the **abrasive feed block** from the Bimba valve cylinder (Figure 3-17) by pulling it straight back.

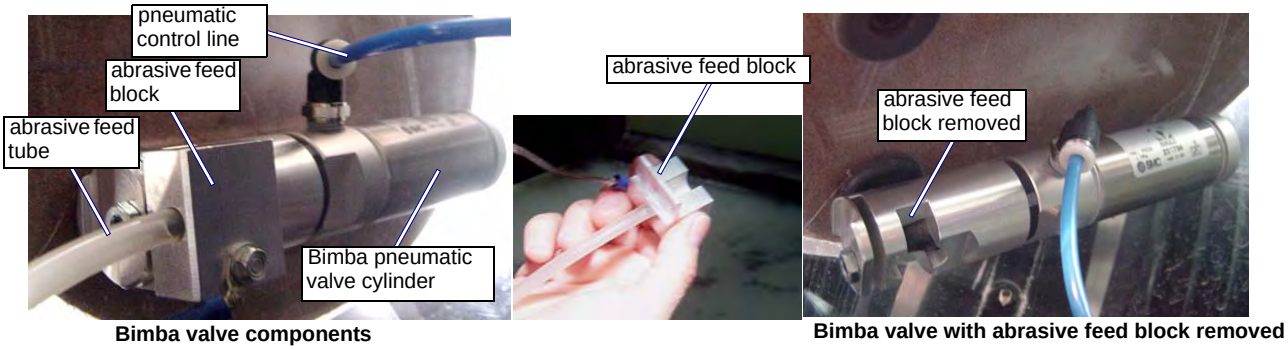


Figure 3-17: Bimba Valve Abrasive Feed Block

b. Place a container directly below the Bimba valve to catch the abrasive released during the measurement flow.

c. Click the **Test** button to display the nozzle test options (refer back to Figure 3-12).

d. Click **Abrasive** 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 Bimba valve.

22. Verify that the "Pump Nozzle Settings" in **Setup** match your actual measured values.

Caution: ***It is critical that the software settings match your 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 your machine. If not properly matched, poor cutting and frustration results.***

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

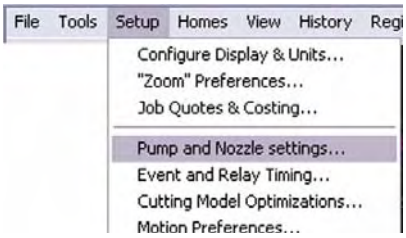


Figure 3-18: Setup Menu for Pump and Nozzle Settings

b. Correct any values being displayed that differ from those recorded when testing your OMAX machine.

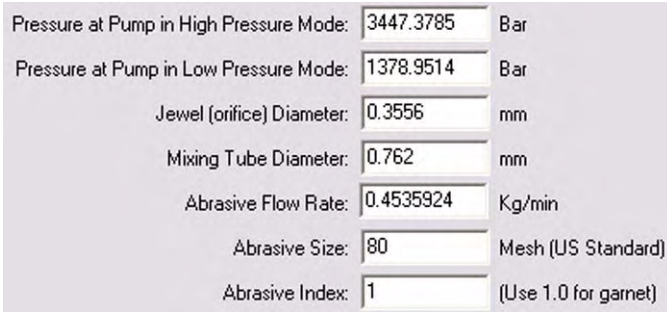


Figure 3-19: Settings for Pump and Nozzle

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

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

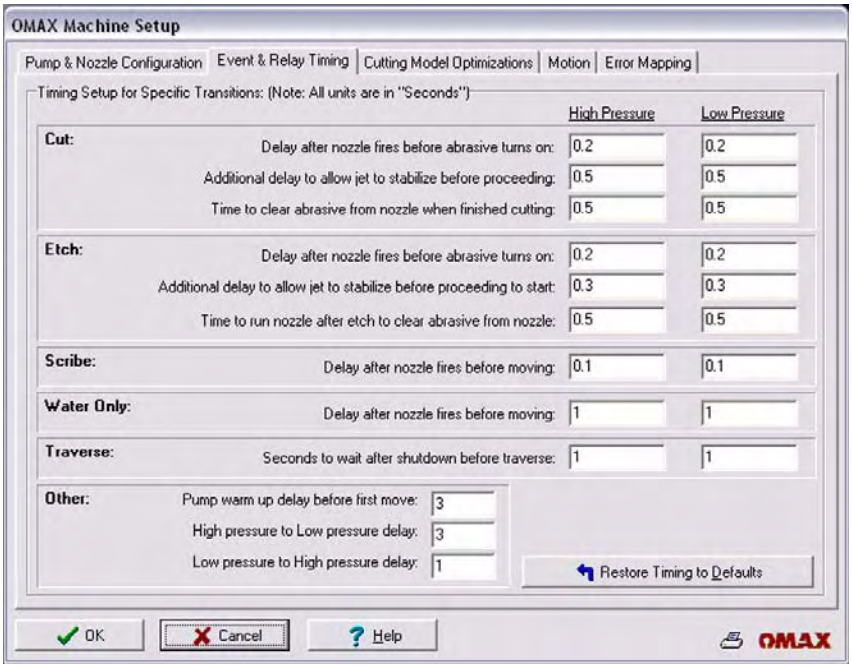


Figure 3-20: Event and Relay Timing Displayed Values

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.*

24. From **Setup**, click **Cutting Model Optimizations** and verify that those selections match your cutting requirements. Click **OK** to save any changes made.

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 your drawing's file is stored.
   b. When located, clicking the **.ord file name** opens that drawing in the adjacent preview screen.

Note: *If your drawing was developed using another PC other than the OMAX PC Controller, unless networked, you must move it to the PC Controller by copying it to a CD, diskette, or USB memory stick.*

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

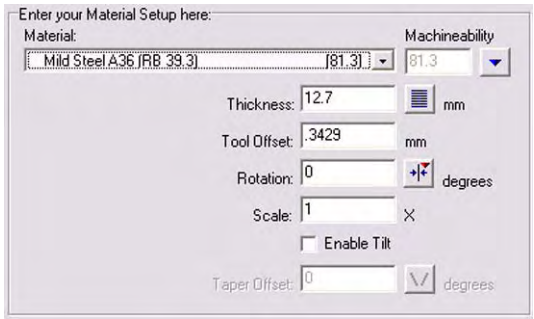


Figure 3-21: Material Setup Example

3. If required, also configure the **Cut Settings** and **Pierce/Terrain Follower Settings**:

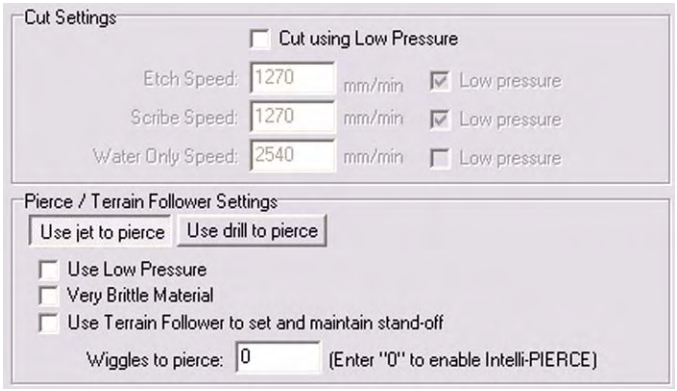


Figure 3-22: Cut, Pierce, and Terrain Follower Setting Options

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. Lower the tank water level to just below the table slats.
3. Place the material to be cut on the slats and use adequate fixturing to keep the material flat and stable during cutting.

Note: *Ensure that small parts do not fall into the tank as they are cut free. Either use jet bricks, position the cut appropriately, or utilize tabs. Refer to Clamping and Positioning Materials for Cutting on page 3-6.*

4. Position the nozzle to begin the cut and set the Path Start Home:
   a. Place the nozzle above the material being cut, ensuring efficient use of the available material and where it will not overshoot the material during the cut.
   b. Once the nozzle is correctly positioned, click **Zero** as the **Distance from Path Start** (see Figure 3-23).

Note: *This step may be omitted, as the distance from path start is always zeroed automatically when the cut is initiated.*

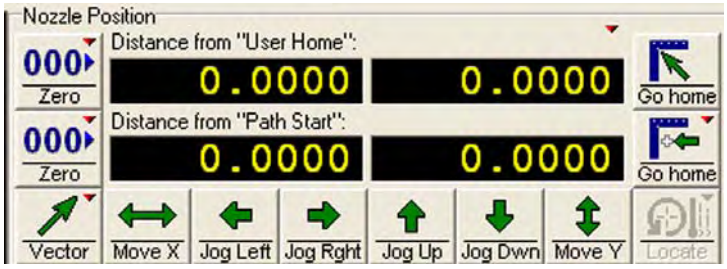


Figure 3-23: Nozzle Position Functions

5. Set your nozzle standoff above the material at 0.060 inches (1.52 mm) and **zero** the Z-axis:
   a. Press **1** to move the nozzle **down** quickly; press **7** to move it **up** quickly.
   b. Press **PageDown** to move the nozzle **down** in 0.1 inch (.254 cm) increments; **PageUp** to move it **up**.
   c. Adjust the **nozzle height** to 0.060 inches (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.

d. When properly adjusted, click **View/Show Z Coordinates** to display the Z Height Coordinates pop-up window:

Figure 3-24: Z-axis Height

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

6. Conduct a dry run to verify your cutting path:
   a. Click the **Begin Machining** button to display the OMAX 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 your **Path Start Home** position and try another dry run.
7. Raise the nozzle using the Z Height adjustment and attach the nozzle's muff.
8. Lower the nozzle to its zero Z-axis coordinates (click the arrow on the right side of the Z Height pop-up display).
9. Raise the water level in the tank above the cutting material.
10. Begin cutting by clicking **Begin Machining**/**Begin**.

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

11. Once machining stops, raise the nozzle, lower the water lever, rinse the abrasive debris from the cut material, and remove the cut part(s) from the machine.

Shutting Down the JetMachining Center

1. Position the nozzle between two table slats at 1 (.254 cm) to 1.5 inches (3.81 cm) above the water surface.
2. Allow the pump to run for 20 seconds 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 (3.81 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: Pump and Nozzle Test Options

b. Select **High**-pressure**,** then click **Water** to begin the jet stream.

c. After at least 20 seconds click **STOP** to halt the jet stream.

3. Lower the tank **water** to its lowest level.
4. Move the nozzle to a table area where it will be out of the way during cleanup.
5. Wipe down the machine table and surrounding area, cleaning up any splashed water and abrasive material.
6. Remove any debris floating in the water.
7. Complete any shop-specific clean-up procedures.
8. Remove any discs or USB memory devices that may still be in the PC Controller.
9. For a Terrain Follower, secure the foot in its Up position using a bungee cord or similar device.
10. Close OMAX **Make** and all other software applications running on the OMAX PC Controller.
11. Click the Windows **Start** button and select **Shut Down**.
12. Verify that the computer has powered down (indicator lights off and a blank screen).
13. If applicable, depressurize the **Bulk Feed Hopper**.
14. Turn the charge pump **OFF**.
15. Switch the water supply valve **OFF**.
16. Power the PC Controller **OFF**.
17. Switch the air supply valve **OFF**

Caution: ***NEVER turn the PC Controller power OFF without first shutting down the PC using the proper Windows shut down procedures (Start/shutdown). Always wait for the PC to completely shut down before powering OFF the PC Controller. Failure to do a shutdown properly can corrupt Windows with the loss of critical files.***

18. Turn the pump power switch **OFF**.
19. Turn the air supply valve **OFF**.

Note: *Turning the air supply OFF as the last step prevents the Terrain Follower from dropping the Z-axis.*

20. Depressurize the common water level air tank.
21. Disconnect the breaker box that provides main power to the OMAX equipment.

Startup Checkoff Sheet

Use the following checkoff sheet to ensure that all equipment startup tasks are completed and in the required sequence. For more detailed startup instructions, refer to Cutting Parts, page 3-12.

WARNING! ***Safety First – Always wear safety glasses, ear protection, and hand protection when operating your OMAX JetMachining Center.***

1. ❒ **Main breaker box POWERED ON**.
2. ❒ **Bleed valves CLOSED** for bulk hopper and common water air tank.
3. ❒ **Air supply valve OPENED**.
4. ❒ **Water supply valve OPENED**. Verify white tank water level.
5. ❒ **High-pressure pump POWERED ON**. Verify that pump LED screen becomes active.
6. ❒ **Charge Pump POWERED ON**. Verify cooling flow from 3 white tank hoses.
7. ❒ **PC Controller POWERED ON**.
8. ❒ **Bulk feed hopper PRESSURIZED** (if applicable).
9. ❒ **OMAX "Make" STARTED**.
10. ❒ **Table AUTO HOMED** to ensure that absolute home position is correct.
11. ❒ **Nozzle POSITIONED between slats**, 1 to 2 inches (2.54 - 5.1 cm) above the water level.
12. ❒ **Nozzle low-pressure water test STARTED**. Click "Test", "Low", and "Water".
13. ❒ **Straight and narrow jet stream VERIFIED** while pinching the abrasive feed tube.
14. ❒ **RPM and Pressure ADJUSTED and RECORDED** from the pump LCD screen.
15. ❒ **Nozzle low-pressure test STOPPED**.
16. ❒ **Nozzle high-pressure test STARTED.** Click "Test", "High", and "Water".
17. ❒ **Straight and narrow jet stream VERIFIED** while pinching the abrasive feed tube.
18. ❒ **RPM and Pressure ADJUSTED and RECORDED** from the pump LCD screen.
19. ❒ **Charge pressure at full flow RECORDED**.
20. ❒ **Nozzle high-pressure test STOPPED**.
21. ❒ **Water and Abrasive test STARTED**. Click "Test", "High", and "Water & Abrasive".
22. ❒ **Increased sound level and stream diameter CONFIRMED**.
23. ❒ **Abrasive flow rate MEASURED**.
24. ❒ **Setup and Pump Nozzle settings VERIFIED** correct.
25. ❒ **High- and Low-pressure values SET** to match pump settings above.
26. ❒ **"Event & Relay Timing" settings VERIFIED** correct.

You are now ready to begin machining.

Shutdown Checkoff Sheet

Use the following checkoff sheet to ensure that all equipment shutdown tasks are completed and in the required sequence. For more detailed shutdown instructions, refer to Shutting Down the JetMachining Center, page 3-20.

WARNING! ***Safety First – Always wear safety glasses, ear protection, and hand protection when operating your OMAX JetMachining Center.***

1. ❒ **Nozzle POSITIONED between slats**, 1 to 2 inches (2.54 - 5.1 cm) above the water level.
2. ❒ **Nozzle high-pressure test STARTED.** Click "Test", "High", and "Water".
3. ❒ **Pump RUN for 20 seconds** to clean and clear all abrasives, then test stopped.
4. ❒ **Water LOWERED** to lowest level.
5. ❒ **Nozzle POSITIONED** at desired location for shut down.
6. ❒ **Floppy diskettes REMOVED** from drive.
7. ❒ **Terrain Follower foot SECURED** in up position.
8. ❒ **OMAX "Make" CLOSED**.
9. ❒ **Windows "Shut Down" CLICKED**.
10. ❒ **PC Controller POWERED OFF**.
11. ❒ **PC shutdown VERIFIED** (no PC lights; black monitor screen).
12. ❒ **Bulk feed hopper DEPRESSURIZED** (if applicable).
13. ❒ **Charge pump POWERED OFF**.
14. ❒ **Water supply valve CLOSED**.
15. ❒ **PC Controller POWERED OFF**.
16. ❒ **High-pressure pump POWERED OFF**.
17. ❒ **Air supply valve CLOSED** (air is off last so Terrain Follower will not drop the Z-axis).
18. ❒ **Water level air tank DEPRESSURIZED.**
19. ❒ **Main** breaker box **POWERED OFF**.

Your OMAX equipment is now properly shutdown.

Chapter 4

Maintenance

Using the maintenance schedule in combination with the maintenance log provided in this chapter (page 4-59) is important to ensure reliable equipment performance and accuracy. Typically, 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 that these activities be scheduled more frequently than indicated in the table below.

Pump Maintenance

WARNING! ***All pump maintenance activities must be performed by OMAX qualified personnel. Refer to the OMAX Pump Service and Maintenance Guide for more detailed maintenance information.***

General

Power End Maintenance Performed	Recommended Hours
Change oil, check belt tension	First 50, thereafter every 300
Clean white water tank, remove debris from filter screen	As required
Change water filters whenever the difference in pressure between the inlet and outlet gauges is equal to, or larger than, 20 psi	Variable
Replace electrical enclosure air filters approximately once per month, or more frequently as required	Variable
Nozzle Last Chance Filter	Weekly or whenever the nozzle is removed for cleaning

Main Electric Motor Lubrication

The main electric motor is supplied with pre-lubricated ball bearing. The motor ball bearings should be lubricated at intervals as follows:

Hours of Service Per Year	Recommended Relube Interval
Continuous	1 Year
Seasonal (Idle 6 months or more)	1 Year (beginning of season)
• Continuous, High Ambient Temperature • Dirty or Moist Locations • High Vibrations	6 Months

Changing Crankcase Oil

To avoid excessive wear and damage to the crankcase bearings, it is important to change 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 (ISO 100) non-detergent motor oil. Use of other types of oil may shorten pump life. If the temperature in the pump's physical environment exceeds 90° F (32° C), use SAE 40 (ISO 150) non-detergent motor oil. The crankcase holds two quarts (1.9 L) of oil.

Note: *Whenever extended periods of pump operation at a motor RPM that is less than shown below are anticipated, you should add one additional quart (3 total) of oil to the pump crankcase.*

Pump Model	Add additional quart of oil if RPM is less than
P3050V	750
P3055V	850
P4055V	650

To change the oil in the pump crankcase:

1. Disconnect the pump's AC power source.
2. Lift the pump's cover lid and remove the front panel cover.
3. Place a drain pan at the end of the red Oil Drain Hose to catch the oil when the Plug is removed from the Fitting.

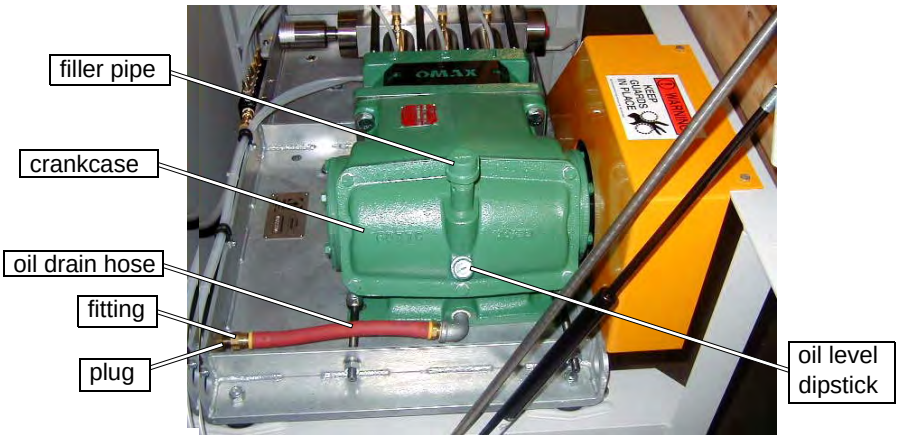


Figure 4-1: Changing the Pump's Crankcase Oil

4. Pump Crankcase, Oil Drain Hose, Filler Pipe
5. Allow the oil to drain.
6. To force out remaining oil, apply a small amount of shop air to the hole in the oil filler tube with the filler cap still in place.
7. Replace the plug at the end of the red drain hose.
8. Refill the oil through the filler pipe.
9. Replace the filler pipe cap.
10. Replace the front cover.

Routine Maintenance Schedule

Wet-end Maintenance	Recommended Hours	
	P3050/3055V	P4055V
Install Minor Maintenance Kit (P/N 302700)	500	-
Install Major Maintenance Kit (P/N 302701)	1000	500
Install Minor Maintenance Kit (P/N 302700)	1500	-
Install Major Maintenance Kit (P/N 302701)	-	1000
Install Major Maintenance Kit (P/N 302701)	-	1500
Install Overhaul Kit (P/N 305098)	2000	2000

Note: *Repeat the above sequence for the corresponding pump after every Overhaul Kit installation.*

Less Frequent Maintenance Schedule

Wet-end Maintenance	Recommended Hours	
	P3050/3055V	P4055V
Replace Plunger Assemblies (P/N 304885)	Every 2000	Every 2000
Replace Liquid Displacers (P/N 303294)	Every 2500	Every 2500
Replace Cylinders (P/N 300737)	Every 4000	Every 3500
Replace Manifold (P/N 301350)	Every 5000	Every 4500

JetMachining Center Maintenance

WARNING! ***All table maintenance activities must be performed by OMAX qualified personnel. Refer to The OMAX JetMachining Center Service and Maintenance Guide for more detailed maintenance information.***

Table Maintenance Schedule

Activity		Frequency
Tank Maintenance	Wash away the abrasive accumulation from the equipment and work 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 quickly accumulate on the material being machined
	Inspect individual slats for wear, replacing and rotating	Inspect and rotate monthly. Replace when excessively scored and no longer stable
	Clean the outlet water filter	Check monthly (Figure 4-13)
	Run tank cleaning program	As needed when using the OMAX Solids Removal System (SRS)
	Add anti-bacterial chemicals to the tank water controlling tank odor and bacteria growth	Check monthly and replace before chemicals in the floating device become depleted and bacteria growth can thrive
Table Maintenance	Lubricate carriage components	Yearly
	Lubricate X-axis components	Yearly
	Lubricate the Motorized Z-axis	Yearly
	Inspect the timing belts	Yearly
	Inspect the high-pressure plumbing	Yearly
	Rebuild the abrasivejet nozzle	As required to maintain cutting quality
PC Controller Maintenance	Clean Keyboard and Mouse	As required
	Replace air filters	Every three months or sooner as necessary
	Clean monitor screen	As necessary to maintain clear viewing
	Update OMAX Software	As soon as updates are released by OMAX
	Reboot PC Controller	Daily
	Run Windows Defragmenter program	Monthly
	Replace CMOS battery in the PC Controller	As needed (normally will last approximately 5 years or more)

Rebuilding the Nozzle

This section provides instructions for rebuilding the nozzle assembly which includes the following activities:

- Preparing for nozzle removal
- Removing the nozzle
- Disassembling the nozzle assembly
- Cleaning and inspecting nozzle parts
- Rebuilding and replacing the nozzle assembly
- Testing nozzle operation

Note: *The nozzle assembly includes all the parts from the inlet body to the tip of the nozzle mixing tube.*

Refer to the nozzle configuration documentation provided with your OMAX JetMachining Center. These documents contain part numbers needed for ordering replacement or spare parts. Additional documents may be ordered by contacting OMAX Customer Support. Most documents can be downloaded from the OMAX web site (http://www.omax.com) from the Technical Support page.

Nozzle Operation

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

Identifying When to Repair and Rebuild the Nozzle

Nozzle assembly use affects these consumable components:

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

Indications that nozzle repair is needed:

- Water leaks out of the nozzle assembly weep hole
- The jet stream is not well formed
- 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

Preparing for Nozzle Repair/rebuild

Prior to working on the OMAX nozzle assembly, assemble the following tools and documentation:

Filter Seal Assembly Removal Tool
Extreme Pressure Lube (EPL)
Push Tool 0.550" (1.4 cm) diameter by 1.2" (3.0 cm) long (or a deep 3/8" socket)
1" open-end wrench
1-1/8" open-end wrench (for the MiniJet nozzle)
1-¼" open-end wrench
5/8" open-end wrench
Spanner wrench (supplied with the Tilt-A-Jet)
Arbor press
Electronic weighing scale

Microscope
Blue Goop
Lubriplate
Drift tool 3" (7.6 cm) long and 0.330" (8.4 mm) in diameter
Applicable OMAX nozzle drawings
JetMachining Center Operator's Guide (this document)
Nozzle Rebuild DVD

Note: *Refer to the applicable Nozzle Assembly Drawing for specific OMAX tool part numbers.*

After preparing your work space and obtaining the necessary nozzle documentation and tools, prepare the OMAX machine for nozzle removal as follows:

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

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

2. Raise the Z-axis to a height that allows the **nozzle assembly** to be accessed and easily removed.
3. Move the **nozzle head** to an X-Y position convenient for **nozzle assembly** removal.
4. Shut down the applications on the PC Controller by following proper shutdown procedures.
5. Power Off the **PC Controller**.
6. Power Off the OMAX **pump**.
7. Switch Off the main AC power, air, and water sources to the machine. Tag and lock them out according to established safety practices. Follow all other company-specified safety procedures.

Removing a MaxJet® 5 Nozzle Assembly from a Tilt-A-Jet

There are eight basic steps for disassembling a MaxJet 5 Nozzle Assembly on a Tilt-A-Jet:

Step **One**: Remove the **nozzle mixing tube** (see page 4-6)

Step **Two**: Remove the **nozzle body** from the **inlet body** (see page 4-6)

Step **Three**: Remove the **filter seal assembly** from the **inlet body** (see page 4-7)

Step **Four**: Remove the **orifice assembly** (see page 4-7)

Step **Five**: Remove the **mixing chamber disc** (see page 4-8)

Step **Six**: Remove the **mixing chamber** (see page 4-8)

Step **Seven**: Clean the **nozzle** components (see page 4-9)

Step **Eight**: Inspect the **nozzle** components (see page 4-9)

Note: *Although a number of steps are involved in the nozzle rebuild process, it generally takes approximately 15-20 minutes to remove, inspect, and clean a Nozzle Assembly.*

Removing the Nozzle Mixing Tube

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

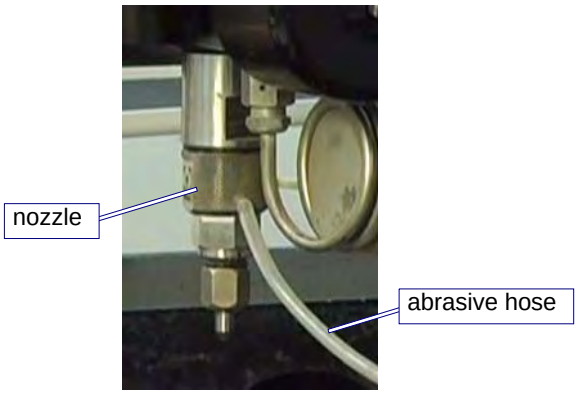


Figure 4-2: Remove the Abrasive Hose from the Nozzle

2. Place a piece of **cardboard** or equivalent blocking material directly under the **nozzle** to prevent any dropped parts or tools from falling into the tank during servicing.
3. Remove the **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 4-3).
   b. Loosen the **mixing tube locking nut** using an **11/16" open-end wrench**. When loose, hold the **mixing tube** with your fingers to prevent it from dropping while unscrewing it.

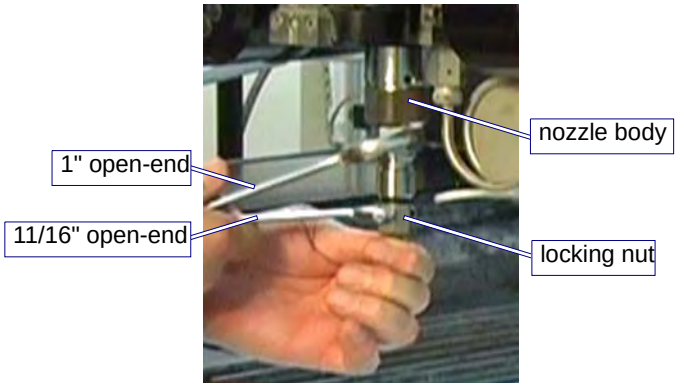


Figure 4-3: Removing the Nozzle Mixing Tube

   c. Remove the **mixing tube** along with the **locking nut** and **collet**. Carefully place all parts on your working area for later cleaning and inspection.

Caution: ***The mixing tube, even though it is made from abrasive resistant material, will break if dropped or struck hard.***

Removing the Nozzle Body from the Inlet Body

1. Place a **1/2" wrench** on the upper hex portion of the **inlet body** located at the top of the **nozzle assembly**. This will hold the **inlet body** in place when removing the **nozzle body** and counteract any induced torque that can alter the Tilt-A-Jet's alignment and accuracy.
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.

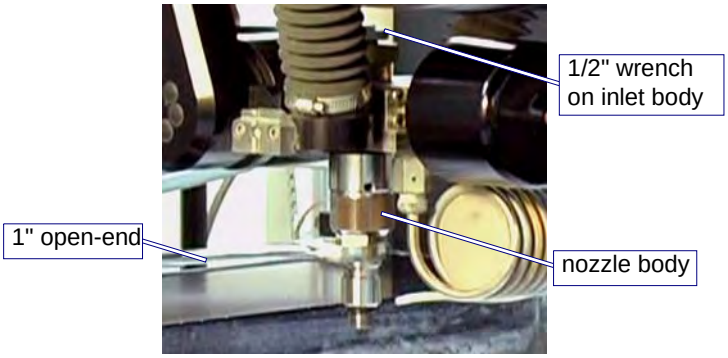


Figure 4-4: Removing the Nozzle Body from the Inlet Body

3. Unscrew the loosened **nozzle body** by hand and place in your working area for cleaning and disassembly.

Removing the Filter Seal Assembly from the Inlet Body

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

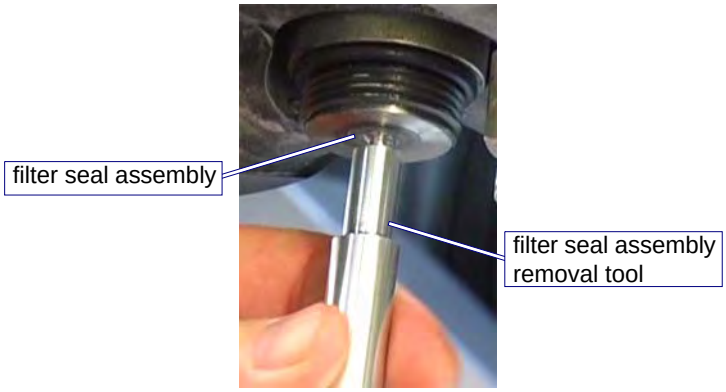


Figure 4-5: Screwing the Removal Tool into the Filter Seal

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

Removing the Orifice Assembly

Carefully remove the **orifice assembly** from the **nozzle body** onto your working surface for later cleaning and inspection.

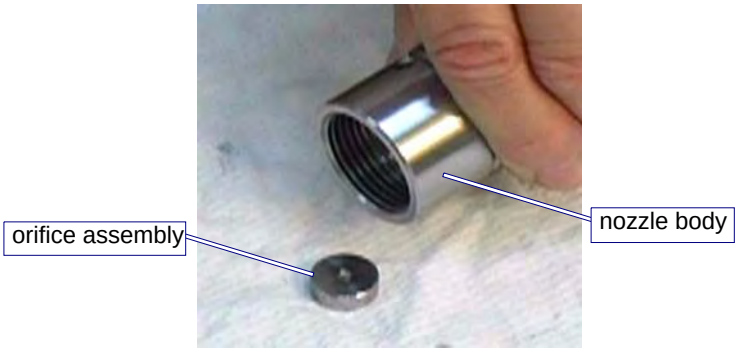


Figure 4-6: Removing the Orifice Assembly from the Nozzle Body

Removing the 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**.

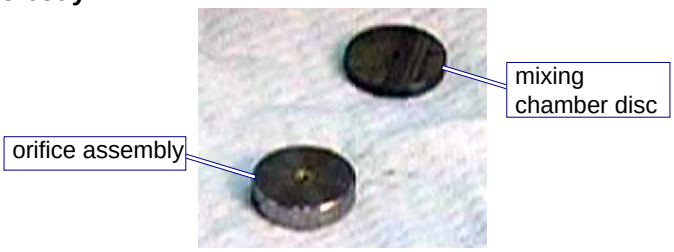


Figure 4-7: Removed Orifice Assembly and Mixing Chamber Disc

Note: *If the mixing chamber disc does not easily fall out of the nozzle body, carefully blow compressed air into the abrasive inlet, ensuring that 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 3/16" Allen wrench or similar device suitable for pushing.*

Removing the Mixing Chamber

The mixing chamber is an infrequent wear item.

1. Inspect the **mixing chamber** prior to removing it.
2. If the **mixing chamber** needs to be replaced, clean the area above the chamber.
3. Press the **mixing chamber** out of the **nozzle body** using the **arbor press** and an old **mixing tube** (or similar device) as a pushing tool.

Figure 4-8: Pressing the Mixing Chamber from the Nozzle Body

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. It will not be necessary to remove the inlet body from the machine unless leakage is noted in this area.*

Removing the Nozzle Body O-Ring

O-rings should be removed for inspection and replaced during the nozzle rebuild when necessary.

1. Remove the **o-ring** from the **nozzle body**.

Figure 4-9: Removing the O-ring from the Nozzle Body

2. This **o-ring** is a consumable item and should be replaced when necessary.

Cleaning and Inspecting Nozzle Components

Cleaning

Cleaning nozzle assembly 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 your hands are clean prior to handling clean nozzle components. In general, you should wash all parts using a non-abrasive, mild soap with water, or use an ultrasonic cleaner.

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

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

Figure 4-10: Rinsing Parts with Clean Water

4. Place the cleaned components onto a clean working space for later inspection.

5. Clean the **orifice** or **jewel assembly** using an **ultrasonic cleaner** filled with **white vinegar**.

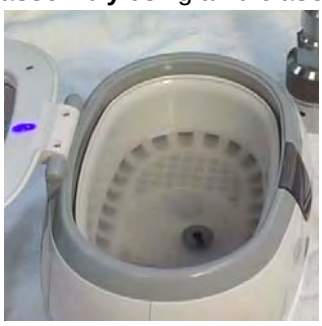


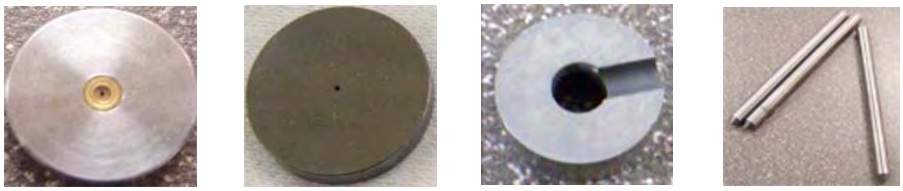
Figure 4-11: Cleaning Parts in Ultrasonic Cleaner with White Vinegar

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

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 4-12: The Four Primary Nozzle Assembly Components Requiring Inspection

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 4-12), which contains the jewel, is a consumable item that requires inspecting, cleaning, and replacing if damaged. The hole in the jewel is very small, approximately 0.014" (0.36 mm) in diameter for the MAXJET 5 orifice assembly and 0.010" (0.254 mm) in a MiniJet orifice assembly. Water travelling through the orifice is accelerated to extremely high speeds. The jewel may have a small chip or mineral buildup that is difficult to see with the naked eye. The jewel can also be plugged, cracked, worn, or misaligned.

In Figure 4-13, "Good Jewel Orifice", note that the edges 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.

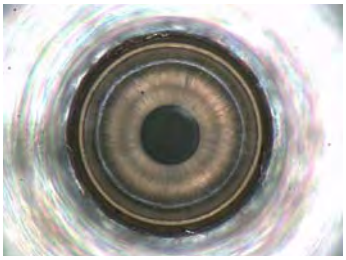


Figure 4-13: Good Jewel Orifice

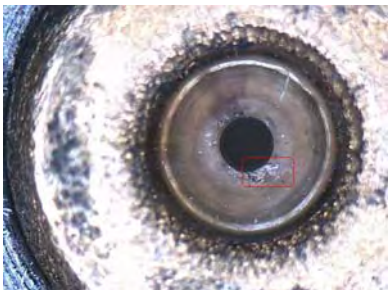


Figure 4-14: Chipped Orifice Assembly Jewel

Particles of debris traveling at high speeds through the orifice can easily chip or damage the jewel by hitting an edge of the orifice. Garnet in the vent under the orifice assembly can cause premature wear to the mixing chamber which in turn allows garnet to get past the orifice assembly, resulting in the jewel chipping. Whenever the vent under the orifice plugs, garnet may end up on top of the orifice assembly. This might also cause the jewel to chip.

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

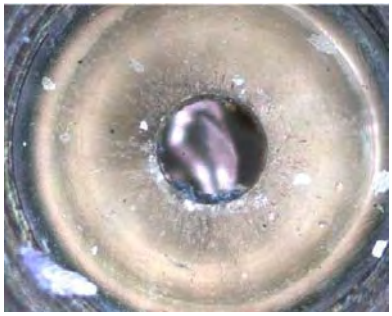


Figure 4-15: Plugged Jewel Orifice

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," 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 on the mixing tube.

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 replace. If orifice chipping is a chronic problem and not corrected by using filters or following proper procedures, consider using a diamond orifice assembly. Diamond orifices are highly resistant to chipping from particle impact and have a much longer wear life. Additional jewels may be purchased from OMAX's Customer Service.

Mixing Chamber Disc

The mixing chamber disc (Figure 4-12) is also a consumable item requiring close inspection. Magnification may be needed to accurately detect wear or disc damage. Begin by measuring 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 0.020" (0.51 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** .030" (.76 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 4-16 provides examples of worn mixing chamber discs.

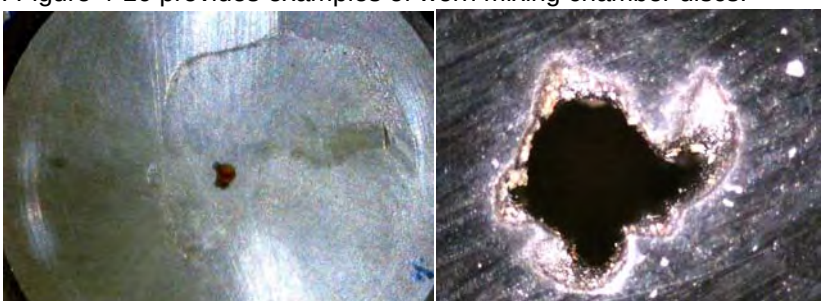


Figure 4-16: Worn Mixing Chamber Discs

When the wear pattern is 'star shaped,' it generally means the orifice or jewel is chipped. This star 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 may weaken the disc, leading to eventual cracking.

Mixing Tube

Although the mixing tube (Figure 4-12) is made from an extremely hard material, over time, the flow of high-pressure water and abrasive will wear away the inside of the mixing tube. This results in a gradual, irregular widening of the internal diameter of the mixing tube, causing a less accurate stream of abrasive and water. Figure 4-17 provides some examples of worn mixing tubes. A cross section of these mixing tubes reveals the irregular wear of their internal diameter.

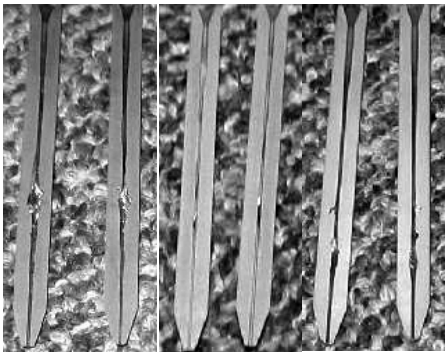


Figure 4-17: Worn Mixing Tubes

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, 0.030" (0.76 mm) on a MaxJet 5 and 0.021" (0.53 mm) on a MiniJet, 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 OMAX's Make software, click the **Test** button to display the *Test Pump and Nozzle* options:

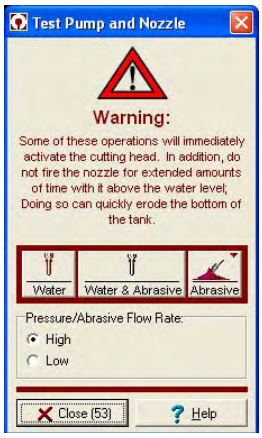


Figure 4-18: Pump and Nozzle Test Options

2. Select **High** pressure**,** then click the **Water** button to begin the jet stream.
3. Try turning **Water** 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 **JetMachining Center**.
7. Again, click the **Test** button and repeat the **Water** only test to try and dislodge the clogged material.

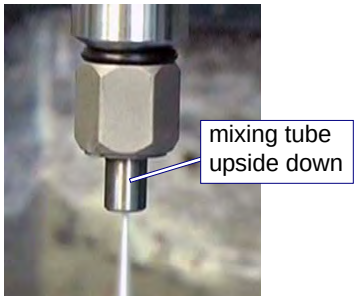


Figure 4-19: Installing the Mixing Tube Upside Down to Dislodge a Clogged Opening

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 4-22 for a filter example.

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 0.026" (0.66 mm) or if it shows excessive oblong wear.

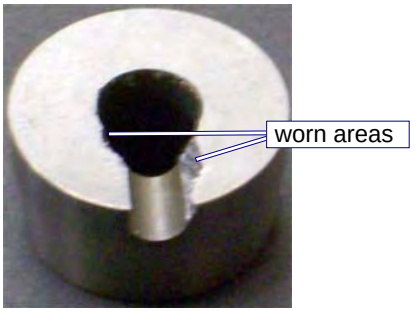


Figure 4-20: Worn Mixing Chamber

Reassembling the Nozzle Assembly

1. After cleaning, inspecting, and obtaining replacement **nozzle components**, you are ready to reassemble the **nozzle assembly** and re-install it on the machine.
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 4-18 for test menu). Repeat this test two or three times.

Figure 4-21: Purging the High-pressure System of Contaminates with the Nozzle Removed

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

Nozzle Filter Seal Assembly

1. Insert the **nozzle filter seal assembly** into the **inlet body**:

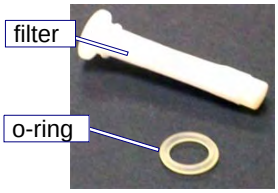


Figure 4-22: Nozzle Filter Seal Assembly

2. Apply a light coating of **Lubriplate** to the filter's **o-ring**.
3. Slide the lubricated **o-ring** onto the **filter**.

4. Push the **filter** with **o-ring** installed up into the **inlet body**.

Figure 4-23: Filter Seal Assembly Inserted into Inlet Body

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

Mixing Chamber

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:

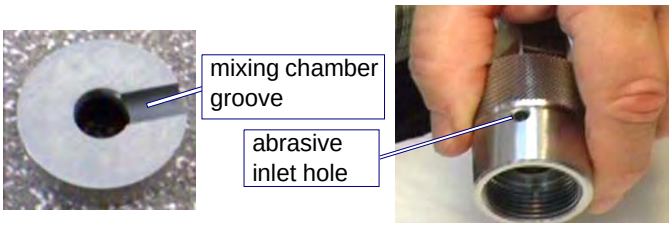


Figure 4-24: Locating the Mixing Chamber Groove and Abrasive Inlet Hole for Alignment

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. Screw the **mixing tube retainer nut** onto the **nozzle body threads** to prevent thread damage, or place a **1" deep-well socket** over the 1" hex on the **nozzle body** for support (Figure 4-25).
4. Place the **nozzle body** in the **arbor press** and press the **mixing chamber** into the nozzle body bore using the **0.550" push tool** and a **1" deep-well socket**.

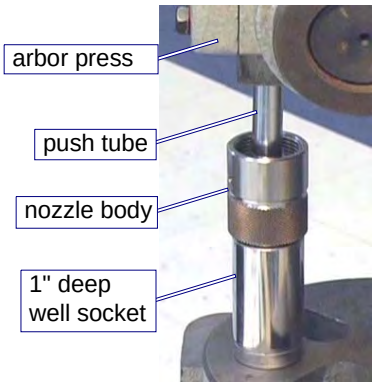


Figure 4-25: Using the Push Tool and Arbor Press to Insert the Mixing Chamber into the Nozzle Body

Note: *If you have trouble inserting the mixing chamber, placing it in a freezer prior to insertion makes it easier to fit into a tight nozzle body.*

5. 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 an **O-ring** onto the **nozzle body**.

Figure 4-26: Installing the O-ring on the Nozzle Body

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

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

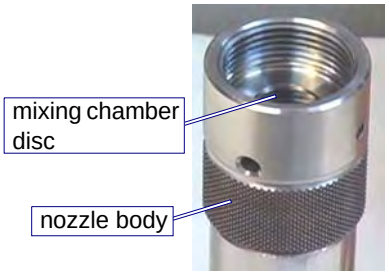


Figure 4-27: Placing the Mixing Chamber Disc in the Center Bore of the Nozzle Body

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

Figure 4-28: Inserting the Orifice Assembly in the Nozzle Body with the Jewel Side Facing Up

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

Nozzle Body

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

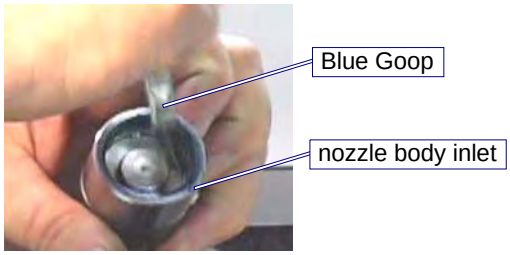


Figure 4-29: Applying Blue Goop to the Nozzle Body Inlet Threads

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**.

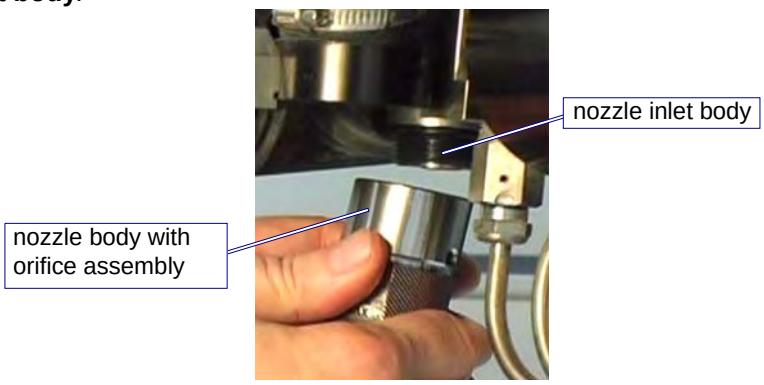


Figure 4-30: Installing the Nozzle Body onto the Nozzle Inlet Body

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**.

Note: *The threads on the nozzle assembly of the Tilt-A-Jet are clocked to ensure that the abrasive inlet hole ends up in the proper position for attaching the abrasive hose:*

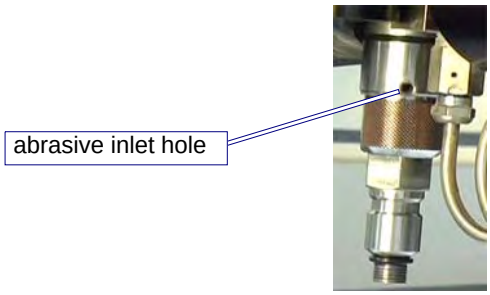


Figure 4-31: Aligning the Nozzle's Abrasive Inlet Hole

If the orifice assembly is not seated properly prior to tightening, the abrasive inlet hole will not end up in the correct position and will also cause damage to the inlet body. If this happens, 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 4-32 for an example of an orifice that had been tightened several times while off-center and not correctly seated in its bore.

Figure 4-32: Damage Caused by an Off-center Orifice

5. Place the **spanner wrench** onto the **brass retaining nut** at the top of the **nozzle body** and a **1/2" box end wrench** on the upper hex of the **inlet body** and tighten the **brass retainer nut**.

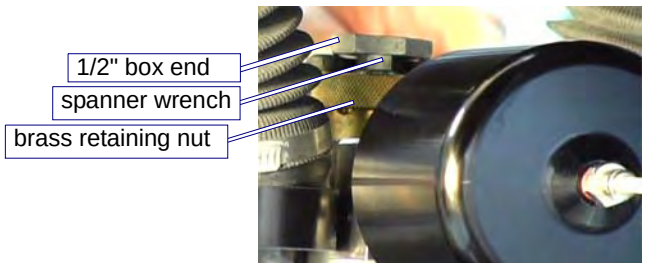


Figure 4-33: Tightening the Nozzle's Brass Retainer Nut

6. Remove the **spanner wrench** and use the **1/2" box end wrench** to hold the **inlet body** in place to counteract any torque when tightening the **nozzle body**. Using a **1" open-end wrench** placed on the **nozzle body**, turn slowly clockwise to tighten the **nozzle body** to the **inlet body**.

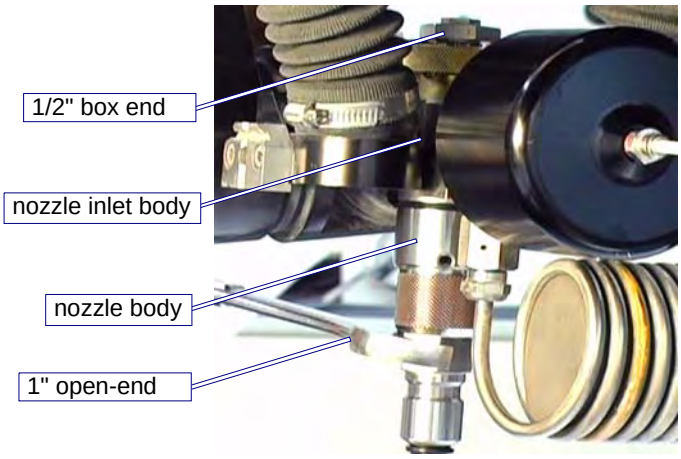


Figure 4-34: Tightening the Nozzle Body to the Inlet Body

7. Tighten the **nozzle body** to approximately 30 - 40 ft lbs (40.7 - 54.2 Nm).

Caution: ***The nozzle body uses a soft filter seal, not a high-pressure metal-to-metal seal. If it leaks, check the seal and change it if necessary. Over-tightening will not fix a leak and most likely creates additional repair issues.***

Mixing Tube

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

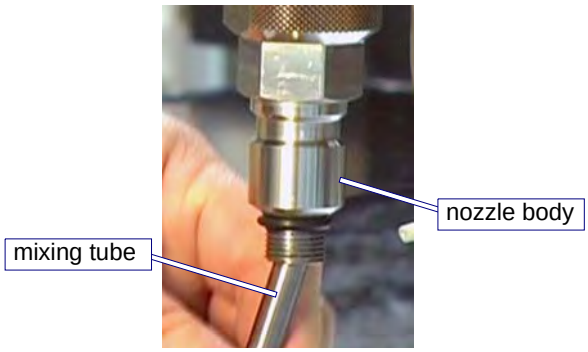


Figure 4-35: Inserting the Mixing Tube into the Nozzle Body

2. Slip the **mixing tube collet** 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**.

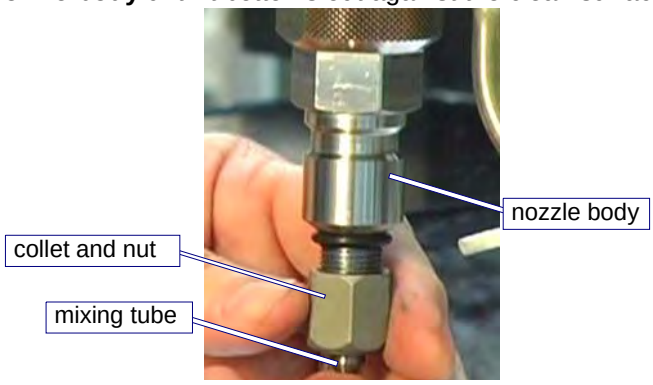


Figure 4-36: Placing the Mixing Tube Collet and Nut onto the Mixing Tube

3. While holding the **mixing tube** in place, tighten the **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.

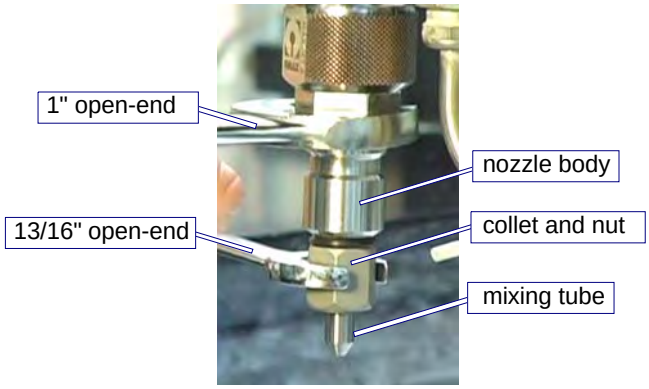


Figure 4-37: Tightening the Mixing Tube onto the Nozzle Body

Nozzle Tests

Once the nozzle has been installed, run the standard nozzle tests provided in OMAX's Make software to verify the water seal of the assembly fittings and the jet stream quality:

1. Set the 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.

WARNING! ***Eye protection must be worn at all times when operating the OMAX JetMachining Center. Always wear ear protection when operating the abrasivejet nozzle out of water. An out-of-water abrasivejet can produce noise in excess of 120 decibels.***

2. First, test **nozzle** operation with **Water** only at **Low** pressure and then follow by testing with **Water and Abrasive** at **High** pressure. Refer to Figure 4-18 for an illustration of the pump and nozzle test screen.
3. When running these **pressure tests**, inspect for water leaking from the **high-pressure fittings** and inspect the jet stream to ensure it remains straight and focused. Refer to Figure 3-13, "Example of Both Good and Poor Quality Jet Streams" on page 3-15. The jet stream should be narrow and well-formed near the nozzle. A certain amount of spreading is to be expected at approximately 1.5 to 2.0 inches (3.8 to 5.1 cm) down the jet stream. A bad jet stream will be wide and poorly formed and flares almost immediately upon leaving the nozzle. Refer to Figure 3-13 on page 3-15.

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

Maximizing Nozzle Life

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

- 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.
- If the surface quality and accuracy are as expected, continue using the Nozzle Assembly.
- If the quality of the cut part is not as expected, prompt correction of the problem minimizes complications.
- Take advantage of features in the OMAX Make software that allow the using of different offset values and mixing tube diameters to adjust for Mixing Tube wear.
- Maintain part tolerances and extend Mixing Tube use by entering the correct offset value in Make.

All nozzle components are negatively affected by contamination, dirt, or other materials present in high-pressure systems. In general, cleanliness is a key controllable factor in extending the life of nozzle components. Some simple but effective ways to maintain cleanliness include:

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

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

- Do not use damaged parts. Visually inspect parts and all orifices prior to use.
- Always use pump manifold and last chance nozzle filters. Inspect and replace them on a regular basis.

- Consider using a diamond orifice assembly if orifice chipping is a chronic problem not overcome by using filters or by following proper procedures.
- Depending on your application, and if speed and longer life are the primary concern, use a 0.042" mixing tube instead of the standard 0.030" mixing tube. Be aware that parts will have slightly more taper and a wider kerf.
- If unusual cutting conditions are permitting dirty water to enter the nozzle vent hole, route a piece of tubing from the vent hole to the top of the Z-axis.
- Use only high-quality abrasive as it contains less dust and a more uniform particle size.
- Use a nozzle guard assembly to help protect the mixing tube from damage during cutting.

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.

Some machine practices that will also extend the life of the nozzle and its components are as follows:

- Use a nozzle muff and, whenever possible, cut underwater to reduce splash-back. The splash-back contains water, garnet, and eroded material from the tank. If these solids enter the vent under the orifice it can cause premature wear to the mixing chamber, allowing garnet to get on top of the orifice and chipping it. Figure 4-38 provides an example of the damage caused to a Tilt-A-Jet assembly when the machine cut without a muff. This is preventable damage that will affect your warranty.

Figure 4-38: Abrasive Damage from Not Using a Nozzle Muff

- After servicing the pump, nozzle, or replacing a piece of hard-plumbing, always flush the system by performing a “water only” test for several minutes with both the orifice and last chance filter removed.
- Rotate the Mixing Tube 90 degrees following every eight hours of cutting. This distributes wear more evenly around the internal diameter of the Mixing Tube if the orifice is chipped or misaligned.

Removing and Reinstalling the Inlet Body on a Tilt-A-Jet

The inlet body is an infrequent consumable item; however, because it cycles between 0 Psi and 55 Ksi with every on/off cycle, it eventually can wear or crack.

1. Disconnect the **air hose** that goes into the **on/off valve** by pushing back on the **air canister actuator fitting ring** on top of this valve and pulling on the air hose.

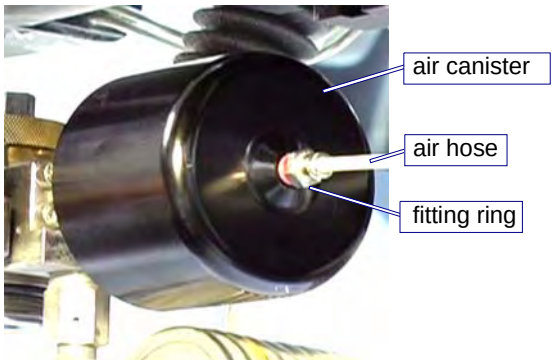


Figure 4-39: Removing the Air Hose from the Air Canister Fitting Ring

2. Use a **1-1/8" open-end wrench** to unscrew the **on/off valve air canister** from the **on/off valve body**.

Figure 4-40: Using a 1-1/8" open-end Wrench to Remove the Air Canister

3. Use a **5/8"** and a **3/4" open-end wrench** to carefully remove the **coil nipple** from the **on/off valve body adapter fitting**. Set this **coil** aside.

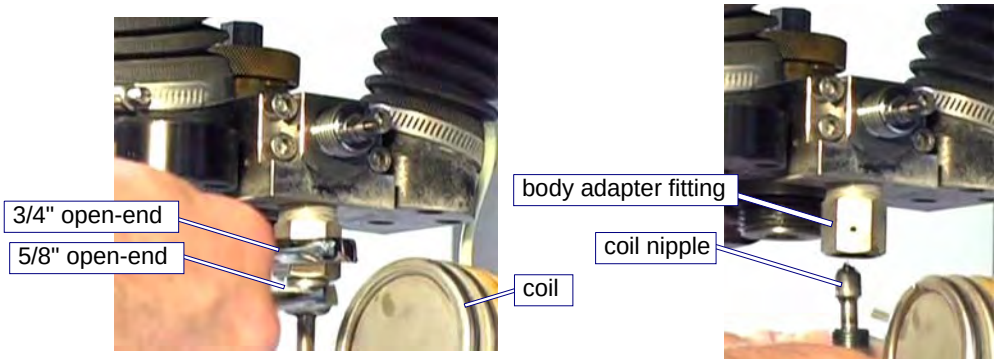


Figure 4-41: Removing the Coil Nipple From the On/Off Valve Body Adapter Fitting

4. Using a **5 mm Allen wrench** and following a continual pattern, loosen the four **screws** that secure the **on/off valve body** to the **tilting plate** (loosen each screw using a ¼ to ½ turn at a time until all screws are loose). Remove the four **screws** from the **tilting plate**.

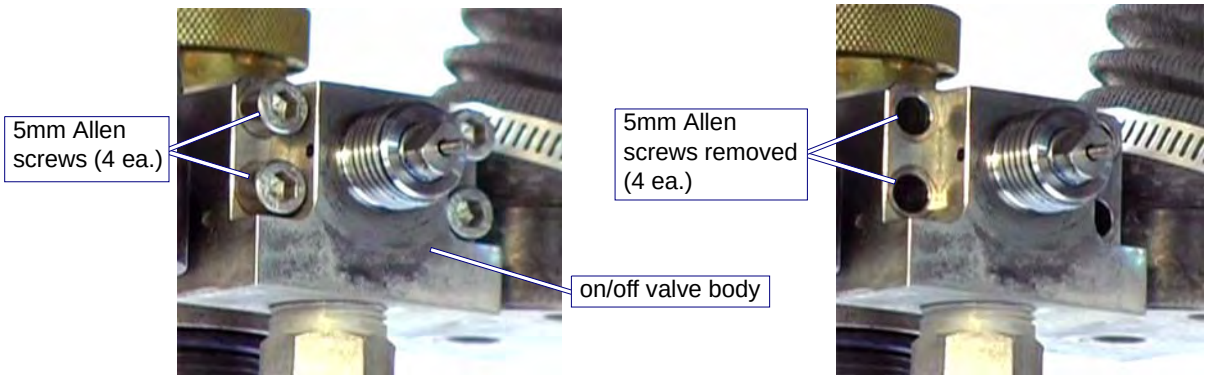


Figure 4-42: Removing the 5mm Allen Screws that Secure the On/Off Valve Body

5. Pull the **on/off valve body** with the **valve body seat** out of the **tilting plate**.

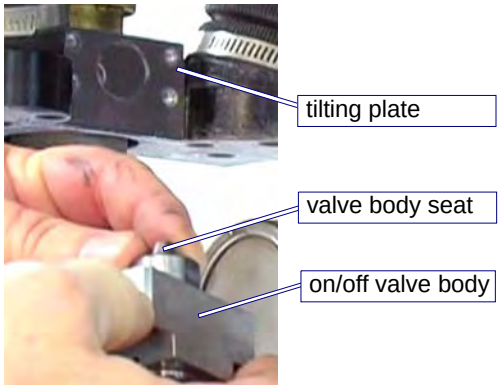


Figure 4-43: Removing the On/Off Valve Body with Seat from the Tilting Plate

6. Place a **spanner wrench** on the **brass retainer nut** that holds the **inlet body** and place a **1/2" wrench** on the upper hex of the **inlet body**, holding it in place to counteract any torque while removing the **inlet body** from the **tilting plate**.

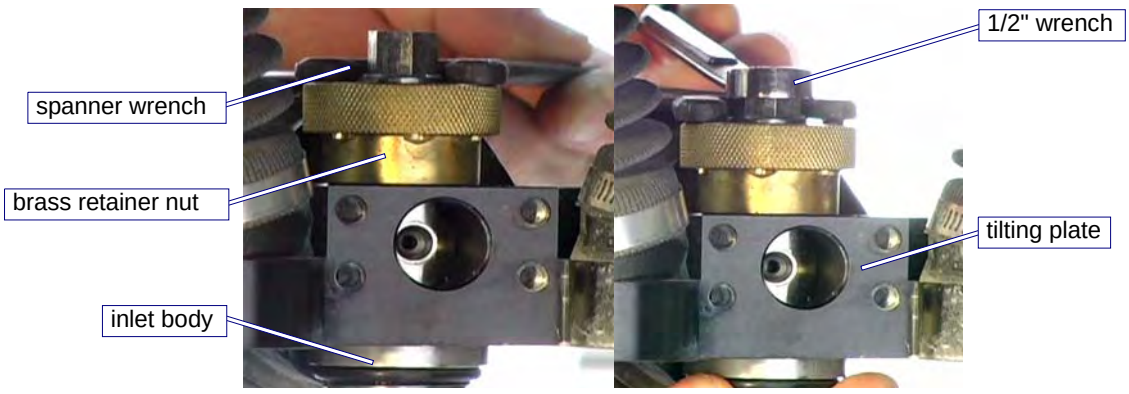


Figure 4-44: Removing the Inlet Body from the Tilting Plate

7. Use the **spanner wrench** to loosen the **brass retainer nut** while holding the **inlet body**. The **inlet body** should detach from the machine at this time.

Caution: ***If the inlet body is stuck, you may need to use the tools provided in kit, Part Number 304096, to remove it. Under no circumstances should a hammer or similar object be used to strike this assembly!***

Removing a Stuck Inlet Body

1. To remove a stuck **inlet body**, insert the **inlet body removal tool post** (thread side down) up into the **inlet body**.

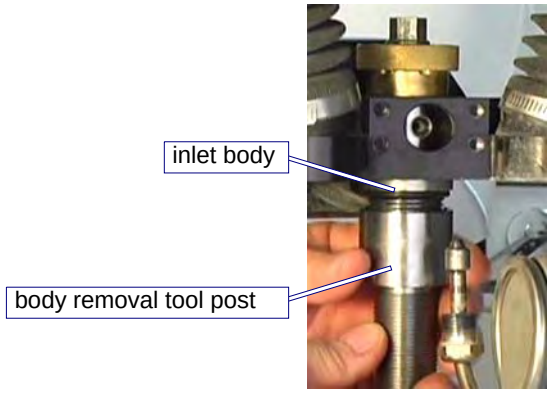


Figure 4-45: Installing the Body Removal Tool Post to Remove a Stuck Inlet Body

2. Slide the **tube** over the threads on the **tool post** and thread the **flange nut** onto the **tool post**.

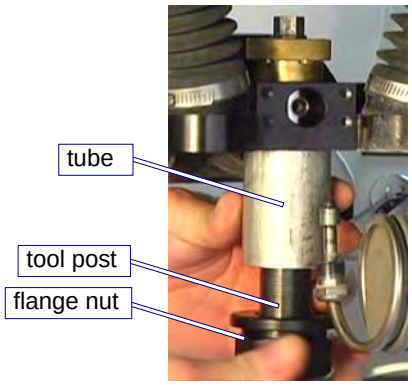


Figure 4-46: Placing the Tube over the Tool Post and Tightening the Flange Nut

3. Use the **spanner wrench** provided with your Tilt-A-Jet to remove the **brass inlet body retaining nut**.

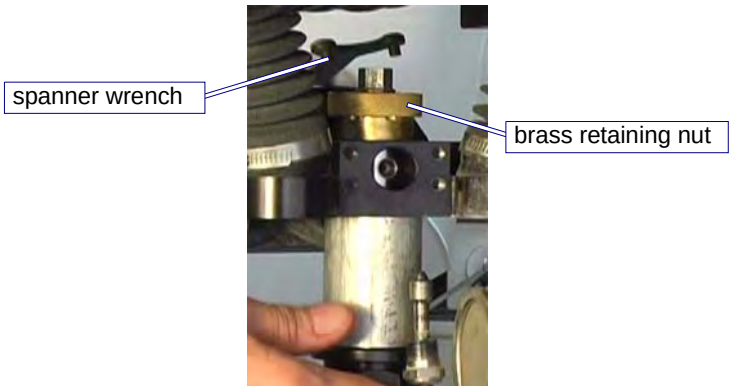


Figure 4-47: Removing the Brass Inlet Body Retaining Nut with the Spanner Wrench

4. Saturate the area with **white vinegar** where the **inlet body** contacts the **tilting plate** to help break down water deposits that have bonded the **inlet body** to the **tilting plate**. Allow the vinegar to soak for at least 15 minutes.

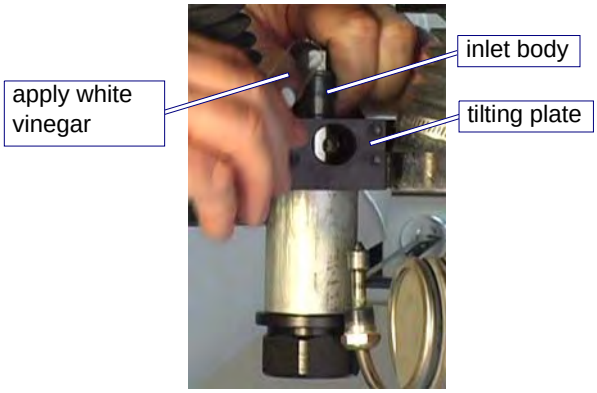


Figure 4-48: Using White Vinegar to Loosen a Stuck Inlet Body

5. Tighten the **flange nut** by turning it to the right (if needed, use a 1-5/8" open-end wrench) to detach the **inlet body** from the machine.

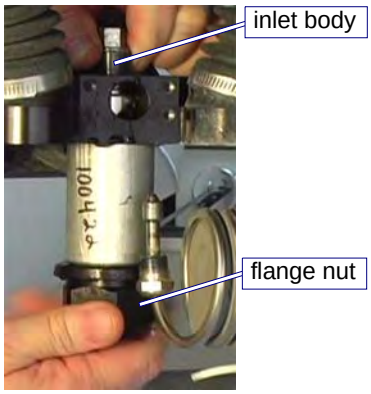


Figure 4-49: Tightening Flange Nut to Detach the Inlet Body

Cleaning the Inlet Body

1. After removing the **inlet body**, clean the hole where the **inlet body** sits, using a brush with soapy water to remove any grit buildup.

Figure 4-50: Cleaning the Inlet Body Hole with Brush and Soapy Water

2. Rinse the hole with clean water and blow it completely dry using compressed air.
3. Also clean the removed **inlet body** with mild, non-abrasive soap and water, rinsing it with clean water and blowing it dry.

Reinstalling the Inlet Body

1. Apply a light coating of **Blue Goop** to the male threads of the **inlet body** and to the bore diameter around the **inlet cone** to minimize water deposit buildup around the **inlet body**.

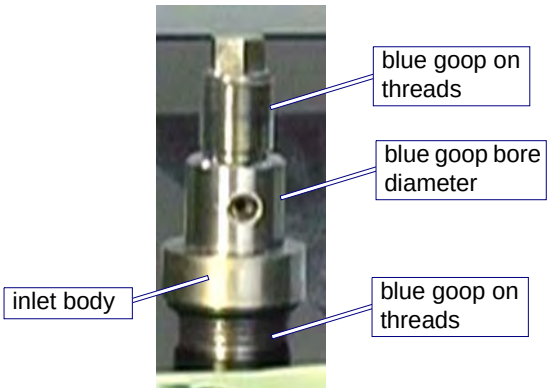


Figure 4-51: Applying Blue Goop to the Inlet Body Male Threads and Bore Diameter

2. Insert the **inlet body** through the **tilting plate**. Screw the **brass retaining nut** onto the **inlet body** and hand-tighten it to the **tilting plate**. Rotate the **inlet body** until the hole in the **inlet body** appears in the center of the hole in the **tilting plate**.

Note: *Only hand-tighten at this time to allow the On/Off Valve and high-pressure plumbing to be properly aligned in the steps that follow.*

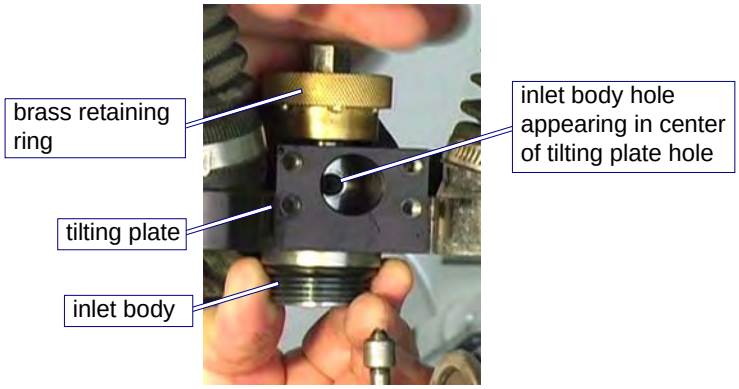


Figure 4-52: Hand Tightening the Inlet Body and Aligning to Tilting Plate Hole

3. Apply a small amount of **anti-seize** to the threads on each of the 4 **Allen-head screws**.
4. Apply **Blue Goop** to the fitting threads and the **on/off valve body seat**.

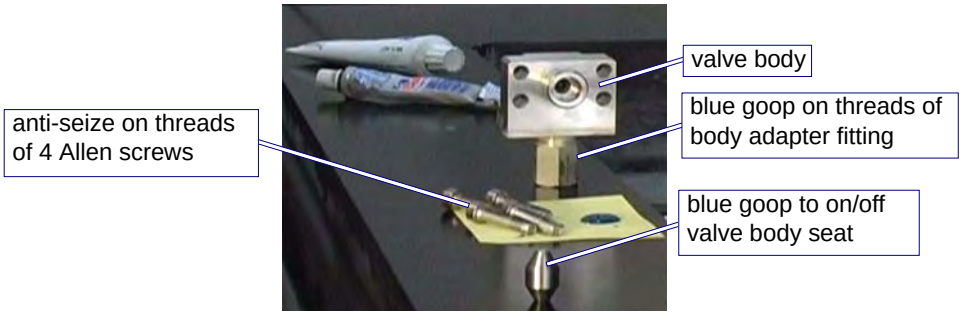


Figure 4-53: Applying Blue Goop and Anti-seize Compounds to Valve Body Components

5. Insert the **valve body seat** into the **on/off valve body** with the small hole end inward and the large hole end pointing outward (see Figure 4-54).

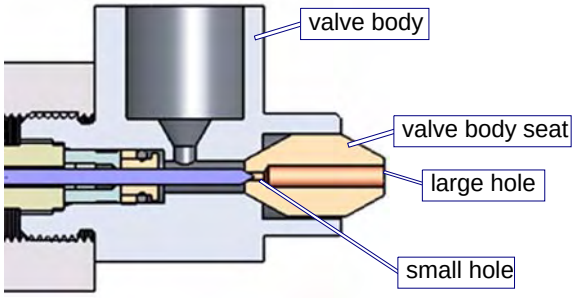


Figure 4-54: Correct Placement of the Valve Body Seat into the Valve Body

6. Place the **on/off valve body** against the **nozzle inlet body** and line up the **valve body seat**.

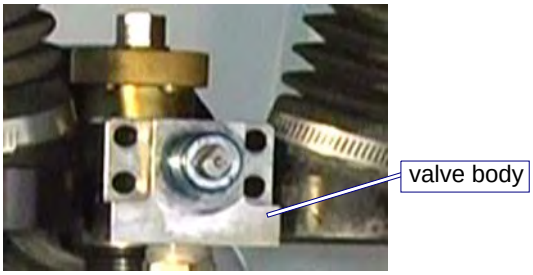


Figure 4-55: Placing the On/Off Valve Body Against the Cutting Head Inlet Body

7. Using a **5 mm Allen wrench** and following a tightening pattern, reinstall and tighten the four screws that secure the **on/off valve body** to the **tilting plate**. Tighten ¼ to ½ turn at a time until all screws are tightened evenly. Apply a coating of **Blue Goop** to the **gland nut** of coil nipple fitting.

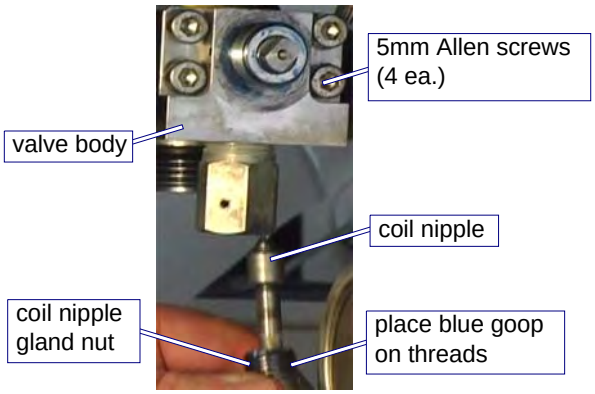


Figure 4-56: Tightening the Four Valve Body Screws and Applying Blue Goop to the Gland Nut Threads

8. Using a **5/8"** and a **3/4" open-end wrench**, carefully reinstall the **coil nipple** to the **on/off valve body adapter fitting**.

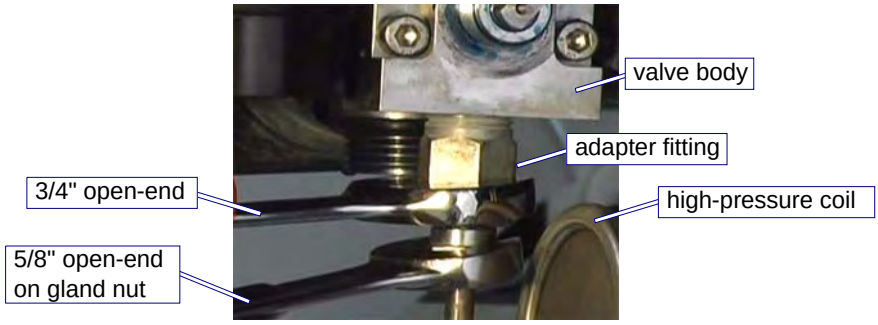


Figure 4-57: Tightening the Coil Nipple to the On/Off Valve Body Adapter Fitting

Caution: ***Be careful not to allow torque to twist the high-pressure coil as you tighten.***

9. Screw the **on/off valve air canister** back onto the **on/off valve body**, tightening it with a **1-1/8" open-end wrench** (torque at 250 in. lbs).

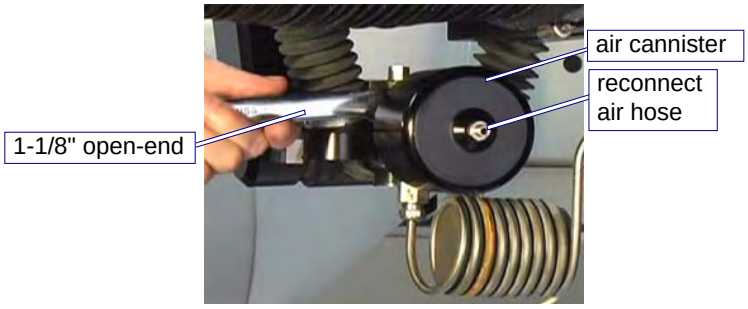


Figure 4-58: Installing the On/Off Valve Air Canister

10. Reconnect the **air hose** going to the **on/off valve** by pushing the hose into the **air canister actuator** on top of the valve.

Removing and Reinstalling a Mini-MaxJet 5 Nozzle Assembly

This section provides additional steps that are required when removing and repairing a MaxJet 5 MiniJet Nozzle Assembly from a Tilt-A-Jet.

Disassembling a MiniJet Nozzle

The procedure for removing the MiniJet Nozzle Assembly from a Tilt-A-Jet are the same as removing a MaxJet 5 Nozzle Assembly with the exception of the additional steps required to remove the Inlet Body Extension, the Dummy Orifice, and the additional o-rings and Ring Seals specific to the MiniJet Nozzle.

Note: *Only the additional steps required to remove the MiniJet 5 from the Tilt-A-Jet are presented here. Refer to the steps presented in Removing a MaxJet® 5 Nozzle Assembly from a Tilt-A-Jet on page 4-5 for common procedures.*

Removal Procedures

Step 1: Remove the Nozzle Mixing Tube

Step 2: Remove the MiniJet Nozzle Body from the Inlet Body Extension (page 4-29)

Step 3: Remove the Inlet Body Extension from the Inlet Body (page 4-29)

Step 4: Remove the MiniJet Dummy Orifice from the Inlet Body Extension (page 4-30)

Step 5: Remove the Nozzle Filter from the Inlet Body

Step 6: Remove the Orifice Assembly

Step 7: Remove the Mixing Chamber Disc

Step 8: Remove the Mixing Chamber

Step 2: Remove the MiniJet Nozzle Body from the Inlet Body Extension

The MiniJet nozzle assembly has an inlet body extension component that is attached between the nozzle body and the inlet body and requires removal.

1. To remove the **MiniJet nozzle body** from the Inlet **body extension**, place a **1-1/8" open-end wrench** on the Inlet **body extension**.

Caution: ***Hold the inlet body in place to counteract any induced torque when removing the inlet body extension. This prevents induced torque from affecting the Tilt-A-Jet's alignment and accuracy.***

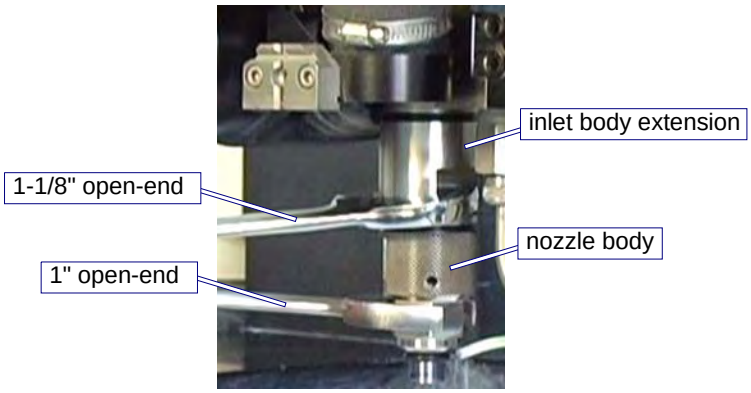


Figure 4-59: Removing the MiniJet Nozzle Body from the Inlet Body Extension

2. With a **1" open-end wrench** placed on the **nozzle body**, loosen the right-hand threaded **nozzle body** from the **inlet body extension** using both wrenches (Figure 4-59) and unscrew the **nozzle body** the rest of the way by hand.

Step 3: Remove the Inlet Body Extension from the Inlet Body

1. Place a **1/2" wrench** on the **inlet body** located at the top of the **nozzle assembly**.

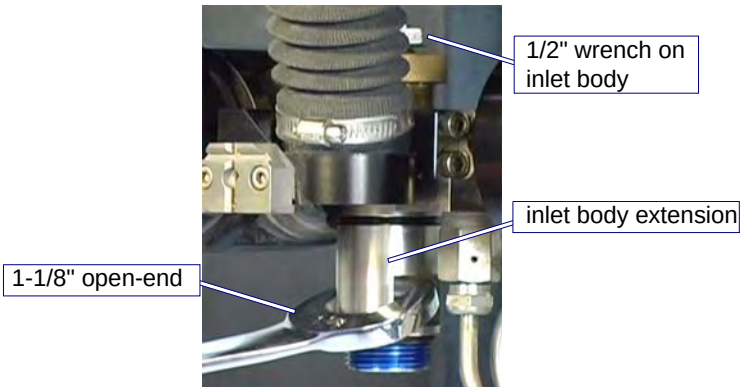


Figure 4-60: Removing the Inlet Body Extension from the Inlet Body

Caution: ***Hold the inlet body in place to counteract any induced torque when removing the inlet body extension. This prevents induced torque from affecting the Tilt-A-Jet's alignment and accuracy.***

2. Using a **1-1/8" open-end wrench** placed on the **inlet body extension** (Figure 4-60), unscrew the right-hand threaded **inlet body extension** from the **inlet body**.

Note: *The Inlet body extension is a consumable item; however, it is expected to last through multiple nozzle rebuilds.*

3. Inspect the surface on each end of the bore on the **inlet body extension** for erosion marks. If there are erosion signs, the ring seal(s) may leak, requiring that the **inlet body extension** be replaced.

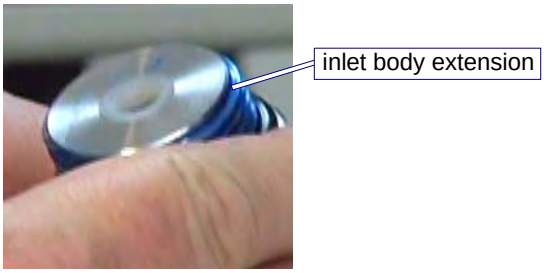


Figure 4-61: Inspecting the Body Extension for Erosion Marks

Step 4: Remove the MiniJet Dummy Orifice from the Inlet Body

The MiniJet 5 also has a dummy orifice that sits at the top of the inlet body extension and needs to be removed. This dummy orifice provides a flat surface for the inlet body seals.

1. Remove the **dummy orifice** by tipping the Inlet **body extension** upsidedown and letting it fall out.

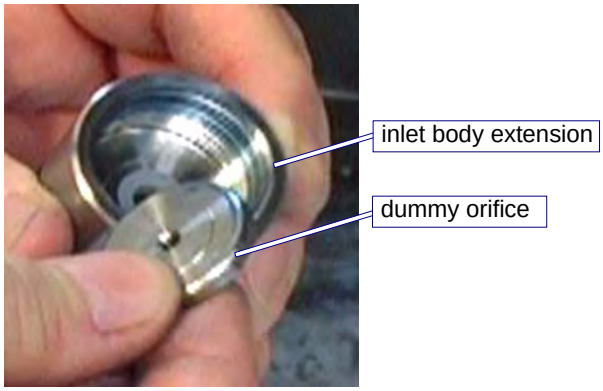


Figure 4-62: Inspecting the Dummy Orifice for Erosion Marks

2. Inspect the **dummy orifice** for erosion marks on both the upper and lower surfaces where the **ring seal** must seat. If there is evidence of erosion, the **ring seal**(s) will leak and the **dummy orifice** must be replaced.

Step 9: Remove Ring Seals and O-Rings

All ring seals and o-rings should be removed and replaced as needed during a nozzle rebuild.

1. Remove the **o-ring** from the **MiniJet nozzle body**.
2. Remove the **o-ring**s and **ring seals** from the Inlet **body extension**.

Figure 4-63: Removing O-ring and Ring Seals from the Inlet Body Extension

Reassembling the MiniJet Nozzle Assembly

After the inlet body and filter seal assembly are installed on the machine, install the inlet body extension on the inlet body:

1. Lubricate the two **ring seal's** o-rings with Lubriplate and install them on the **ring seals**. See Figure 4-63 for an example of these ring seals.
2. Insert the **ring seal** assemblies into each end of the **inlet body extension**.

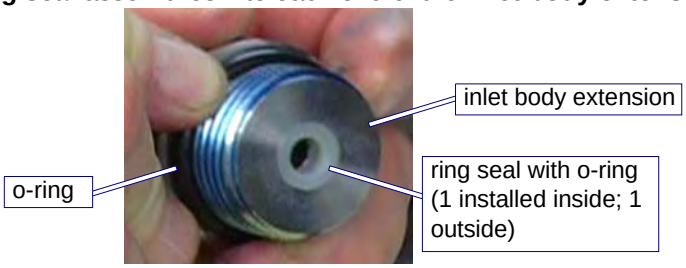


Figure 4-64: Installing Ring Seals and O-rings in the Inlet Body Extension

3. Place the large **o-ring** on the bottom of the **inlet body extension** (Figure 4-64).
4. Insert the **dummy orifice** inside the top of the Inlet **body extension**, ensuring that it sits flat against the **ring seal**.

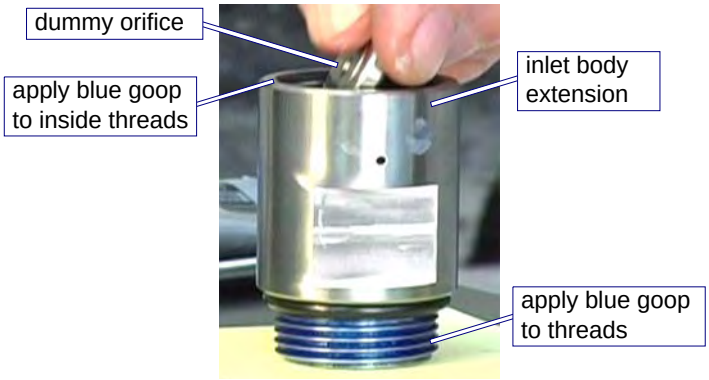


Figure 4-65: Inserting the Dummy Orifice into Inlet Body Extension

5. Apply **Blue Goop** to both the inside and outer threads of the **inlet body** prior to installing the Inlet **body extension**.
6. Slowly screw the Inlet **body extension** onto the **inlet body** and hand-tighten (Figure 4-66).

7. Place a **1/2" wrench** on the **inlet body** at the top of the nozzle assembly to hold the **inlet body** in place and counteract any induced torque when installing the **inlet body extension**. This prevents any induced torque from affecting the Tilt-A-Jet's alignment and accuracy.

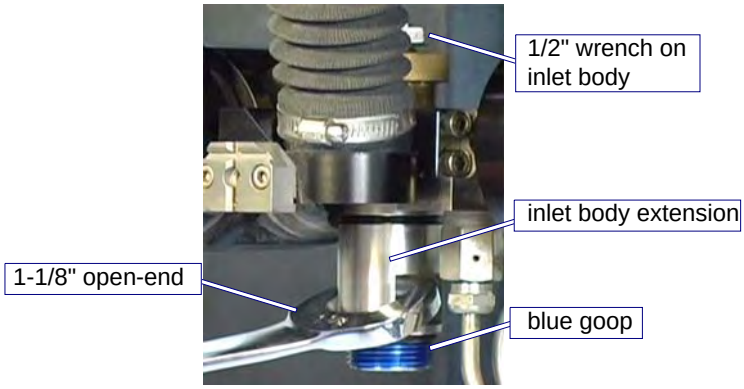


Figure 4-66: Tightening the Inlet Body Extension to the Inlet Body

8. Using a **1-1/8" open-end wrench** placed on the **inlet body extension**, tighten the right-hand threaded Inlet **body extension** to the **inlet body** using both wrenches (Figure 4-66).
9. Tighten the **inlet body extension** to approximately 30 - 40 ft. lbs. (40.7 - 54.2 Nm).
10. In the MiniJet **nozzle body**, ensure that the **orifice assembly** and **mixing chamber disc** are properly installed and can seat as required with the **inlet body extension**.

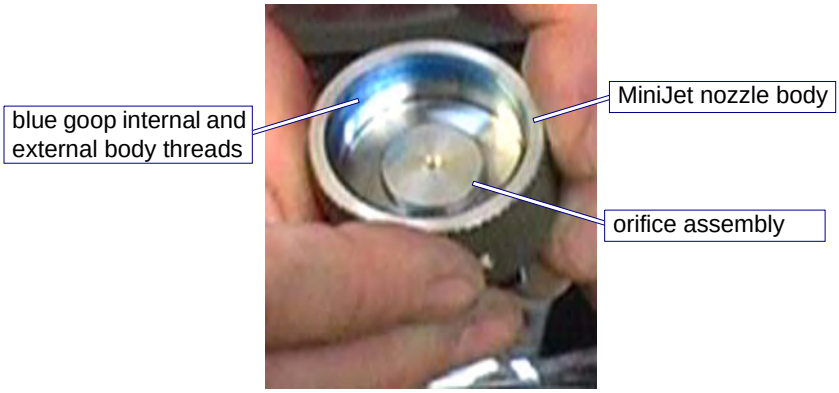


Figure 4-67: Inspecting for Properly Seated Orifice Assembly and Mixing Chamber Disc

11. Apply **Blue Goop** to the internal and external threads of the **MiniJet nozzle body**.
12. Hand tighten the **MiniJet nozzle body** onto the **inlet body extension**.

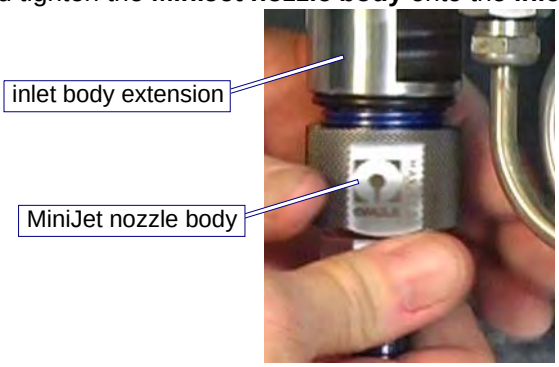


Figure 4-68: Hand Tightening MiniJet Nozzle Body to the Inlet Body Extension

13. Place a **1-1/8" open-end wrench** on the **inlet body extension** to hold the **inlet body extension** in place and counteract any induced torque when installing the **MiniJet nozzle body**.

14. Using a **1" open-end wrench** placed on the **MiniJet nozzle body**, carefully screw the right-hand threaded **nozzle body** to the Inlet **body extension** using both wrenches. Ensure that the **orifice assembly** always remains centered in the **nozzle body** bore.

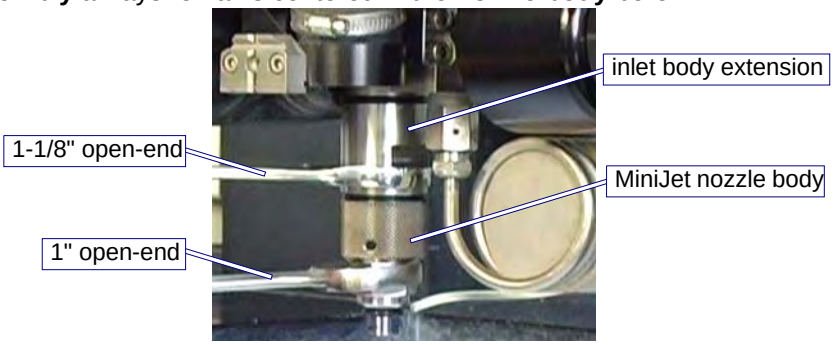


Figure 4-69: Tightening the MiniJet Body to the Inlet Body Extension

15. Tighten the **MiniJet nozzle body** to approximately 30 - 40 ft lbs (40.7 - 54.2 Nm).

Mini-Maxjet 5 Installation and Operation

Installing the Mini-Maxjet 5

1. Remove the existing **Maxjet 5 nozzle body**, **orifice**, and **mixing tube**. Leave the **inlet body** in place.
2. Install the **Mini-Maxjet 5 assembly** onto the **inlet body**.
3. Pull the **abrasive valve** (refer to Figure 3-17) from the bottom of the cylindrical abrasive hopper.
4. Replace the existing **abrasive orifice** with the one provided with the **Mini-Maxjet 5** (P/N 301730-01).
5. Reinstall the **abrasive valve**.

Note: *When using the rectangular hopper (P/N 300439), you must make a new abrasive gate by using the computer file, `Abr_Gate.dxf`, and changing the hole diameter to 0.15" (3.8 mm).*

6. Replace the **dump valve orifice** with the **-10 orifice** provided. Refer to *Changing the Dump Valve Orifice Size*, page 4-39.

Operating the Mini-MAXJET 5

Caution: ***To avoid deadheading the pump, lower its RPM to minimum before turning On the nozzle jet. When operating the pump at lower RPMs for extended periods, see Changing Crankcase Oil on page 4-1 for additional oil requirements. If you're not using a variable RPM pump, contact OMAX Technical Support.***

Note: *OMAX recommends using a 120–150 mesh garnet with the Mini-MAXJET 5 nozzle. To avoid plugging the nozzle, never use 80 mesh or coarser garnet.*

1. Calibrate the actual abrasive flow rate (refer to *Measure the abrasive flow rate:*, page 3-17).
2. Click **Setup** in Make and select **Pump and Nozzle Settings**:

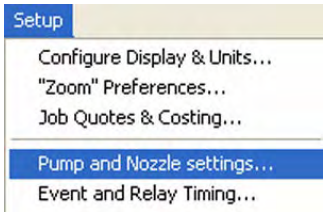


Figure 4-70: Setup Menu for Pump and Nozzle Settings

3. Correct any values being displayed that differ from those recorded when testing your OMAX machine. Change the "Abrasive Flow Rate" to the value you determined above (if calibration is not done, enter 0.3). Set the "Jewel (orifice) Diameter" to 0.010", the "Mixing Tube Diameter" to 0.021", and the "High Pressure" to the value set for your pump:

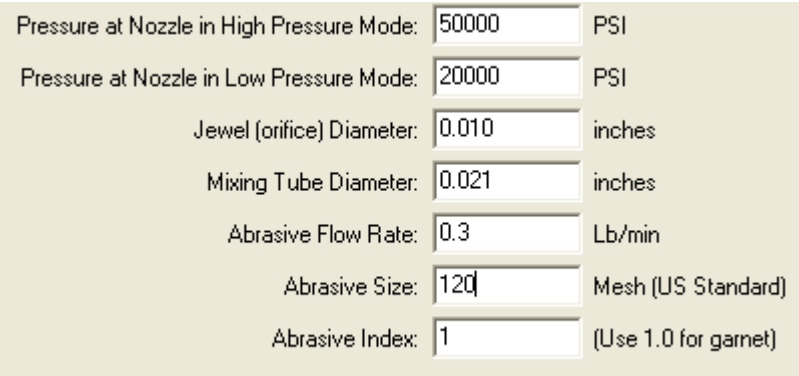


Figure 4-71: Settings for Pump and Nozzle

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

Note: *The Low Pressure mode is not available when using the Mini-Maxjet4 nozzle - contact OMAX Technical Support for additional information.*

5. The tool offset for the Mini-MAXJET 5 nozzle should be determined after some test cuts are completed. The value of 0.012" may be used for the initial setup.

Dump Orifice Maintenance

The Dual On/Off Valve controls water flow through the cutting nozzle (Figure 4-72) and operates in conjunction with a *dump orifice* (Figure 4-73) installed in the OMAX high-pressure pump.

Figure 4-72: Dual On/Off Valve with MAXJET®5 Nozzle

When the nozzle is no longer cutting and the high-pressure water shuts off, the software automatically re-routs this water through the pump's dump orifice until the nozzle is again turned on and resumes cutting. This action allows a continual pump operation during times when the nozzle is not cutting and assures that the water pressure always remains the same, and the starting and stopping of the waterjet stream takes place without delay. This technique also enables dual pressure operations, as required for low-pressure glass piercing, for example, by opening both the dual on/off valve and the valve for the dump orifice simultaneously.

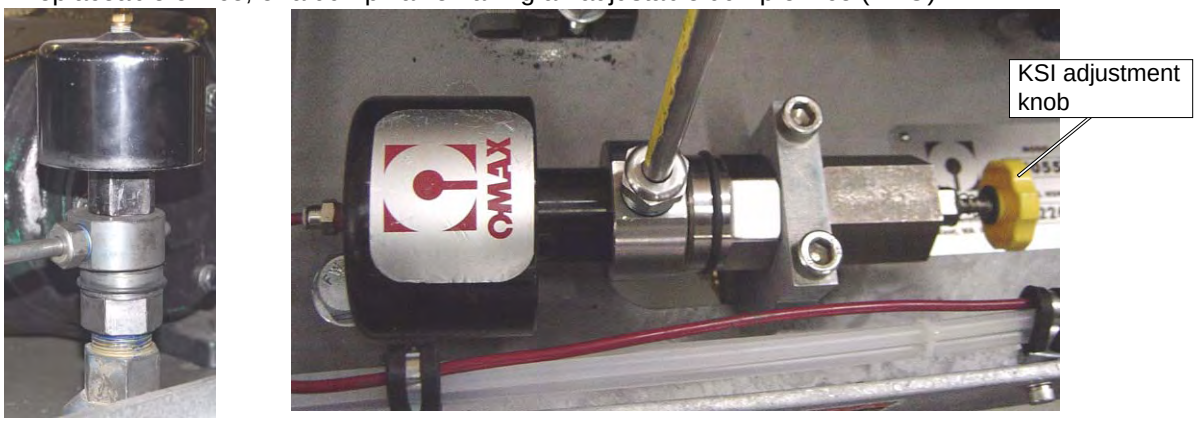
Matching the size of the nozzle orifice with the size of the dump orifice is important in preventing damage to ultra high-pressure components. Ideally, at the end of a cut, water pressure gently will fall to the traverse pressure, and, at the end of the traverse, the pressure will rise to the cut pressure without overshooting the mark.

The cutting head pressures observed when the machine is actually cutting should be 3-5 KSI above the dump orifice pressure. Dump orifice pressures are observed when the machine is traversing towards the next cut. For example, a cutting head pressure observed at 50 KSI should see traverse pressures of about 46 KSI.

Possible causes to a 5 KSI or greater difference in pressures include:

- Worn or chipped edges on either or both orifices.
- Mismatched orifice sizes between the cutting head and dump orifice size or setting.
- On/Off Valve needing repair.
- Manifold filter not being replaced at each pump maintenance interval.
- Last chance filter not being replaced as recommended to protect the cutting head orifice.

Two types of dump orifices are used in OMAX pumps (Figure 4-73): either a dump valve with a fixed, replaceable orifice, or a dump valve having an adjustable dump orifice (ADO).



dump valve with fixed orifice size **dump valve with adjustable orifice**

Figure 4-73: Two Types of Dump Valves used in OMAX Pumps

Setting the Adjustable Dump Orifice (ADO)

Follow these steps to equalize the ADO pressure with the nozzle cutting pressure.

1. Power up both the pump and PC Controller.
2. Open the pump's top lid to access the knob on the ADO.

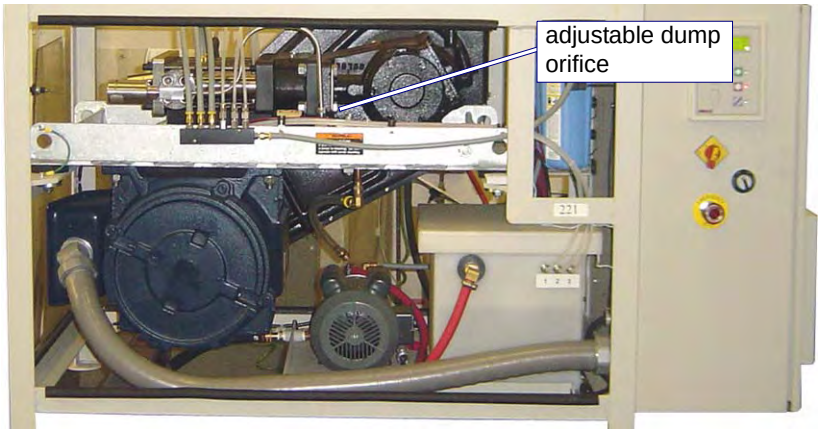


Figure 4-74: Adjustable Dump Orifice Location in OMAX Pump

3. Back the ADO pressure adjustment knob (Figure 4-75) out a couple of turns counter-clockwise (viewed from end of knob) to ensure the valve is not completely closed when the pump starts.

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

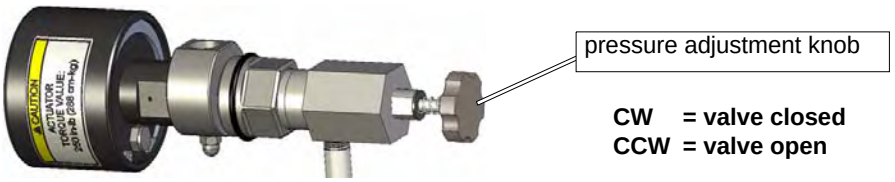


Figure 4-75: The ADO Pressure Adjustment Knob

Note: *Excessive tightening of the ADO knob may jam the valve stem into its seat. If resistance is met while closing the valve, stop tightening!*

4. Launch the OMAX **Make** software and position the nozzle to accommodate a high-pressure, water-only test.
5. In Make, select **File/Open (Change Path Setup)...** to open the **Choose tool path for machining Window**, then select the ***Variable Dump Orifice Adjustment Routine.ord*** file:

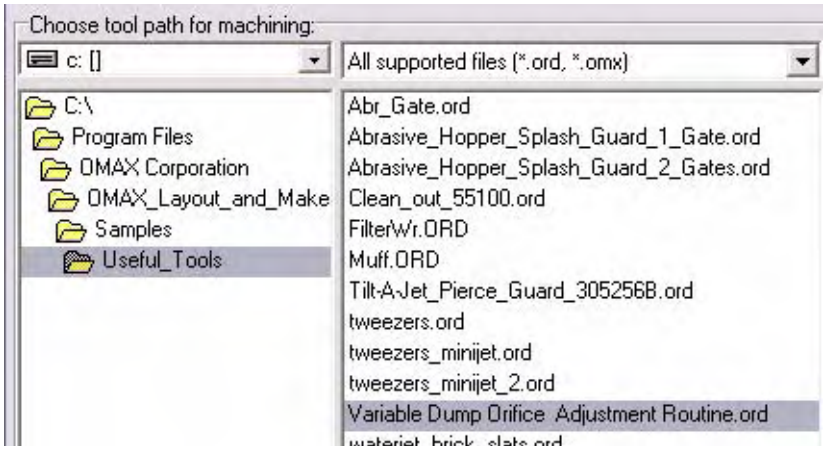


Figure 4-76: Select the ORD file, ***Variable Dump Orifice Adjustment Routine***

6. Click **OK** to open the selected ORD file:

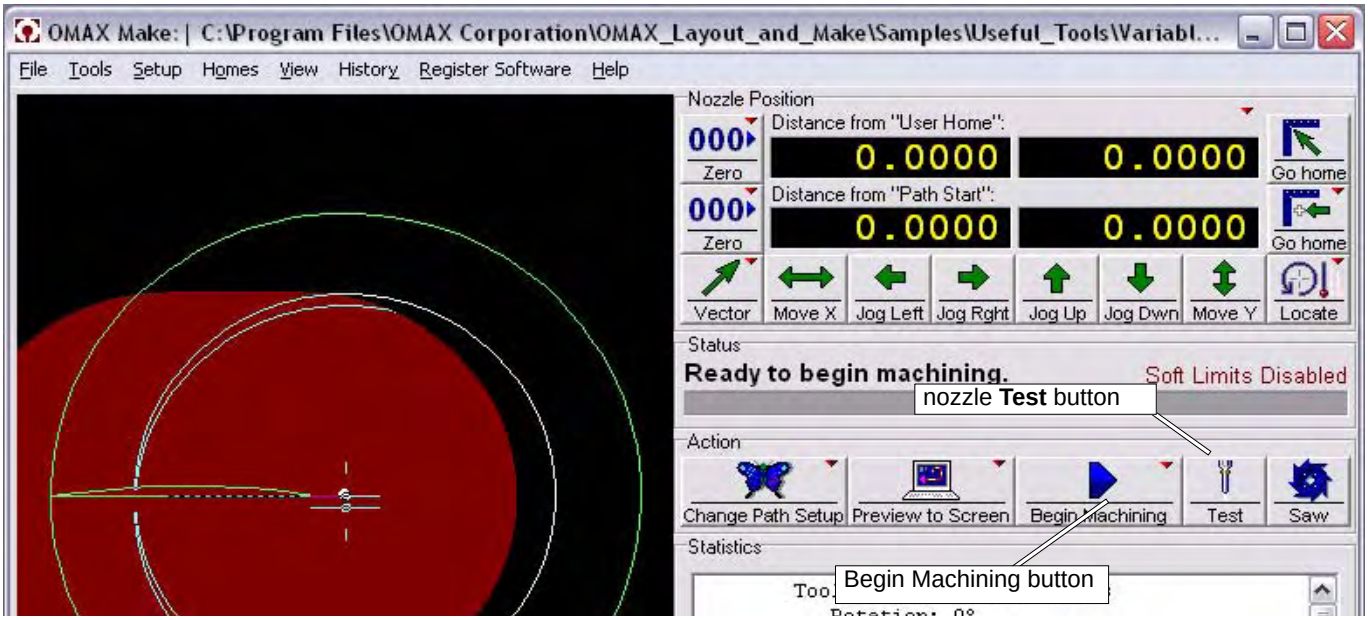


*Figure 4-77: Click the Nozzle **Test** Button to Set Pump Pressure*

7. Click the **Test** button to view the **Test Pump and Nozzle** window options:

Figure 4-78: The Test Pump and Nozzle Window

8. Select **High** or **Low** depending on your desired cutting 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.***

9. Click the **Water** button to start the pump and fire the nozzle.

10. On the pump control panel, use the **UP** and **DOWN** arrow keys to set your desired cutting pressure while the nozzle test is active:

*Figure 4-79: Set the KSI for **WaterPres** on the Pump's LCD*

11. When your desired water cutting pressure is set, click **STOP** to halt the test and remove nozzle pressure:

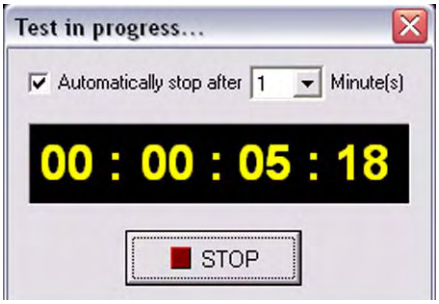


*Figure 4-80: Click the Test **STOP** Button After Setting Your Desired Pump Pressure*

12. With the ***Variable Dump Orifice Adjustment Routine.ord*** file still opened, click the **Begin Machining** button (Figure 4-77) to view the **OMAX Path Control** window:

*Figure 4-81: Click **Start** to Pressurize the Adjustable Dump Orifice*

13. Click the **Start** button to activate the pump.
    Note that the nozzle begins tracking the ORD file path with the water flow routed only to the ADO.
14. At the ADO, turn the Pressure Adjustment Knob (Figure 4-75) until the pressure indicated on the pump's control panel LCD (Figure 4-79) equals the **KSI** set previously in Step #10 above.

Note: *The ADO pressure should 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.***
The pump should never be running while the ADO pressure adjustment knob is not securely screwed in place.

15. Once the correct pressure is set, click the **Pause** button in the OMAX Path Control window (Figure 4-81) followed by clicking **Close**.

16. Replace all removed pump panels and close the pump lid.
17. 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.*

Changing the Dump Valve Orifice Size

Excessive differences in pressure between the cutting head pressure and the traverse or dump valve pressure may cause premature failure throughout the plumbing system in parts such as the on/off body, swivel body, UHP (ultra high-pressure) plumbing, and the pump outlet manifold. It is very important that the size of the cutting orifice be matched up with the correct dump valve orifice size as follows:

- Match a 0.010" cutting orifice with a 302028-10 dump orifice
- Match a 0.014" cutting orifice with a 302028-13 dump orifice
- Match a 0.015" cutting orifice with a 302028-14 dump orifice

Follow these steps to change the dump valve orifice assembly size to match the size of the nozzle orifice in use.

Disassemble the Dump Valve and Removing the Orifice Assembly

1. Power down the **JetMachining Center** using approved tag and lockout procedures.
2. Open the **cabinet lid** and remove the **front side cover**, enabling easy access to the **dump valve**:

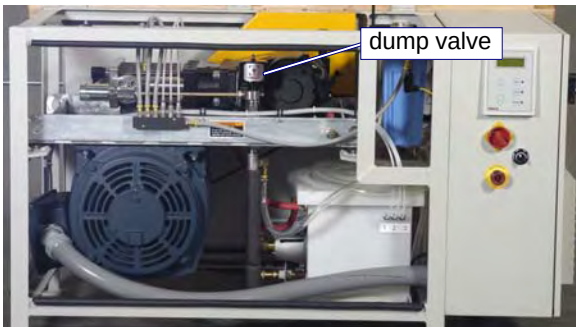


Figure 4-82: Dump Valve Location in Pump

3. Remove the Pump Front Cover to Access the **Dump Valve** Assembly.

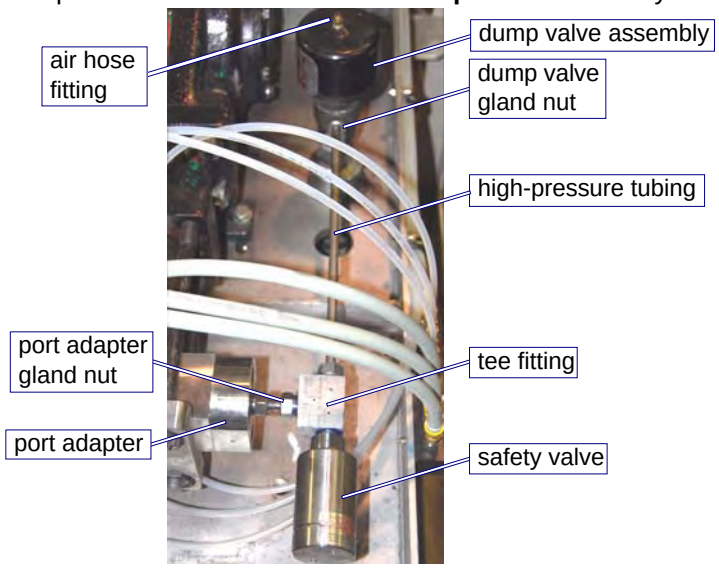


Figure 4-83: Dump Valve and Associated Components

4. Remove the **red air hose** from the **brass air fitting** located at the top of the **dump valve assembly** (Figure 4-83).
5. From the **dump valve**, loosen the high-pressure tubing **gland nut** by placing a **13/16" open-end wrench** on the **gland nut** and a **1" open-end wrench** on the **fitting ring**:

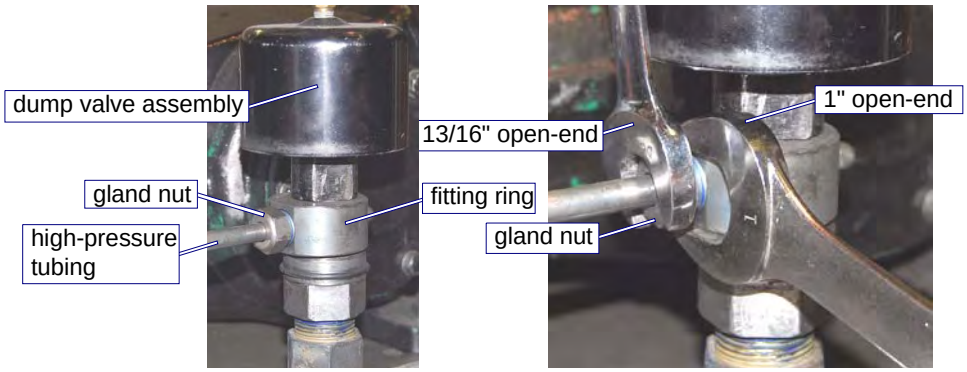


Figure 4-84: Loosening the Gland Nut on the Dual On/Off Valve

6. Unscrew the **gland nut** from the **port adapter** by placing a **13/16" open-end wrench** on the **gland nut** and a **1" open-end wrench** on the **tee fitting**:

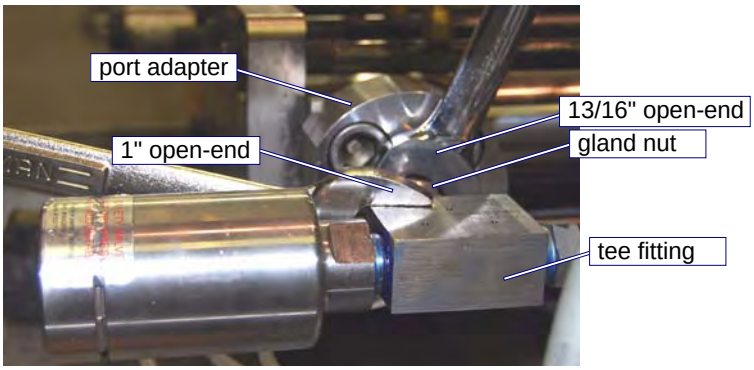


Figure 4-85: Removing the Gland Nut from the Port Adapter

7. Pull the **gland nut** and **tubing** from the **port adapter**:

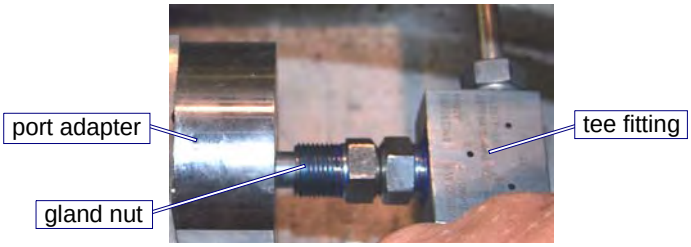


Figure 4-86: Removing the Gland Nut and Tubing from the Port Adapter

8. Completely unscrew the **gland nut** at the **dump valve** (Figure 4-84) and remove the entire **high-pressure tubing assembly** from the pump enclosure and set it aside.

9. Grasp the top of the **dump valve assembly** and, using a **1.5" open-end wrench** on the **body assembly nut** and a **1.5" open-end wrench** on the bulkhead adapter, unscrew the **valve body nut** from the **bulkhead adapter**.

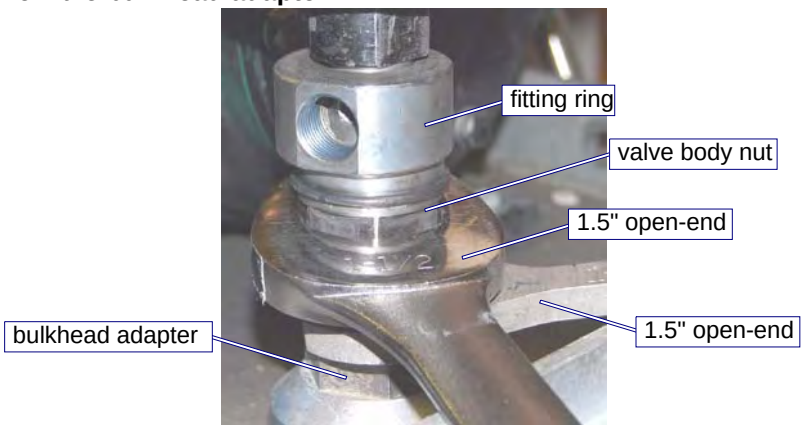


Figure 4-87: Removing the Valve Assembly from the Dump Valve Body

10. Lift the **dump valve assembly** from the **dump valve body**, exposing the valve seat sitting on top of the **orifice assembly**:

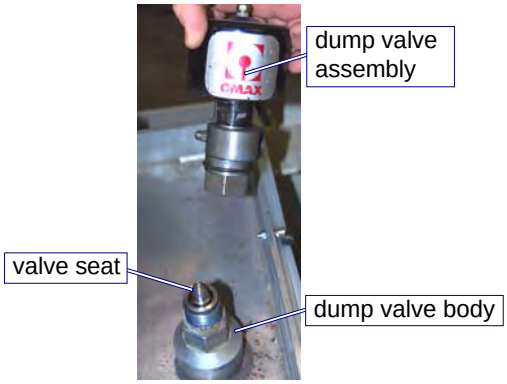


Figure 4-88: Lifting the Valve Assembly from the Dump Valve Body

11. Lift the **valve seat** from the **dump valve body** and set it aside:

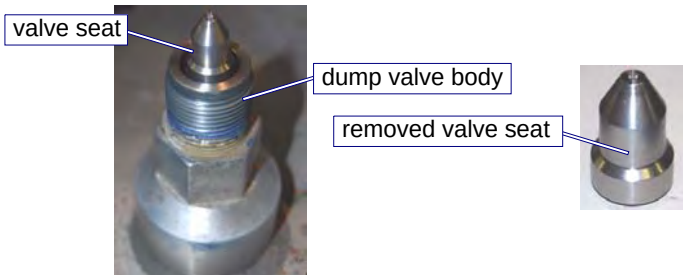


Figure 4-89: Removing the Valve Seat from the Dump Valve Body

12. Remove the **orifice assembly** from the **dump valve body**:

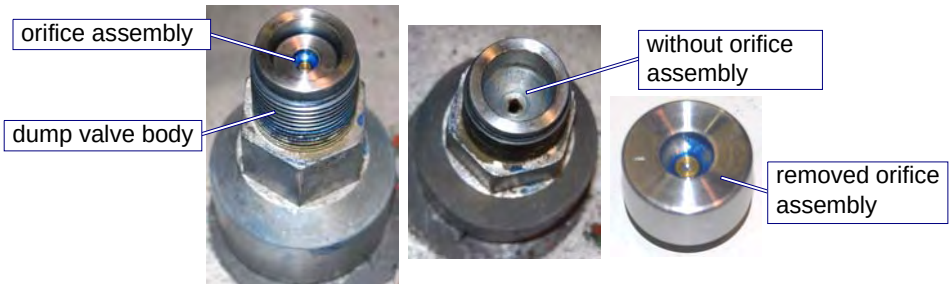


Figure 4-90: Removing the Orifice Assembly from the Dump Valve Body

Reassembling the Dump Valve With Replacement Orifice Assembly

1. Apply a thin coating of **Blue Goop** to the conical surface of the new **orifice assembly** and place it in the **dump valve body** with conical side down and jewel side up:

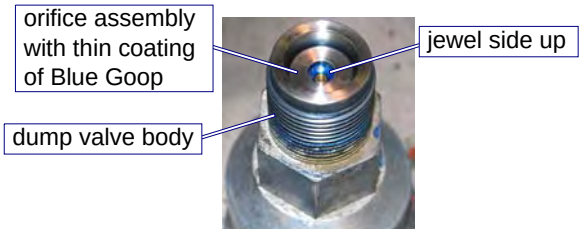


Figure 4-91: Apply Blue Goop and Place Orifice Assembly in Dump Valve Body

2. Apply a thin coating of **Blue Goop** to both the base and conical surfaces of the **valve seat** and insert in into the **dump valve body** on top of the **orifice assembly** as illustrated:

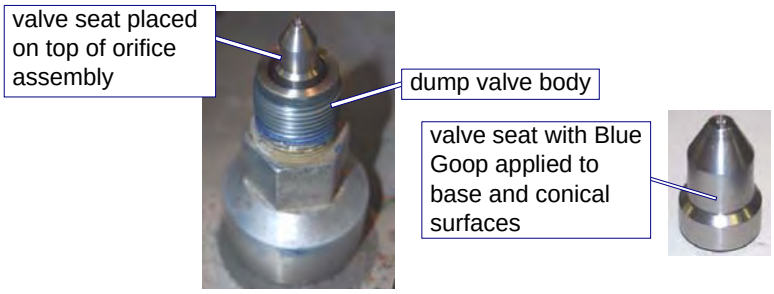


Figure 4-92: Apply Blue Goop and Insert Valve Seat in Dump Valve Body

3. Attach the **dump valve assembly** to the **dump valve body**:

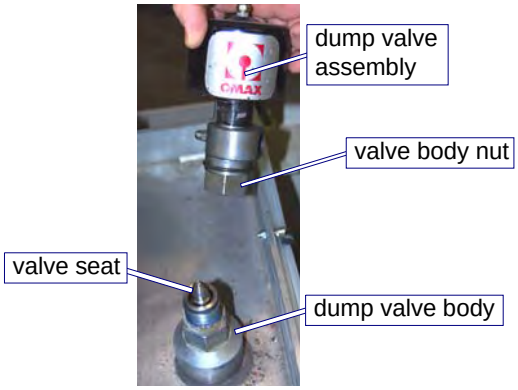


Figure 4-93: Attaching the Dump Valve Assembly and Body

4. Screw the **valve body nut** onto the **dump valve body**. Finger tighten only at this time!

5. Re-install the **high-pressure tubing** to both the **port adapter** and **dump valve assembly**. Finger tighten only at this time. Refer to Figure 4-83.

Note: *When installing the tubing and gland nut into the dump valve assembly, rotate the fitting ring and dump valve assembly to align the threads of the fitting ring with the water inlet hole in the dump valve assembly:*

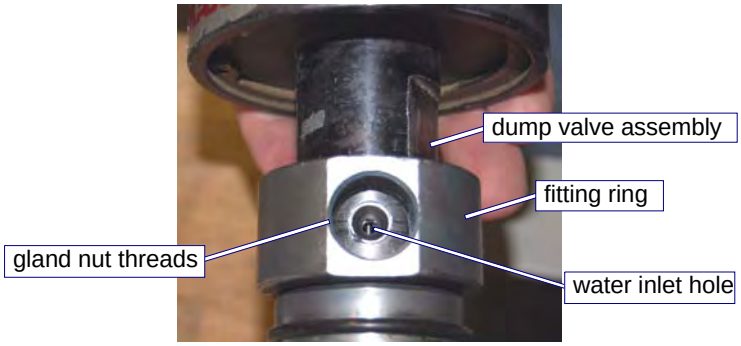


Figure 4-94: Aligning the Gland Nut Threads with the Water Inlet Hole

6. Tighten the **gland nut** on the **port adapter** by placing a **13/16" open-end wrench** on the gland nut and a **1" open-end wrench** on the tee fitting (refer to Figure 4-85). Torque to 50 - 75 foot pounds.
7. Tighten the **valve body nut** to the **bulkhead adapter** by placing a **1.5" open-end wrench** on the **valve body nut** and a **1.5" open-end** on the **bulkhead adapter** (refer to Figure 4-87).

Caution: ***To prevent side twisting of the dump valve assembly, ensure that the bulkhead adapter is held firmly in place and not allowed to rotate while tightening the valve body nut.***

8. Tighten the **gland nut** on the **dump valve assembly** by placing a **13/16" open-end wrench** on the **gland nut** and a **1" open-end wrench** on the **fitting ring** (refer to Figure 4-84).
9. Reconnect the **red air hose** to the **brass air fitting** located on top of the **dump valve assembly** (see Figure 4-83 for location).
10. Re-install the pump's **front panel**.
11. Re-apply power to both the **pump** and **PC Controller**.
12. Run a high-pressure water only test and verify that no water leaks from the **dump valve** and associated **high-pressure plumbing**.
13. Close the **pump lid** and release the equipment for operation.

Software Updates

Software updates are available from the OMAX Customer Support Web site at www.omax.com/support. To gain access, you need a user name and password, which you can obtain by contacting OMAX Technical Support.

New versions of the software are typically posted once or twice a year. These updates provide newer versions of the OMAX software and will automatically overwrite your existing version.

Caution: ***You should not uninstall the current version of your OMAX software before successfully installing its replacement. You may lose valuable history and settings files, causing your OMAX machine to make substandard parts. Simply run the installation program for the new software to install it.***

You can also use the OMAX technical support web site to download "beta" versions of the software. Beta software is software that is still being tested, but may contain useful features. This same support site

contains instructional videos and updated technical information. You are encouraged to regularly visit this support web site to stay up-to-date on your OMAX equipment.

Troubleshooting the OMAX Pump

Use this section to help resolve many of the common problems that can occur while operating the OMAX JetMachining Center.

Display Screen Messages

All fault messages, except those related specifically to the Variable Frequency Drive (VFD), appear on the keypad display.

Normal Operation Messages

When the pump is operating normally, the keypad displays these four lines of text:

Water Pres	**xx.x KSI**	pump output pressure in Ksi
High PreSet	**xxxx RPM**	preset drive motor high RPM
Low PreSet	**xxxx RPM**	preset drive motor low RPM
RunTime	**xxx HRS**	accumulative number of pump run hours

Pump Fault Messages

When a fault condition during pump operation occurs, the pump shuts down with one or more of the following messages appearing in the first three lines of the keypad display (the fourth line always displays the cumulative pump run hours):

Charge Pressure Low
Water pressure immediately downstream of the water filters is less than 50 psi.

Charging Pump Contactor
The charge pump contactor did not close or opened for some reason. It generally occurs along with the message "Charge Pressure Low."

Dead Head
Reported when pump output pressure equals or exceeds 60,000 psi.

Variable Drive Fault
There is an issue with the Variable Frequency Drive.

Possible Pump Faults

Problems covered in this troubleshooting section include:

- Fault message "**Charge Pressure Low**"
- Fault message "**Charging Pump Contactor**"
- Fault message "**Dead Head**"
- Fault message "**Variable Drive Fault**"
- Low Pump Output Pressure
- No Power at Pump Unit
- Pump Does Not Start
- No Keypad Display

If you are unable to determine and correct a pump problem by following these procedures, contact OMAX Customer Service for assistance.

Fault Message, "Charge Pressure Low"

This fault message appears on the pump's keypad display when the water pressure downstream of the pump's water filters drops less than 50 psi.

To troubleshoot a "Charge Pressure Low" message:

1. Check to see if the Charge Pump On/Off switch is in its On position.
2. Check the source of the white tank water supply and verify adequate flow and pressure. Replace the pump water filters if they are restricting flow.
3. Verify that the water source is turned On. Ensure that the water inlet to the Charge Pump is not blocked.
4. Check the 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. The Pump requires servicing. Contact OMAX Customer Service for assistance.
5. Check that the Water Filters are not plugged or damaged. If the pressure difference between the water filter pressure gauge readings is more than 20 psi, have the Filter Cartridges replaced.

Fault Message, "Charging Pump Contactor"

This fault appears on the pump's keypad display if the charge pump contactor did not close or opened properly. It generally appears along with the message "Charge Pressure Low."

To troubleshoot a "Charging Pump Contractor" message:

1. Check that the Charge Pump On/Off switch is in its On position.
2. Check the source of the white tank water supply and verify there is adequate flow and pressure. Replace pump water filters if restricting flow.
3. Check for a blown Fuse in the DIN rail located directly below the 24 VDC Power Supply. If the fuse holder's red light is lit, a blown fuse is indicated. Have the proper maintenance personnel replace this 0.5 amp Fuse.

Note: *A box of 0.5 amp fuses is supplied with every new pump unit and is stored in a plastic container attached at the bottom of the enclosure.*

4. If replacing the Fuse did not correct the fault, the pump requires servicing. Contact OMAX Customer Service for assistance.

Fault Message, "Dead Head"

This fault is reported on the OMAX keypad LCD when pump output pressure equals or exceeds 60,000 psi.

To troubleshoot a "Dead Head" fault message:

1. Check that the high-pressure Orifice and Nozzle are not plugged, or partially plugged.
2. Check that the orifice used is not too small, particularly if it has just been installed.
3. If equipped with Dual On/Off Valves, check that air is supplied to the On/Off Valves.
4. If the fault continues, the Pump requires servicing. Contact OMAX Customer Service for assistance.

Fault Message "Variable Drive Fault"

The VFD provides power, protection, and speed control for the pump motor. If the VFD faults for whatever reason, the message "Variable Drive Fault" appears on the keypad's display and the red LED next to the Reset button lights.

To restart the OMAX pump, the fault causing the message must be cleared and the Reset button on the keypad pressed. If all goes well, the display returns to the same display it had prior to the fault trip, the LED next to the Reset button goes out, and the LED next to the Stop button lights; however, if the condition that caused the VFD fault was not corrected, the VFD will continue to fault and prevent

operation of the pump. If a VFD fault persists after pressing Reset, the pump requires servicing. Contact OMAX Customer Service for assistance.

Low Pump Output Pressure

To troubleshoot low pump output pressure:

1. Inspect the High-pressure Plumbing for leaks, loose fittings, or split tubing.
2. Check the Pressure Gauges on top of the Water Filters. Reduced output pump pressure can result from clogged filters. If the pressure difference between water filter pressure gauge readings is more than 20 psi, have the Filter Cartridges replaced.
3. Check the Pressure Safety Valve for leakage. If the valve leaks more than 1 drop per minute, the Pump must be serviced.
4. If the Abrasivejet Orifice is worn or chipped, it may pass the full flow of the high-pressure pump without developing its rated pressure. Rule out a suspected defective orifice by replacing it with a known good one.

Caution: ***Do not run the OMAX pump once the pressure at a given RPM for a given nozzle drops more than 2000-4000 psi. Continued operation with damaged check valve seats or failed dynamic seals can result in further damage to components in the pump's wet-end and may result in higher rebuild costs.***

5. If there is low pressure with high vibration, a Plunger may have come loose. Immediately turn Off power. The Pump requires servicing. Contact OMAX Customer Service for assistance.

No Power at the Pump Unit

1. Have a certified electrician check that power is coming into the main power disconnect by measuring the voltage at all three legs.
2. Check the Fuses at the main power disconnect.
3. Verify that the Main Power is switched to the On position.
4. Check that the On/Off switch on the Pump is On and that the On/Off switch on the OMAX JetMachining Center is also On.
5. Check that the emergency stop switches on both the Pump and the JetMachining Center Controller are in their "reset" (pulled out) positions.
6. If this problem continues, the Pump requires servicing. Contact OMAX Customer Service for assistance.

Pump Does Not Start

1. Check that the main AC Power Source is switched On.
2. Check that the Pump On/Off Switch is On.
3. Check that the emergency stop switches are in their "reset" (pulled out) positions. The emergency stop switch on the Pump will shut down both the Pump and X-Y Table (if connected). Likewise, the emergency stop switch on the JetMachining Controller will shut down both the X-Y Table and Pump. To reset an emergency stop switch, simply pull it out to its original position.
4. Check the FAULT condition displayed on the OMAX Keypad display. If the display indicates a fault, refer to the troubleshooting steps in this section and try to correct it. More than one fault may be reported. Each will have to be corrected before the unit will run properly. After correcting the conditions that created the fault(s), press the Reset Button on the OMAX Keypad to clear the Display and re-enable the Pump.
5. Check if the pump Keypad Display is lit. If it is not, refer to "No Keypad Display," page 4-47.

6. Check the display on the VFD Keypad inside the electrical enclosure. It should display the condition "Ready" and "Remote" in the center upper part of the display. If the VFD does not, contact OMAX Customer Service.
7. If this problem continues, the Pump requires servicing. Contact OMAX Customer Service for assistance.

No Keypad Display

The display on the OMAX pump is blank and none of the red LED's next to keypad buttons are On.

1. Check that no Emergency Stop Switches are engaged.
2. Check that the On/Off Switch on both the Controller and Pump are in their On positions.
3. If this problem continues, the Pump requires servicing. Contact OMAX Customer Service for assistance

Troubleshooting the OMAX JetMachining Center

This section lists most problems encountered with the OMAX Pump. Possible causes are provided for each problem with the most likely causes listed first. If you continue having a problem with your OMAX pump after following these procedures, contact OMAX Customer Service.

Machine Motion

Abrasivejet Nozzle Doesn't Move	
Condition and Possible Causes	**Corrective Action**
The emergency stop switch was pushed in.	**Note:** *Reset the emergency stop switch by pulling it out. Whenever the emergency stop switch is used, it will be necessary to redefine your values for the machine's soft limits and homes.*
A soft limit has been reached.	You may want to reset your soft limits if they are too small. **Note:** *The 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, it will be necessary to redefine values for the machine's soft limits and homes.*
The nozzle collided with the cutting material and stalled a servomotor.	Cycle machine power Off and then On. **Note:** *Follow proper shutdown procedures.*
Parts are Too Short or Flat Spots Appear on Curves	
Condition and Possible Causes	**Corrective Action**
The cutting material is not securely fixtured.	The material was able to move during the cutting process due to drag of the nozzle or upwelling of the water below. Ensure that the material being cut is securely fixtured. This is the most common reason for scraped parts.
The nozzle has reached its hardware limits.	Relocate the work piece toward the table center. Set the software limits to provide a warning before hardware limits can be reached.
Home Position or Soft Limits are Lost	
Condition and Possible Causes	**Corrective Action**
The nozzle has reached its hardware limits.	Relocate the work piece toward the table center. Set the software limits to provide a warning before hardware limits can be reached.

Machining Quality

Poor Surface Finish	
Condition and Possible Causes	**Corrective Action**
The values defined in Make are not consistent with the actual cutting requirements.	Check that the values entered for the following parameters were correctly entered in Make: • Machinability — Thickness Click on **Setup** in Make, choose **Pump and Nozzle settings**, and verify that values entered for these parameters are correct: • Water pressure • Orifice diameter • Mixing tube diameter • Abrasive flow rate

An abrasive other than the recommended garnet is being used.	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. Garnet is recommended because it allows a good cutting rate with relatively low mixing tube wear. Garnet is also nonhazardous and, as such, is easily disposed. Other abrasives may increase mixing tube wear and may be a disposal hazard. **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.***
The mixing tube is excessively worn and unable to form a perfect jet stream	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.
The jewel that forms the jet is chipped, dirty, or out-of-tolerance.	Replace the jewel and the jewel holder.
The abrasive flow is stopped or has been reduced by the presence of dirt or wet abrasive.	Disassemble the plugged items, blowing them clean and dry with an air hose. **WARNING!** ***Never point the air stream at anyone during the cleaning process. Always wear eye protection!***
Poor fixturing of the cutting material.	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 low cut quality such as 1 or 2.

The pump is not delivering the pressure specified.	Measure the pressure to see if it is below specification. Follow the pump troubleshooting procedures.
Holes are Too Large and Parts Undersized	
Condition and Possible Causes	**Corrective Action**
The tool offset is set incorrectly.	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.
Tool offset is on the wrong side of the path.	Switch the lead-in and lead-out and then use the **Generate Tool Path** command in Layout to recreate the part. You can check your tool offset using **Preview** in Make.
Excessive Taper on Part Edges	
Condition and Possible Causes	**Corrective Action**
The cut was made with the quality value set too low.	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). Remember that different qualities can be set on different portions of the same part.

The standoff between the abrasivejet nozzle and the material is excessive.	The standoff should be no more than 0.050" (1.3 mm) for best results. **Note:** *0.060" (1.52 mm) is generally recommended, especially with the Tilt-A-Jet option. Typically, lower standoff distances decrease the amount of taper, but a lower standoff increase the likelihood of nozzle plugging. The pierce and cut heights can be set at different heights using* ***Motion Preferences*** *in Make.*
Setup values in Make are not consistent with the actual physical requirements.	Check that the material setup values for the following parameters are correctly set in Make: • Machinability — Thickness Click **Setup** in Make, choose **Pump and Nozzle settings**, and verify that values for the following parameters are set correctly: • Water pressure • Orifice diameter • Mixing tube diameter • Abrasive flow rate •

An abrasive other than the recommended garnet is being used.	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. Garnet is recommended because it allows a good cutting rate with relatively low mixing tube wear. Garnet is also nonhazardous and, as such, is easily disposed. Other abrasives may increase mixing tube wear and may be a disposal hazard. **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.***
The mixing tube is worn and unable to form a perfect jet stream	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 diameter by 0.005" (0.13 mm), the mixing tube is near the end of its useful life for precise cutting.
The jewel that forms the jet is chipped, dirty or out of tolerance.	Replace the jewel and the jewel holder.
Holes are Not Round	
Condition and Possible Causes	**Corrective Action**
The cutting material is not securely fixtured.	The material was able to move during the cutting process due to drag of the nozzle or upwelling of the water below. Ensure that the material being cut is securely fixtured. This is the most common reason for scraped parts.
The jet is elliptical rather than round due to wear in the mixing tube or a slightly imperfect orifice.	Change the orifice first. If the jet remains elliptical, change the mixing tube.

Abrasivejet Not Piercing Material	
Condition and Possible Causes	**Corrective Action**
Setup values entered in Make are not consistent with the actual physical requirements.	Check that the material setup values for the following parameters are correctly set in Make: • Machinability — Thickness Click on **Setup** in Make, choose **Pump and Nozzle settings**, and verify that values for the following parameters are set correctly: • Water pressure • Orifice diameter • Mixing tube diameter • Abrasive flow rate
An abrasive other than the recommended garnet is being used.	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. Garnet is recommended because it allows a good cutting rate with relatively low mixing tube wear. Garnet is also nonhazardous and, as such, is easily disposed. Other abrasives may increase mixing tube wear and may be a disposal hazard. **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.***
The standoff between the abrasivejet nozzle and the material being cut is too high.	The standoff should be no more than 0.050" (1.3 mm) for best results. **Note:** *In Make, under **Motion Preferences**, it is possible to set the pierce height to be different from the cutting height if you have a motorized Z-axis. To help reduce nozzle plugging, consider setting the pierce height higher than the cutting height.*
The abrasive flow is stopped or has been reduced by the presence of dirt or wet abrasive.	Disassemble the plugged items, blowing them clean and dry with an air hose. **WARNING!** ***Never point the air stream at anyone during the cleaning process. Always wear eye protection!***
The mixing tube has worn excessively and is unable to form a perfect jet.	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 diameter has increased by 0.005" (0.13 mm), the mixing tube is near the end of its useful life for precise cutting.
The jewel that forms the jet is chipped, dirty or out of tolerance.	Replace the jewel and the jewel holder.
The pump is not delivering the pressure specified.	Measure the pressure to see if it is below specification. Follow the pump troubleshooting procedures.
Abrasivejet Quit Cutting	
Condition and Possible Causes	**Corrective Action**
The abrasive flow is stopped or has been reduced by the presence of dirt or wet abrasive.	Disassemble the plugged items, blowing them clean and dry with an air hose. **WARNING!** ***Never point the air stream at anyone during the cleaning process. Always wear eye protection!***

The mixing tube in the abrasivejet nozzle is plugged.	In an attempt to dislodge the plug, use Make to turn the water pump On and Off. If this fails, you may need to disassemble the nozzle and clean it, or replace the mixing tube.
The jewel orifice is plugged with foreign material.	Remove the nozzle and flush the lines. Replace the jewel with a new one.
The pump is not delivering the pressure specified.	Measure the pressure to see if it is below specification. Follow the pump troubleshooting procedures.
No high-pressure water yet Make continues to control nozzle as if cutting	
Condition and Possible Causes	**Corrective Action**
No water in white tank or charge pump pressure has fallen below 50 PSI. Pump display reads "Charge Pressure Low" followed by "Charge Pump Contactor".	Check the source of white tank water supply and verify adequate flow and pressure. Replace pump water filters if they are restricting flow.
80160 Not Cutting Square Parts	
Condition and Possible Causes	**Corrective Action**
The Y-axis is no longer exactly perpendicular to the machining table.	Square the Y-axis bridge against the hard stops. You should re-square the Y-axis whenever: • The X-axis drive motor faults • The Y-axis bridge crashes

Software Problems

Also refer to the OMAX Interactive Reference (OIR) for help in troubleshooting software problems.

Keyboard or Mouse Doesn't Work	
Condition and Possible Causes	**Corrective Action**
Wires or connections in the computer may have become loose.	Verify that the mouse and keyboard connections in the back of the Controller PC are firmly inserted.
Blue Screen Errors	
Condition and Possible Causes	**Corrective Action**
Loose USB cable. If the USB cable is unplugged while Make is running, the monitor will blue-screen.	Ensure that the USB cable is plugged in adequately. Reboot the PC.
Using older version of Windows 2000	Update to Service Pack #2 or newer version of Windows 2000.
Corrupt device driver	Simply re-installing OMAX 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.

"Babysit Triggered" Message

Note: *The OMAX has several switches monitoring machine operation. When any of these switches are triggered, the abrasive jet nozzle immediately stops operation and no longer continues machining or is able to be moved. When an attempt is made to restart operation, a "Babysit Triggered" error message appears. To recover from a babysit condition, first, correct the cause that triggered the babysit, then hold down the Override switch on the controller front panel.*

Caution: ***Caution: Ensure that you know what triggered the condition before attempting a babysit override. Continuing to operate the OMAX by overriding these switches may damage the OMAX. If you are unable to determine what triggered a babysit condition, contact OMAX Customer Support.***

Condition and Possible Causes	Corrective Action
Low air pressure	Verify that system air pressure is 70 - 95 PSI.
Fault in a servo circuit	Check the fault relays on the controller back door for a light identifying which axis is at fault. Whenever a fault is indicated, contact Technical Support.
Pause button pressed	Release Pause button.
Access Control Circuit triggered. (Optional accessory)	Re-arm the circuit.

Nozzle and Abrasive System

Condition and Possible CausesCorrective Action

Water Comes Up the Abrasive Tube	
Condition and Possible Causes	**Corrective Action**
The nozzle body is loose.	Tighten the nozzle body.
The mixing tube in the abrasivejet nozzle is plugged.	Use Make to turn the pump On and Off in an attempt to dislodge the plug. If this does not work, it may be necessary to disassemble and clean the nozzle, or replace the mixing tube.
The 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.	Increase the standoff between 0.040" (1.0 mm) and 0.050" (1.3 mm). **Note:** *With a motorized Z-axis, in Make, under **Motion Preferences**, it is possible to set a pierce height that is different from the cutting height. To help reduce nozzle plugging, consider setting the pierce height higher than the cutting height.*
The pump is not delivering the pressure specified.	Measure the pressure to see if it is below specification. Follow the pump troubleshooting procedures.
The jet looks wide and fuzzy	
Condition and Possible Causes	**Corrective Action**
The jewel that forms the jet is chipped, dirty or out of tolerance.	Replace the jewel and the jewel holder.

The mixing tube is worn and unable to form a perfect jet stream	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 diameter by 0.005" (0.13 mm), the mixing tube is near the end of its useful life for precise cutting.
Abrasive Has Stopped Flowing	
Condition and Possible Causes	**Corrective Action**
The abrasive flow is stopped or has been reduced by the presence of dirt or wet abrasive.	Disassemble the plugged items, blowing them clean and dry with an air hose. **WARNING!** ***Never point the air stream at anyone during the cleaning process. Always wear eye protection!***
The 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.	Increase the standoff between 0.040" (1.0 mm) and 0.050" (1.3 mm). **Note:** *With a motorized Z-axis, in Make, under **Motion Preferences**, it is possible to set a pierce height that is different from the cutting height. To help reduce nozzle plugging, consider setting the pierce height higher than the cutting height.*
The shop air pressure is insufficient to open the abrasive valve.	The abrasive valve requires 60 to 120 psi (4 to 8 bar) shop air.
Abrasive Pours Out the Top of the Abrasive Tube	
Condition and Possible Causes	**Corrective Action**
The abrasive flow is stopped or has been reduced by the presence of dirt or wet abrasive.	Disassemble the plugged items, blowing them clean and dry with an air hose. **WARNING!** ***Never point the air stream at anyone during the cleaning process. Always wear eye protection!***
The jewel orifice is plugged by foreign material in the water line.	Remove the nozzle and flush the lines. Replace the jewel with a new one.
The 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.	Increase the standoff to between 0.040" (1.0 mm) and 0.050" (1.3 mm).

Miscellaneous

Water Spurts Out of the tank	
Condition and Possible Causes	**Corrective Action**
The part is positioned on top of a slat, causing the jet stream to reflect upwards.	Contain the spray with a muff around the nozzle. A disc cut from a 2" (5 cm) thick sponge makes an effective muff.
The abrasivejet is not piercing the material.	See the earlier item, *Abrasivejet not piercing material,* under "Machining Quality."

Water level too low.	On some machines, if the water level is raised too high, the air bladder "burps" excess air back into the tank, causing water to overflow over the sides. To prevent this, ensure there is enough water in the tank to allow the water level to be raised sufficiently before the air bladder fills.
Abrasive Piles Up on the Work Piece	
Condition and Possible Causes	**Corrective Action**
The accumulation of abrasive silt at the bottom of the tank is excessive.	Remove the slats and clean out the abrasive from the tank bottom.
The tank has an Unpleasant Odor	
Condition and Possible Causes	**Corrective Action**
Excessive bacteria growth in the tank.	Check the floating device to ensure it contains an adequate amount of the bacteria-killing chemicals supplied with the OMAX.

Positioning Accuracy Overview

OMAX Jet Machining Centers specify a positioning accuracy of +/- 0.003" for ball bar circularity (over 12 inches) at maximum velocity and at any table location. In addition, the 2626|xp specifies a positioning accuracy of 0.001" when environmental requirements are met.

These specified values use an industry standard method of measuring cutting tip positional accuracy. An abrasive waterjet machine is a **soft** cut machine. This means cutting head accuracy is only one of several parameters involved in the overall cutting accuracy of a part. A **hard** cut machine, such as a Bridgeport Mill, has a hard tool that is always exactly in the same location relative to its spindle's X- and Y-axis position. A **soft** machine may be positioned accurately, but the cutting process is also affected by a number of other important considerations such as the mixing tube diameter, mixing tube out-of-round, jewel wear, mixing disc wear, Z-axis being square to the table, cut taper, offset entered in Make, abrasive flow rate entered in Make, etc., etc.

When positioning accuracy and tolerance become an issue with an OMAX JetMachining Center, carefully investigate the following:

- Ensure that all lead screws and belts on all axes are adequately lubricated. The rotation for each should be smooth as silk.

Caution: ***The linkage arms on a Tilt-A-Jet do not require lubrication. NEVER lubricate them with WD40 (or equivalent). This lubricant will react with the joint epoxy, causing them to permanently freeze up and require replacement.***

- The jewel, mixing disc, and mixing tube should all be new.
- Install a new nozzle body and mixing chamber and last chance filter.
- Examine your settings for SETUP and PUMP AND NOZZLE SETTINGS. Is every value entered accurately? When was the abrasive flow rate last measured? Was it repeated three times just to be sure? Is the water pressure entered the actual pressure indicated on the pump when cutting? Is the mixing tube rotated frequently? Are Barton's abrasives being used; can the abrasive index be counted on for accuracy? Is correct tool offset being used?
- Run the Z-axis up and down to ensure it's square to the table. Has the Tilt-A-Jet been checked for accuracy?
- Is there any end play in either X- or Y-axis? Oval holes may indicate this problem. If end play is indicated, examine the axial bearing.
- Disassemble and lubricate all UHP swivels. Ensure that the two weldments on the 55100 rotate smoothly on the swivel body. Install a new bushing if needed.
- The gantry style Y-axis may be out-of-alignment and requires re-squaring.
- Loosen one end of all UHP tubes on the cutting head or swivels. Retighten each ensuring that the tube is not being twisted while tightening. A twist in the UHP tube induces friction into the swivel, affecting positioning accuracy.

- A cut's taper may be an issue. If the abrasive waterjet's normal taper is out of acceptable tolerances, then consider using a Tilt-A-Jet.
- Adequately secure the material to prevent movement. It may weigh 800 pounds, but when it's hit with 50,000 pounds of water pressure, it can move!
- Cut a one inch square in a piece of one inch steel. Do the same by cutting a circle. A close examination of these two parts should reveal if an axis is out of tolerance. Cut a part using 4 separate 3" movements in one direction followed by a 12" return movement. There should be 4 moves out and one move back! Verify that the nozzle returned to the exact starting location without loosing steps. Repeat this for both axis.
- When convinced that all of the above checks are functioning accurately and the machine's positioning accuracy remains an issue, contact OMAX Customer Service.

Consumable Parts

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

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

Part	Description	Part Number
MaxJet 5	Inlet Body, Integrated	303279
	Inlet Body, Non-Integrated	303475
	Nozzle Body	303295
	Orifice Assembly, MaxJet 5, Size 0.014", with filter	304352-14
	Orifice Assembly, MaxJet 5, Size 0.014", Diamond Jewel	305322-14
	Mixing Chamber	303565
	Mixing Chamber Disc	303566
	Mixing Tube, 4" /500/0.030"	300766-030
	Ring Seal, Maxjet 5 Inlet Body	202685
	O-Ring Filter	202545
	O-Ring, 3/32Wx12 ID	202570
	Collet, Mixing Tube	303275
	Nut, SBR	303453
	On/Off Valve Rebuild Kit	301927
MaxJet 5 Water only	Kit, Water Only Nozzle, with Jewels	303486
	Dummy Orifice	303305
Mini-Maxjet 5	Kit, Nozzle, Mini-Jet	303606-10
	Inlet body Extension, Short	303297
	Nozzle body, Size 0.010"	303301
	Orifice Assembly, Maxjet 5, Size 0.010"	303281-10
	Orifice Assembly, Size 0.010", Diamond Jewel	305322-10
	Mixing Tube, 2.25" /500/0.021"	304166
Tilt-A-Jet	Inlet Body	303329
	On/Off Valve Rebuild Kit	303639
	On/Off Valve Body	303327
Filters	20" Pre-filter, 20 micron, Wall Mount, Water filtration	202466
	20" Pre-filter, 5 micron, Wall Mount, Water Filtration	202465
	200 Mesh Strainer, Charge Pump Tank, Reservoir	200935
	10" Cartridge, Fine, 0.5 micron, Charge Pump Pre-filter	202533
	10" Cartridge, Fine, 0.2 micron, Charge Pump Pre-filter	202532
	Filter/Seal Assembly with O-ring	304351
	Air Filter, 11.5" x 3.5", bottom of controller & inside pump enclosure	202736
	Air Filter, 11.5" x 2.5", bottom of controller & inside pump enclosure	200084
	Air Filter, 6.9" x 2.5", Inside Pump Enclosure	202552
	Filter/Seal Assembly, Nozzle Assembly Last Chance Filter	304080-2

Part	Description	Part Number
Miscellaneous	Arctic Grease, Y- and X-axis	202335
	Slats, 2626 and 2652	300135
	Slats, 55100	300933
	Extreme Pressure Lube, 1/4 oz.	202496
	Lubriplate, 1.75 oz.	201304
	Blue Goop, 2 oz.	302692
	Tubing, Abrasive feed, 1/4" OD x 3/16" ID	100100
	Tubing, Abrasive Feed, 1/8" ID x 3/16" OD	201735
	Waterjet Brick, 4" x 4" x 48"	202145
	Nozzle Muff	300614
	Garnet, 80 Mesh Abrasive HPX, 50 LBS	201321
	Garnet, 120 Mesh Abrasive, HPX, 50 LBS	201991
	Fuse, Time Delay, 250 VAC, 0.5 A, 5mm x 20mm, Glass	201704

These additional items are also recommended to support operation of your OMAX:

- Sponges for cleanup
- Steel, brass, or lead weights for holding materials in place during machining
- Stainless steel flats to push weights against
- Safety goggles
- Gloves
- Ear protection
- Eye wash station
- Paper towels
- Spreader bars for securing parts on table
- Squeegee

Maintenance Log

Run Hours	Maintenance Performed	Done By	Date

Training Log

Date	Training Description	Trainer	Trainee

Chapter 5

Customer Support

This chapter explains how to reach OMAX Customer Service and provides instructions for the ordering and returning of parts.

Contacting OMAX Customer Service

OMAX Customer Service personnel can be reached throughout the workday for technical questions or ordering parts as follows:

8am – 8pm EST Monday through Friday
8am – 5pm EST Saturday and Sunday

Voice: 253.872.2300 x3 or 800.298.4036
International: 01 253.872.2300 x3
Fax: 253.872.7446
E-mail: techsupport@omax.com
Ordering parts: parts@omax.com

Ordering Parts

OMAX parts can be ordered from Customer Service either by calling **800.298.4036** (international **01 253.872.2300 x3**), faxing **253.872.7446**, or emailing to **parts@omax.com**.

When ordering parts, please provide the following information:

- part name
- part number
- quantity needed
- date required
- your shipping information
- purchase order number

Parts in stock are shipped within 3 working days from receiving the order. When not in stock, OMAX provides an estimated shipment date. Same-day shipments for system-down emergencies can be accommodated if the requested part is in stock and the order received before 12:00 noon, Pacific Time.

Returning Parts

All parts returned to OMAX Corporation, for any reason, are handled according to the Returned Material Procedure described below. Return procedures vary, depending upon the reason for the return. The normal process for returned parts takes approximately ten working days once the part is received. All returned parts must have an RMA number and be returned within 30 days of the shipping date with proof of purchase to be considered for credit.

Returned Material Procedures

The following procedures are used by OMAX Corporation to handle part returns. OMAX issues credit for returned parts if received in their original condition, or had failed under conditions covered by the OMAX warranty.

Please follow these steps when returning parts:

1. Contact the Customer Service Department to obtain a Return Material Authorization number (RMA).
2. Please provide the following information:
   - your company name and address
   - your name and telephone number
   - OMAX sales order number
   - original purchase order number
   - itemized list of all parts being returned, including quantity, part number, and description
   - reason for return (defective, ordered in error, repair, etc.)
   - any additional helpful information
3. Write the RMA number at the top of the packing list and on the shipping label and include a copy of your sales order.

Note: *Each RMA number is different. This number must appear on the shipping label and on all shipping documentation. All inquiries concerning the returned parts should also refer to this number.*

4. Ship your returned parts prepaid to:

   OMAX Corporation
   Attn: Customer Service Department
   21409 72nd Avenue South
   Kent, WA 98032 USA

Parts Ordered in Error

Returned parts ordered by a customer in error are subject to a testing and restocking charge of 15% of the list price. Parts returned for restocking must be returned prepaid to OMAX Corporation within 30 days of the original parts order ship date.

To return a part ordered in error for credit:

1. Obtain an RMA number. Return your ordered in error parts prepaid to OMAX Corporation within 30 days of the date the part was originally shipped.
2. Returned parts are examined by the Customer Service Department to ensure they are unused, in new condition, and free of handling damage.
3. If the parts are determined to be new and received within the 30-day limit, you receive full credit for the amount charged, minus the 15% restocking fee. A copy of the credit memorandum will be forwarded to you for use on future orders.
4. You must issue a new purchase order for any replacement parts.
5. Parts are shipped to you FOB Kent, Washington, USA.
6. If the returned parts are not new, or if OMAX receives them after the 30-day limit, the OMAX Customer Service Coordinator determines their proper disposition.

Unused Parts

To return unused parts for credit:

1. Obtain an RMA number. Return your unused parts prepaid to OMAX Corporation within 30 days of the shipping date the part was originally shipped.
2. All parts are examined by the Customer Service Department to ensure they are unused, in new condition, and free of handling damage.
3. If the parts are determined to be new and are received within the 30-day limit, you receive full credit for the amount charged, minus the 15% restocking fee.
4. A copy of the credit memorandum will be forwarded to you for use on future orders.

Parts Shipped in Error

To return parts shipped in error for credit:

1. Obtain an RMA number. Return your shipped in error parts prepaid to OMAX Corporation within 30 days of the shipping date when the part was initially sent.
2. All parts are examined by the Customer Service Department to ensure they are unused, in new condition, and free of handling damage.
3. If the parts are determined new and are received within the 30-day limit, you receive full credit for the amount charged, and the part originally ordered is shipped.
4. If the returned parts are not new, or are received by OMAX after the 30-day limit, the OMAX Customer Service Coordinator determines the proper disposition.
5. If the replacement parts are needed sooner than 10 working days, issue a new purchase order and clearly label it with the RMA number and a tag that reads "Shipping Error."
6. If in stock, the replacement part will be shipped within three working days (same-day for urgent requests).
7. If the claim is approved, a credit memorandum for the originally shipped parts is forwarded to you. This credit can be used on future orders.

Parts Returned for Repair

To return parts for OMAX Repair Services:

1. Obtain an RMA number. Ship the parts along with a purchase order to OMAX Corporation.
2. Repair charges are based on standard rates for labor plus the currently listed price for any replacement components required.
3. You will be notified if the repair charge exceeds 50% of the cost for a new part.
4. The OMAX Repair Department completes the repair. If the parts are either not repairable, not cost effective to repair, or not approved for repair, they are either returned to you or scrapped upon your request.

Parts Returned for Warranty Repair or Replacement

To return parts for warranty repair or replacement:

1. The Customer Service Department evaluates all parts returned to ensure that they are covered by the OMAX Corporation warranty.
2. When a part is under warranty, OMAX determines if the part should be repaired or replaced.
3. When a part is not under warranty, it will either be repaired at your expense, returned to you without repair, or scrapped at your request.
4. When a part is urgently needed while the equipment is still under warranty, OMAX suggests that you issue a new purchase order for the required part.
5. Write the RMA number on the purchase order, and also note that the parts ordered are to replace parts sent in for warranty consideration.
6. If the part is in stock, it is shipped within three working days. If it is not in stock, the part will be sent as soon as possible.
7. If the warranty claim is approved, OMAX issues a credit memorandum for the parts.
8. A copy of the credit memorandum is sent to you for use on future orders.

Two-year Limited Warranty

OMAX Corporation ("OMAX") warrants its OMAX JetMachining® Center and all components of its manufacture (the "Products"), to be free of defects in workmanship and material for a period of two years from the date of shipment or 4,000 operational hours, whichever comes first. This warranty covers all machinery and electronics equally, however, it does not include wear parts and consumable parts such as seals, valves, abrasive-jet nozzles, mixing tubes, orifices, high-pressure hose or high-pressure pump components. Further, Buyer is strongly cautioned that poor water quality and high inlet water temperature will significantly affect operational life of Products. This warranty specifically excludes coverage of any claims for the effects of corrosion, erosion, adverse water conditions and temperature, normal wear and tear, or component failures caused by (i) accident, (ii) negligence, misuse, improper installation or abuse, or (iii) unauthorized repair or alteration, or failure to maintain the OMAX JetMachining® Center that contains the affected components in accordance with the technical bulletins and specifications provided by the OMAX.

All labor is the responsibility and expense of the Buyer. The liability of OMAX under this warranty is limited, at OMAX's exclusive option, solely to repair or replacement with equivalent items or refund of the purchase price upon return of the subject nonconforming Product. Replacement parts may be either new or reconditioned, at OMAX's option. Freight charges, brokerage charges, duties and taxes for return of parts and for parts or components provided by OMAX under this warranty, will be the responsibility of the Buyer. This warranty is conditioned upon (a) OMAX being notified in writing by Buyer within 30 days after discovery of defects; (b) the return of presumed defective components to OMAX within 30 days of notification, transportation charges, brokerage charges, duties and taxes prepaid by Buyer, and (c) OMAX's examination of such components disclosing to its satisfaction that such defects were not caused by negligence, misuse, improper maintenance, abuse, improper installation, accident, or unauthorized repair or alteration. Accessories or equipment manufactured by others but furnished by OMAX shall carry the warranty conveyed by the manufacturer to OMAX, which may be passed on to the Buyer. The original warranty period of any component that has been repaired or replaced by OMAX shall not thereby be extended.

OMAX will indemnify Buyer for any damages and costs finally awarded against Buyer on the grounds that a Product, (but not any items manufactured by third parties), infringe any valid United States patents or copyrights of any third party, provided that Buyer notifies OMAX in writing of any such claim within ten days after learning thereof and that Buyer gives OMAX full control over the defense and settlement of the claim, and fully cooperates with OMAX with respect thereto. If any such claim is brought or appears to OMAX likely to be brought, OMAX may at its option replace or modify the Products to make them non-infringing, or refund to Buyer, upon return of the Products at issue, the price paid therefor, less twenty percent for each year which has passed since the date of delivery hereunder. Buyer shall discontinue all use of any portion of the Products that has been replaced or modified or for which a refund has been tendered. OMAX's obligations hereunder shall not apply to any claim based on: i) OMAX having followed Buyer's specification or requests; ii) the use of Products to practice a process not recommended by OMAX, or iii) in conjunction with items or modifications not supplied by OMAX, and the Buyer shall similarly indemnify OMAX with respect to such claims**. THE FOREGOING STATES OMAX'S SOLE RESPONSIBILITY AND BUYER'S SOLE REMEDY FOR ANY INFRINGEMENTS OF PROPRIETARY RIGHTS.**

OMAX MAKES NO OTHER WARRANTY, EXPRESS OR IMPLIED, OF ANY KIND, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR USE OR THOSE ARISING FROM COURSE OF PERFORMANCE, COURSE OF DEALING OR USAGE OF TRADE. IN NO EVENT SHALL OMAX BE LIABLE TO BUYER OR TO ANY THIRD PARTY FOR INDIRECT, SPECIAL, INCIDENTAL, CONSEQUENTIAL OR PUNITIVE DAMAGES INCLUDING WITHOUT LIMITATION, LOSS OF USE, DELAYS OR LOST PROFITS OR SAVINGS RELATED TO THE PRODUCTS, THE USE OR LOSS OF USE THEREOF, THE PERFORMANCE OR BREACH OF THIS AGREEMENT BY OMAX, OR OTHERWISE, EVEN IF OMAX IS AWARE OF THE POSSIBILITY OF SUCH DAMAGES, AND EVEN IF THE EXCLUSIVE REMEDIES STATED HEREIN FAIL OF THEIR ESSENTIAL PURPOSE. BUYER'S RIGHTS AS STATED HEREIN ARE ITS EXCLUSIVE REMEDIES.

Buyer agrees that regardless of the form or action, whether in contract or tort, including negligence, OMAX's liability for damages hereunder or otherwise with respect to the Products or their use shall not exceed the total sum paid by Buyer to OMAX for the Products causing such damages. *(R/02/21/06)*

Chapter 6

OMAX Glossary

Abrasive

Abrasive is material entrained within the high pressure water stream to speed the machining process. Machining a hard material requires the use of abrasive. Some soft materials such as foam can be cut without abrasive either by using a water only nozzle, or by plugging the abrasive line with a piece of tape to prevent air from entering.

Abrasive Flow Rate

The rate at which abrasives are blown through the mixing tube. The abrasive flow rate should be measured for your OMAX machine every couple of weeks, or whenever you change abrasive size or brand. The flow rate is usually measured in Lbs/Min or Kg/Min. Generally speaking, the higher the abrasive flow rate, the faster the cut. Increasing the flow rate too high, however, can result in frequent plugging of the mixing tube.

Abrasivejet

A machining tool that combines high-pressure water with an abrasive such as garnet. The water and garnet are mixed and emerge through a narrow orifice at high-speed. As this “jet” is moved across material, it quickly erodes the material, cutting through the material.

Alpha Software

Alpha Software refers to software that it is not yet ready to be called Beta. Typically it is barely usable, contains a lot of bugs, and much of it is incomplete. It is usually released internally, or to a very select group of experienced customers, primarily for the purpose of testing.

Attenuator

An attenuator is a pressure vessel that maintains output pressure for a constant water flow, compensating for uneven pressure generated by some pumps. (Also called an accumulator.)

AWJ (abrasive waterjet)

A waterjet with the addition of abrasive. Used to cut or machine nearly any hard material such as metal, stone, glass, etc.

Bankers Rounding

Banker’s rounding is a method for rounding a number where the fractional part is exactly 0.5. Rather than always round up, or always round down, banker’s rounding uses the following rule:
If the integer portion of the number is even, then it is rounded down.
If the integer portion of the number is odd, then it is rounded up.

Round(-1.5)= -2
Round(-0.5)= 0
Round(0.5) = 0
Round(1.5) = 2
Round(2.5) = 2
Round(3.5) = 4

Bar

The bar is approximately the pressure of the atmosphere at sea level. Although it is accepted for use with the International System of Units (SI), the preferred unit for pressure is the pascal. Many countries that use the metric system use bar rather than pascal to measure pressure.

You can choose either bar or megapascal when you choose a metric-based unit of measurement in OMAX software.
1 bar = 14.5 PSI
1 bar = 100,000 pascals

Barrel Error

The Barrel Error is the kerf width at mid-thickness minus the average of top and bottom kerf width. A "+" barrel error indicates a drum-shaped kerf.

Barrel Error Per Side

The Barrel Error Per Side is the barrel error divided by 2.

Barrel Taper

Barrel taper is a type of taper where the middle is wider than the top or bottom. Barrel taper tends to occur in thick materials.

Beta Software

Beta Software is software that is still in its testing phase, and is not officially released yet. Before OMAX officially releases the software to all OMAX customers, OMAX will release software as "Beta" to a small group of customers for the purpose of final testing.
Beta software can still contain bugs, although the likelihood that the bugs are major is very small. The purpose of the testing is to reveal problems that occur under special conditions or in particular uses.

Bit stream

A stream of "bits" used to control machine movements on OMAX controllers. Effectively allowing the machine to set independent feed rates at over 2000 points per inch.

Bitmap graphics

Bitmap graphics are composed of individual dots. These are sometimes known as "raster graphics." Most computer artwork is in this format, and it is good for things like photographs and icons. When a bitmap image is magnified, it appears to get chunky, or jagged. The opposite of bitmap graphics are "vector graphics".

Bow

Bow determines the curvature of an entity. Bow can range between -1 and +1. Entities in Layout and Make are defined by their X and Y position, Bow, and Quality.
Bow specifies the curvature of the entity:

- Bow of zero means that it is a line.
- Bow of one means that it is a semicircle.
- Bow of 0.5 means that it is somewhere between a line and a semicircle.
- A bow of infinity means that it is a complete circle.

Because the computer cannot deal with infinity, the bow is limited to between -1 and 1. Therefore all circles are actually two arcs with a bow of 1 (or -1). The sign of the bow indicates the direction of the line (positive values are clockwise and negative values are counter clockwise).

Bridge/bridging

When cutting multiple parts that might tip and fall into the tank, it is sometimes useful to "bridge" the parts with a thin piece of metal that connects them together. Then, once the cutting is finished, the parts are removed from the machine, and the bridges are cut off. (This is similar to the way parts are held together in plastic for plastic hobby models).

BTSfile

A BTS (BiTStream) file is a special file type used internally by OMAX for advanced testing, control, and technical support purposes. The BTS file contains the compiled tool path calculated by Make during the compiling process that occurs after entering in the material information. It contains all the commands for the motors and other outputs from the controller to the machine at the level of thousands of commands per inch.

Bump
Moving the nozzle a small amount

Burr
Burr refers to a rough edge on material that has been machined. On the OMAX, there is only a very slight burr with most materials, which only shows up under extreme magnification. In very thin materials, more burr may be evident.

CAD/CAM
CAD = **C**omputer **A**ided **D**esign
A computer program that provides drawing tools for designing objects. Layout is a CAD program.
CAM = Computer Aided Manufacturing
A computer program that provides detailed information for making a part. A CAM program typically takes the output of a CAD program and translates it for a specific machine tool. Layout is also a CAM program (when it creates an ORD file that specifies the tool path for making a part).

Catch tank
A tank of water underneath the cutting head to allow the cutting beam to disperse, and prevent holes in your floor. Often catch tanks are filled with other material to slow the jet down, such as ceramic balls. The catch tank is also used to accumulate spent abrasive, and part drop outs.

CNC
Acronym for "Computer Numerical Control". In basic terms a CNC machine has a computer that is controlling the motion.

Common line cutting
Common line cutting is used when making multiple parts, so that when one part is cut, a portion of the second part is cut as well. The advantage is that much time is saved, because one cut can make two parts. The disadvantage is that it is sometimes difficult to program (depending on the geometry), and generally produces lower precision cuts than cutting the parts separately.

Corner Looping
Corner loops are additional cutting entities placed at sharp outside corners to allow the jet to continue cutting without having to slow down for the corner. Corner loops are traditionally used to speed up corner cutting on thick parts, but they waste time cutting the scrap material, and require a lot of room.

Corner Passing
Corner Passing refers to the technique automatically used by OMAX software of cutting past one side of an outside corner and then moving back to continue machining. Corner passing lets thick parts be cut faster and to a higher tolerance. Corner passing eliminates the need to slow down the jet to let the jet lag catch up, resulting in both an increase in speed, and an increase in precision. The increase in precision is a result of not having to slow down so much, which would otherwise cause the kerf width to grow slightly. Corner passing is much faster and requires less space than corner looping which is the older "alternate" method.

Crankshaft pump
Crankshaft pumps generate pressure using plungers that are driven by a crankshaft. A triplex pump is a type of crankshaft pump. Crankshaft pumps are also known as "direct drive" pumps.

Cutting index
A number used to represent how easy it is for the abrasivejet or waterjet to machine a given material. Also referred to as "Machinability."

Cutting model
A model of how the abrasivejet or waterjet will behave when cutting. Cutting models are used to predict how to slow down and compensate for the effects of cutting with a "floppy tool".

Cutting quality

A term used on OMAX, and sometimes other controllers to indicate how the machine should cut a given surface of the part. A quality of "1" being a very rough, high speed cut, and a quality of "5" being a very smooth, highly precise operation. "Quality" was coined by OMAX Corporation, and is becoming the standard for describing surface finish for abrasivejet machined parts. **Note, however, that different manufacturers of equipment use "Quality" to mean different things.** For example what is "Quality of 1" by one manufacturers definition is not the same as another's "Quality of 1".

Degrees

When entering values for degrees:

- Positive values move counterclockwise (that is, a line at 90º points straight up)
- Negative values move clockwise (a line at -90º points straight down)
- To enter values greater than 360, subtract 360 from the value until the value is less than 360. (Entering an angle of 450º or 810º is the same as entering 90º). In other words, the number is divided by 360 and the remainder is used as the angle.

Device driver

A "device driver" is software that tells your computer (and specifically Windows) how to communicate with a device. If a scanner is connected to your computer, for example, there is a device driver than lets the computer tell the scanner when to scan.

DOS

DOS is an older operating system using on IBM-compatible personal computers. DOS was introduced in the early 80s and was the main operating system until the early 1990s when Windows 3.0 began to gain popularity.

Dot

A point at either end of an entity. When dots are turned on with the Config command in Layout, they appear white on the screen.

Draft angle

The angle caused by Taper.

DWG File

A DWG file is a drawing file from AutoCAD. This is an unpublished format that is proprietary to AutoDesk, Inc. Layout can read most DWG files by using the Import from other CAD function on the File menu. However, because the file format is not publicly available, it is difficult to get good conversion results when using this file type.

DXF File

DXF (Drawing eXchange Format) is a standard file format used to exchange drawings between CAD (Computer Aided Drawing) programs. Most CAD and drawing programs support DXF files, including AutoCAD, CorelDRAW, Mastercam and SmartCam.

Dynamic pierce

During a "dynamic pierce," the nozzle and abrasive are turned on, and the nozzle begins to slowly move. As the nozzle moves, the material is pierced. Contrast this with a wiggle pierce.

EDM

Acronym for "Electrical Discharge Machining". A slow, but extremely precise method of machining using electrical sparks to remove material in very small increments.

Endpoint

The point at either end of an entity. Each entity (line or arc) has two endpoints. When dots are turned on with the Config command in Layout endpoints appear white on the screen.

Entity

Drawings made in Layout are made up of "entities."

An entity has four parts:

- A starting point
- An ending point
- A line or arc drawn between these two points
- A cutting Quality

An entity is the smallest unit used to make up drawings. There are only two basic types of entities in OMAX--lines and arcs.

E-Stop

Emergency Stop. Typically a button that you press to stop the machine in the event of an emergency.

Etch

Etch is a type of Quality. Both abrasive and water are used with Etch, but the abrasive jet nozzle moves at a specified constant speed across the material, marking the surface without piercing the material. Etch is intended to be used to etch part numbers or designs on hard materials, such as steel.

Feed rate

The speed at which the cutting head moves.

Firmware

Firmware refers to software that is stored on a memory chip in a device, as opposed to software on the computer, which is read into memory and then run. For example, your VCR has firmware that lets you set it up to record programs. Note that firmware is not lost when the device is unplugged. Firmware can be permanent and unchangeable (such as the software that runs a digital watch) or it can be updated (such as a plug-in memory chip used to store pictures in a digital camera).

Fixturing

Fixturing is the process of firmly securing a piece of material so that it does not move during machining. Fixturing is a specialized term used in the machining tool industry (it is also used in the robotics industry). Proper fixturing is important for maximum accuracy with the OMAX. The force of the abrasive jet stream can lift heavy pieces of metal if they are not adequately fixtured.

Focusing tube

Typically referred to as the "Mixing Tube." This is a tube, made from extremely hard material, that focuses the abrasive and water into a coherent beam for cutting.

Frosting

Frosting is a minor surface abrasion from stray abrasivejet particles and is the effect of stray particles abrading the surface of the material being cut. It typically occurs right at the edge the cut, or in a circular pattern around a pierce.

Garnet

Garnet is the abrasive used by the OMAX system's abrasive jet. Garnet is a hard, inert material that is a reddish color. When found in larger crystals, it is a semi-precious stone. The OMAX system uses a ground garnet as the abrasive. Garnet is ideal for this purpose because of its hardness, and because it does not react with other materials (garnet is a silicate mineral--similar to sand). Because garnet is inert, it has little environmental impact.

G-Code

Although not particularly well suited for precision abrasivejet machining, G-Code is the most popular programming language used for programming CNC machinery.

Gradians

A unit of measure for a circle. There are 400 gradians in a complete circle, or 200 in a half-circle. Gradians are useful in some types of calculations.

Grid

The drawing grid in Layout is the same size as the standard OMAX JetMachining Center machining table. The grid is shown as a series of white squares.

Hard Limit

A hard limit is a stop on the machine that prevents the machine from moving further in a given direction. Typically these are used to prevent the machine from moving beyond its physical limits

Hard water

Hard water is water with a large amount of dissolved minerals, typically calcium and magnesium. Because water is an excellent solvent, it dissolves small amounts of minerals as it percolates through rocks and soil. As the mineral content increases, so does the "hardness" of the water. Hard water will tend to leave behind mineral deposits, which require frequent cleaning or replacement of pipes.

Hazing

Same as “Frosting”. An effect of stray abrasive particles "frosting" the material you are cutting. It typically occurs right at the edge of where you have cut, or in a circular pattern around where you pierced the material.

Heads-up Traverse

A Heads-up Traverse is very similar to a regular Traverse Line. The only difference is that before moving, the machining head is raised. By raising the machining head, it can be moved across fixtures without damaging the fixtures or the machining head. Heads-up Traverses are also useful when machining many small parts, which may tip up and catch the machining head.

Home

A spot on the machine that is defined either in software or hardware as a reference point.

IGES file

A CAD file format for exchanging CAD Drawing data between different CAD software systems.

Intelli-MAX®

Intelli-MAX is collection of key software technologies in the OMAX controller that allow for parts that are simultaneously much greater precision and much faster than all other abrasivejet control methods.

This means that you can:

- Program parts faster, making it practical to do short run, just-in-time, or single piece production.
- Machine parts faster, allowing for higher profits and shorter cycle time.
- Machine parts to higher precision--extending the capabilities beyond “traditional waterjet” markets and reducing the need for secondary operations.

Intensifier pump

An older type of high pressure pump that uses hydraulics to make very high pressures. Contrast this with a crankshaft pump.

Jet lag

As the machining head moves across the material that it is cutting, the spot where the jet exits the material will lag behind the spot where it entered the material. This lag is also called “jet lag.” Lag is why it is important to slow the machining head down when entering a corner. Slowing allows the tail to catch up, resulting in a square corner.

Jewel

The orifice from which water exits to form the cutting stream. Typically, jewels are made from sapphire, ruby, or diamond (thus, the name “jewel”).

Kerf

Kerf is the width of the cut made by the abrasivejet. A typical kerf width is 0.020" to 0.060", depending on the nozzle and the amount of wear on the mixing tube. The kerf width must be measured to determine the tool offset.

Kick Back

As the machine accelerates out of a corner that it has just cut, the jet will "kick back". This can cause inside corners to be gouged. Modern controllers help reduce the effects of this by properly adjusting the speeds and/or tilting the cutting head.

Kilopascal (kPa)

The pascal is the preferred unit of measurement for pressure by the SI. One pascal is defined as one Newton per meter squared. You can choose either bar or megapascal when you choose a metric-based unit of measurement in OMAX software. (Megapascals are more convenient because one pascal is a very small amount of pressure.)
1,000 pascals = 1 kilopascal (kPa)
1,000,000 pascals = 1 megapascal (MPa)
1 megapascal = 145 PSI
1 megapascal = 10 bar

KSI

This is commonly used in the United States and is the unit used by OMAX software when you select any of the English units of measurements.
KSI = 1,000 PSI
1 PSI = 0.069 bar
1 PSI = 6900 pascals

Lag

As the cutting head moves across the material that it is cutting, the spot where the jet exits the material will lag behind the spot where it entered the material. This lag is "jet lag".

Layout

Layout is the OMAX CAD program. Use Layout to build a drawing that can be machined using the OMAX JetMachining Center.

Lead IO

Lead IO Quality is used for lead-ins and lead-outs on a part. If the Lead I/O command is used, the lead-in/outs will be automatically assigned a Quality of Lead IO. All leads should use a Quality of Lead IO. The Lead IO Quality distinguishes the lead in/out from the geometry of the part. This is used by functions such as the nesting software and dynamic pierce.

Lead-in

A lead-in is a small section added to a drawing where the abrasive jet begins piercing the material before it begins making the part. Lead-ins can be easily added using the Lead I/O command.

Lead-out

A lead-out is a small section added to the drawing where the abrasive jet continues to pierce the material after the part is finished. The lead-out helps prevent any irregularities that resulting when the abrasive jet is turned off. Lead-outs can be easily added using the Lead I/O command.

Machinability Index

A property of a material that corresponds directly with the speed at which the abrasive jet can cut through that material. The more difficult it is to cut through a material (that is, the harder the material), the lower the Machinability index.

Megapascal

The pascal is the preferred unit of measurement for pressure by the SI. One pascal is defined as one Newton per meter squared.You can choose either bar or megapascal when you choose a metric-based unit of measurement in OMAX software. (Megapascals are more convenient because one pascal is a very small amount of pressure.)
1,000 pascals = 1 kilopascal (kPa)
1,000,000 pascals = 1 megapascal (MPa)
1 megapascal = 145 PSI
1 megapascal = 10 bar

Mesh

The coarseness of abrasive used. For example, 80 mesh abrasive is typical of most abrasive jet applications, but 120 mesh, which is a finer abrasive, might be used for special applications. Larger abrasives (smaller mesh numbers) cut faster, but produce rougher surfaces. The higher the mesh number, the finer the abrasive. An 80 mesh abrasive will be about 177 microns in size, while 120 mesh will be about 125 microns.

MiniJet™ nozzle

The MiniJet nozzle is a replacement nozzle designed to produce small parts, or parts with intricate details. The MiniJet nozzle fits on any standard OMAX machine.

Minimum Taper

The Minimum Taper Quality will adjust the speed of the machining head so that it creates the minimum amount of taper (for metals) in the material you are using. In most cases, Minimum Taper will slow down the cutting speed significantly--often to even slower than a Quality of 5. However, in some cases, where "reverse taper" would otherwise occur, the cutting speed will be faster.

Mixing Tube

The mixing tube is part of the abrasive nozzle assembly. It is here that the abrasive, water, and air are mixed. The mixing tube is made from a hard, brittle material, and is similar to glass. If the mixing tube is dropped or strikes something hard, it can shatter. Although the mixing tube is made from an extremely hard material, with time the flow of high-pressure water and abrasive will wear away the mixing tube. This causes a gradual widening of the mixing tube, which results in a wider, less accurate stream of abrasive and water. The mixing tube should be replaced when tolerances drop below acceptable levels.

Muff

A muff is a protector that muffles the noise of the nozzle as well as lessens the effect of splash back. When practical, a muff should always be installed on the abrasivejet nozzle.

Nesting software

Nesting software arranges parts to get the maximum number of parts from a piece of material. Although nesting software cannot do as well as a human can, it is considerably faster. It is also complicated and tends to do better with parts that have simple shapes, rather than complex parts.

Nozzle

Usually, when someone says "nozzle," they are either referring to the complete nozzle assembly (mixing tube + Jewel + nozzle body and perhaps some plumbing.) Other times, "nozzle" is used as a synonym for Mixing tube.

Off-line Programming

Off-line Programming is the process of drawing parts and making tool paths on a computer that is not connected to an OMAX. This is the preferred method for programming an OMAX because it does not tie up the machine with tasks that you can do on a much less expensive computer.

Offset

The amount by which the abrasive jet nozzle is moved to one side of the tool path. An offset is needed because the cutting jet is not infinitely thin, but has a finite width. By offsetting the nozzle to one side, precision can be maintained. The offset is one-half the kerf.

OIR

The OMAX Interactive Reference is referred to as the OIR. The OIR is this series of interrelated files that provides a collection of information about OMAX software. Our goal is to have all the information in one location so that you can quickly and easily find out what you want to know.

OMX file

The OMX file format is an updated version of the ORD file format. The OMX format supports movement in the Z-axis (up and down), which can be programmed with the 3-D Path Editor for OMAX machines with a programmable Z-axis.

Operating System

An Operating System (OS) is the software that controls the most basic functions of the computer. A computer must have an operating system to function.

When a computer is first turned on, the first thing it does is load the operating system. After the operating system is loaded, the computer is ready to be used. Windows XP is an example of a popular operating system.

ORD Files

An ORD (OMAX Routed Data) file is created from your Layout drawing when you use the Generate Tool Path command. The ORD file contains your tool path (the order in which the entities in your drawing will be made). The Make program uses only ORD files and OMX files—it does not use the DXF file created by Layout. For this reason, several ORD files may exist for the same DXF file (you might use this to make the same part in several different Qualities, for example).

Orifice

The small opening in the jewel that allows high-pressure water to enter the mixing tube.

Orthogonal

At right angles.

Pan

Moving the display without making it larger or smaller. When "panning right," for example, the display moves to the right without changing the zoom.

Parallel

Lines that are parallel are always the same distance apart and never meet. Similarly, planes that are parallel are always the same distance apart and never meet. A rectangle is composed of two pairs of parallel lines.

Perpendicular

A line that is at a 90° angle to another line or circle.

Pierce

A "pierce" is the process of drilling through the material to be machined. Abrasivejets make their own start holes by "piercing" the material.

Pixel

The smallest possible dot that can be turned on and off on the screen. Pixel is short for "Picture Element." The screen resolution is typically given in pixels. For example, a screen resolution of 640 by 480 means that there are 640 pixels across and 480 pixels down. Pixel is usually used to refer to resolution on computer screens (printer resolution is usually given in "dots per inch" which can also be expressed as "pixels per inch").

Post Processor

A Post Processor is a special bit of code that a CAD / CAM system executes in order to generate code that is specific to a particular brand of machine tool. For example, Mastercam provides an OMAX post processor so that OMAX Compatible ORD files can be generated directly from within Mastercam without using Layout.

Pressure units

Pressure is a measure of force against area.

PSI

Pounds per square inch

This is commonly used in the United States and is the unit used by OMAX software when you select any of the English units of measurements.

KSI = 1,000 PSI

1 PSI = 0.069 bar

1 PSI = 6900 pascals

PWJ (pure water jet)
A pressurized jet of water exiting a small orifice at extreme velocity. Used to cut soft materials such as foam, rubber, cloth, paper, etc. See "Waterjet."

Quality
Same as "Cutting Quality".

Quality Numbers
Qualities that pierce the material and move at various speeds. Qualities 1 through 5 use abrasive and water to pierce the material. A Quality of 1 will always pierce all the way through the material. Because the abrasive jet head is moving quickly, however, the surface finish obtained with a Quality of 1 is rougher than that obtained with a Quality of 5 (which is a smooth finish).

Ra
Ra (Average Roughness) is a measurement of surface roughness. Ra is calculated by taking the average of the deviations from the center line of the surface. Ra is also known as Arithmetic Average (AA), Center Line Average (CLA), Arithmetical Mean Deviation of the Profile. Ra is one of the more effective measures of surface roughness and has been commonly adopted in engineering practice, as it is as good descriptor of variations in height of the surface. Ra is frequently used in the automotive industry to specify a surface finish for metal.

Radians
The angle at the center of a circle that intercepts an arc equal in length to the radius. From these definitions, it follows that 1 revolution = 4 right angles = 360º = 2p radians.

RAM
RAM (Random Access Memory) is the main type of "memory" that a computer uses. It consists of high-speed chips that provide storage for programs that the computer is running. When the computer is turned off, all the contents of RAM disappears, so it is used primarily as "working" memory by the computer.

Raster graphics
Raster graphics are composed of individual dots. These are sometimes known as "bitmap graphics." Most computer artwork is in this format, and it is good for things like photographs and icons. When a raster image is magnified, it appears to get chunky, or jagged.

Reticle
A grid or pattern that appears in an eyepiece to aid in positioning. The Precision Optical Locator uses a reticle to precisely position the machining head.

Reverse Post Processor
A reverse post processor is a feature in some CAD / CAM (or other) software that translates a tool path back into editable geometry. In other words, it is the opposite of creating the tool path (which is often created with a post processor).
For example, when loading an ORD file into Layout, you are "reverse posting" it. Or if you have a "G-Code" file, and you want to edit its geometry in your CAD program, you would use a reverse post processor to translate it back into the CAD.

Reverse Taper
An upside-down V-shaped kerf (or a kerf with a negative taper error). This taper is caused because the abrasive-jet stream tends to spread out as it travels. Typically, reverse taper can be reduced or eliminated by simply cutting a little faster (assigning a lower Quality number).

Scanner
A scanner is a device for making a picture of a piece of paper and transferring it to a computer. Most scanners work similar to a photocopying machine—a bar with a bright light and sensitive photoreceptors is moved across the imaging area. The resulting image is sent to a computer, where it is stored as a bitmap image.

Scanning software

Scanning software controls the operation of a scanner. If the scanner is "TWAIN compliant" then many Windows programs (such as Word for Windows) can control the scanner. Otherwise, the scanner is controlled by special software from the manufacturer.

Scientific notation

Scientific notation is used to express large numbers in a more understandable form. Scientific notation uses powers of ten (that is, 10 squared = 100, 10 cubed = 1000, and so forth).
There are various methods to express scientific notation. Each of the following represents the same number (Avogadro's Number, the number of molecules in a mole).
Without scientific notation: 602,200,000,000,000,000,000,000
With scientific notation:
6.022 x E23
6.022 * 10^23
6.022 x 10^{23}
The base number (the first number) is always expressed as a value between 1 and 10. The exponent part shows what power of ten the base number is multiplied by. In the above example, "6.022" is multiplied by ten raised to the 23rd power (100,000,000,000,000,000,000,000).

Screen resolution

The total number of pixels that are displayed on the computer screen at once. Typical screen resolutions are (given as width first, then height):
640 by 480 (also called VGA)
800 by 600 (sometimes called Super-VGA)
1024 by 768
1280 by 960

Scribe

A type of quality designed to inscribe soft materials.

Separation Speed

The Separation Speed is the cutting speed at which the abrasivejet is able to separate the material--that is, the speed at which the abrasivejet just barely cuts all the way through.

Servomotor

A Servomotor ("servo") is a motor that can be directed to move to a particular position using an electrical signal. For example, if a servomotor is connected to an armature, the position of the arm can be controlled by the signal sent to the servomotor. Servomotors allow for the precise positioning of components.

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Silicosis

Silicosis is a disabling and sometimes fatal lung disease which can afflict workers who are overexposed to fine airborne particles of crystalline silica. Since crystalline silica is the second most common mineral in the earth's crust a basic component of sand, quartz and granite rock more than 1 million workers in many different types of jobs are at-risk of developing silicosis, including highway construction workers, miners, sand-blasters, and foundry workers. When workers breathe in dust containing silica, scar tissue can form in their lungs and reduce their ability to extract oxygen from the air. There is no cure for silicosis -- prevention is the only answer.

Slat

Stainless steel plates which support the material being machined in the OMAX tank.

Slug

Slugs are any scrap parts that you remove. One advantage of abrasivejet machining is that the slugs can be valuable for recycling, or for being made into another part on another machine. This is especially true for expen-

sive materials such as titanium. However, slugs can also pose a collision threat when machining, so care must be taken when planning your tool paths to avoid them.

Snap
When snap is turned on (with the Enable Snap Grid command), any time you click in your drawing, you will snap to the closest point on the grid.

Snap Grid
The Snap Grid is used to make drawing parts easier. When this is turned on, lines and arcs will snap to the closest point on the snap grid.

Soft Limit
Soft limits define the allowed range of machine motion. Make will not move the nozzle outside of the rectangle defined by the soft limits.

Splash back
The mess that is made when you don't cut all the way through, or the jet ricochets off of a slat. Very common during piercing, or when nozzles fail. This is the reason you often see sponges or other guards wrapped around nozzles.

Spline curve
A Spline Curve is a smooth curve that passes through two or more points and is generated with a mathematical formula. The two most common types of spline curves are Bezier curves and b-spline curves (sometimes called NURBS for Non-Uniform Rational B-Spline). Originally, splines were drafted by using flexible strips that were guided by points on a piece of paper. The points are called “control points” and define the shape of the curve. A spline may be “interpolating,” which means that it passes through each control point, or “approximating,” where the curve is not required to pass through each control point.

Square
A square is a used in fixturing where a metal plate is bolted to the table, and a L shape is cut from it, leaving a “square,” in which the corner point is exactly known.

Stand-off
The stand-off is the distance between the end of the abrasive nozzle and the material. A small amount of stand-off is necessary to allow the abrasive jet to work properly. Too much stand-off, however, can increase kerf and result in poor quality machining. The recommended stand-off is usually about 0.04".

Stationary Pierce
A method of piercing the material where the jet turns on, then stays stationary until the material is pierced. This is typically a very slow method of piercing, but is fine for thin materials that pierce quickly no matter what. It also allows you to pierce the material in the minimal amount of space, and is the only option for piercing very small holes. The hole diameter drilled using a stationary pierce will be significantly larger than the diameter of the mixing tube, especially in thicker materials. As drilling proceeds, the water and abrasive need to escape out backwards to the sides of the jet; thereby increasing the diameter of the hole.

Step
The smallest possible amount of nozzle movement.

Stepper Motor
A Stepper Motor is a motor that can be precisely controlled by an external motor controller. It is used in the same type of applications that require servomotors. Stepper motors can spin quite rapidly, and can stop precisely, making them ideal for applications that require precise positioning.

Striation marks
The marks left by the jet as it wiggles around. The faster you cut, the more striation marks form.

Surface Roughness

Surface roughness is an indication of the finest (shortest wavelength) irregularities of a surface. Roughness generally results from a particular production process or material condition. For abrasive waterjet cutting, the roughness profile created by individual abrasive particles is compounded with the waviness generated by the dynamics of the jet (so called "striation marks").

Tab/Tabbing

"Tabs" are small pieces of material that hold parts together preventing them from sliding into the collection tank and from being moved by the abrasive jet. Tabs are mostly used with thin materials, both because a tab in thick material can be difficult to break, and because thin materials tend to have more problems with parts floating in the tank.

Table

The area of the machine that contains the slats.

Tail

See "Jet Lag".

Tangent

There are two distinct definitions for "tangent," one from geometry, and one from trigonometry.

Geometry: A line that touches a circle at one (and only one) point. This means the line cannot pass into the interior of the circle (or it would touch the circle twice). This definition of "tangent" is used by the Tangent snap in Layout.

Trigonometry: The tangent of an angle is the ratio of the leg opposite divided by the leg adjacent (for a right triangle). This definition of "tangent" is used for math functions in Layout.

Taper

Taper is the difference in the width of the cut from top to bottom. A certain amount of taper is inherent in all abrasive jets.

Taper angel per side

The Taper Angle Per Side is the taper angle divided by two.

Taper Angle

The Taper Angle is the included angle of the kerf. A positive taper angle indicates a V-shaped kerf.

Taper Error

Taper Error is the top kerf width minus bottom kerf width. A positive taper error indicates a V-shaped kerf.

Taper Error Per Side

The Taper Error Per Side is the taper error divided by two.

Tilt-A-Jet®

Tilt-A-Jet (TAJ) represents the latest OMAX innovation in the continuing search for more accurate abrasivejet machining. Tilt-A-Jet lets the OMAX JetMachining Center achieve virtually zero taper with most materials. As the machining nozzle moves along the tool path, Make calculates the amount of taper, and then tilts the machining head to exactly offset the taper from the abrasivejet.

Tolerance

Tolerance is how close the finished part measures to the original drawing.

Tool Offset

The amount the tool is shifted away from the part to be cut. Tool Offset = 1/2 of the kerf width of the cutting nozzle. This compensates for the stream of abrasive water not being infinitely thin.

Tool Path

The path that the tool will follow when making a part. The tool path includes traverse information as well as cutting information.

Tool Path Font

A font designed for use with the OMAX. A number of tool path fonts are provided with Layout, including ones optimized for Etch and Scribe machining.

Traverse

Normal machine movement without cutting, for example to move the cutting head into position to cut.

Traverse Line

A traverse line (or "rapid traverse" line) indicates where the OMAX abrasive jet head moves with both the water and abrasive turned off. Traverse lines are used to position the abrasive jet head before beginning the next section of the part.

Triplex pump

A triplex pump uses 3 plungers driven by a crankshaft to make pressure. A triplex pump is a type of crankshaft pump.

True Type Font

True Type fonts work on many different printers and types of computers. These fonts don't require a particular type of printer (such as PostScript or PCL fonts do). Most fonts in Windows are True Type fonts, although non-True Type fonts can be installed.

UHP (ultra high pressure)

A term to describe the extreme pressures that are used in waterjet and abrasivejet machining. Typically pressures range from 20,000 PSI to 100,000 PSI. Most pumps are limited to pressures below 60,000 KSI due to metal fatigue limitations in all areas of high pressure plumbing.

USB

USB (Universal Serial Bus) is a relatively new hardware standard that allows the easy connection (and disconnection) of devices from a computer. USB allows up to 128 devices to be connected, and USB "hubs" can be conveniently placed on your desk. In many cases, when connecting a USB device, Windows automatically recognizes the device and activates the appropriate drivers. USB devices are also "hot swappable," meaning that the computer does not need to be turned off before connecting or disconnecting them.

USB Hub

A USB Hub turns one USB connection into several connections. The number of connections provided by the hub typically ranges from four to eight. Since most computers provide only two or four USB connections, hubs are used to support multiple USB devices. You can connect up to 128 USB devices to one computer. In general, a "hub" provides a number of connections. A network hub, for example, provides additional connections to the network.

Vector graphics

Graphics that are composed of lines, or "vectors." Vector graphics can be shrunk with no loss in resolution, and can be magnified with no "blockiness" of the image. Vector drawings offer advantages for CAD drawings. For example, a vector drawing can be magnified without losing resolution. Also, vector file sizes tend to be smaller. The disadvantage of vector drawings is that they are terrible for representing photographs, because it takes many lines and arcs to reproduce a photograph (resulting in very large file sizes).

Virtual Memory

When a computer gets low on RAM memory (because many programs are running, or a large part has been loaded in Layout or Make), Windows will automatically begin using "virtual memory" by employing the hard drive as additional memory. Because hard drives used as memory are 1/1000th as fast as RAM, virtual memory slows down processing considerably, although it allows the programs to continue to operate. I

Wash-out

Wash-out occurs as a result of jet lag. If you imagine that the jet tail is lagging behind the top, then imagine this as it goes around a curve. The tail is pushed to the outside by centrifugal force, causing the bottom of the cut to be wider on the outside. Wash-out will be more noticeable in thicker materials because of the distance between the top and bottom of the jet.

Water Only

Water Only is a type of Quality. OMAX does not use any abrasive for entities with a Quality of Water Only. Water Only is used for machining soft material that can be pierced using only a high-pressure water jet (for example, sponge or foam). Unlike Scribe, with Water Only, the tool path is offset to allow for the width of the cut made by the waterjet. Scribe does not offset the tool path, but always goes down the center.

Water Only Nozzle

A Water Only nozzle is a replacement for the regular abrasive nozzle. A Water Only nozzle is specifically designed to run when using only water with no abrasive.

Waterjet

A WaterJet is similar to the abrasive jet used by OMAX, except no abrasive is added to the water.
A WaterJet forces high-pressure water through a small orifice to create a thin stream of water traveling at high speed. This stream of water is capable of slicing through soft materials, such as foam

Waterjet Brick

Waterjet Brick is a block of corrugated plastic which can be used in the place of slats to provide support for tiny parts. It is also useful in applications where it is undesirable for splash back from the slats to frost the material, such as when cutting glass.

Weep hole

A small hole drilled into a high pressure fittings which allows water to escape in a safe manner should a leak occur. Because the hole is large in diameter, any escaping water will be at a lower pressure than if it were to escape through a tiny crack. All high pressure fittings and components have these kinds of holes.

Wiggle Pierce

Wiggle Piercing is a way to pierce thick materials when other methods won't work. By default, Make uses a highly optimized dynamic pierce when it needs to pierce material and begin machining. The dynamic pierce used by Make is faster than wiggle piercing and traditional types of dynamic pierces.

X-axis

The X-axis is the horizontal axis. On the OMAX table, it is the longer axis. Positive X-axis values move to the right. Negative X-axis values move to the left.

Y-axis

The Y-axis is the vertical axis. Positive Y-axis values move upward (away from the front of the tank). Negative X-axis values move downward.

Zip file

A Zip file is a file that contains one or more "compressed" files. A special program, such as PKZip or WinZip is needed to extract the compressed files. Zipped files are particularly suitable for sending using e-mail, as they can significantly reduce transmission time

Zoom

Making the image larger ("zoom in") or smaller ("zoom out"). If the image is too large to fit in the screen, only a portion of the image is displayed. Originally used in photography and movie making.

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