WardJet® NOT JUST A WATERJET...

Emerald Series
Innovative low-cost waterjet

GX-4816
Large Scale 5-Axis Waterjet

R-3014

L-106

Z-2543

J-108

(330) 677-9100  www.wardjet.com
CUSTOHER FFEDBACK

Here is some customer feedback freely given about WARDJet. We are truly thankful for partnerships we have created over the years.

“I have been in manufacturing for a while and I can honestly say that your company is the best company I have ever worked with. WARDJet is truly a company that stands by their product and provides outstanding support after the sale. Thank you all again.”

C.M.
Armstrong World Industries
$2.6 billion in sales 2012

“I am glad to say we have been in business 5 years this month and are debt free. We have everything paid for; machines, cars, house and we are cutting for people that their machines have broken down. I tell them you should get a "WORK-HORSE" like yours. I’m so glad I have your machine, it is the top of the line.”

G.B.
South-East America
Reference available on request.

“Every aspect from shipping to installation to training and service promised has been more than met. It is amazing that we were literally cutting parts and in production the week of our installation. We love our WARDJet waterjet and look forward to getting another one as soon as possible. The WARDJet team met all our expectations!”

P.M.
CML Alloys UK

“For more feedback visit: wardjet.com/customer-feedback

“I want to thank you for taking the time to come here to our facility and make things right. I am looking forward to many years of using this machine and a great continued relationship with WARDJet. Thanks again for your professional attention to our issues.”

C.D.
K-Line Industries

“Being a part of the installation and learning all about the machine and how it is made has given me tremendous insight into its capabilities and ruggedness. I still can’t believe we were able to set up the machine and get trained to operate it in just one week. That fact is a testament to the quality and knowledge of your employees and the quality and design of your machines.”

D.Y.
Crest Foods Co., Inc.
Control your WARDJet from anywhere with an internet connection

Control jog, Z-height, feed rate and cutting speed all from your Android device. Set up and linking to your machine is as easy as taking a picture with your phone or tablet. Once installed, you can start and stop programs right from your Android device. WARDJet continues to add new features to the software, making sure you are getting the most out of your WARDJet! The Pendant software is available for free on the Play Store.
WARDJet is partners with The University Of Sheffield Advanced Manufacturing Research Centre with Boeing

WARDJet has been selected over every other manufacturer in the industry to provide top-of-the-line waterjet cutting equipment to the University of Sheffield Advanced Manufacturing Research Centre with Boeing. The Advanced Manufacturing Research Centre (AMRC) with Boeing is a £60million partnership that builds on the shared scientific excellence, expertise and technological innovation of the world’s leading aerospace company and the world-class research within the University of Sheffield’s faculty of engineering.

The AMRC’s vision is to become a world-class global research facility developing innovative and advanced technology solutions for advanced materials forming. The AMRC is a tangible demonstration of what is possible when academia, government and industry collaborate to develop cutting-edge technologies enabling world-class scientists and engineers to deliver real economic and environmental solutions benefiting everyone.

Richard Ward (President and Owner of WARDJet) has also been appointed to the board of directors for the AMRC, along with representatives from other partners including SANDVIK, Boeing, Rolls-Royce, ALCOA, RENISHAW, MORI SEIKI and HAAS.
INFINI WINDER 5-AXIS WATERJET CUTTING HEAD FEATURES

Software / Taper Compensation
Allows the programming of bevels on parts or to allow for taper compensation to virtually eliminate the taper commonly found on parts cut by a waterjet.

2D and 3D Capabilities
Post processors are available for both 2D and 3D CAM software.

Speed
Depending on the waterjet system, speeds can be up to 2,000 in/min.

Multiple 5-Axis Heads
Up to nine Infini Winder 5-axis cutting heads can be installed on one cross beam with a single X-Classic controller (which can be retrofitted to all previously released WARDJet systems and to most other waterjet systems).

Crash Sensor (optional)
This accessory is intended to stop the motion of your machine if there is anything in the path of the cutting head that has the potential to break a nozzle or cause other serious damage.

Height Sensor (optional)
This feature can dramatically reduce the potential for broken nozzles by automatically adjusting the height of the cutting head to maintain a fixed distance between the nozzle and the material regardless of any variances in the material.

Range of Travel
Capacity of 12” to 24” vertical travel on Z-axis.

Wide Cutting Angle
From 0° vertical to 90° horizontal.
WARDJet’s unique design for 5-axis cutting in all its forms allows for 500,000 encoder counts per revolution for the A and C motors respectively, ensuring the unit can conservatively achieve accuracies of ± 1 arc minute, backlash free motion, with a torque of 39Nm or 345 in-lbs, easily outstripping the competition.

WARDJet utilizes 2 harmonic drive actuators, commonly used in precision robotic applications, to ensure the Infini Winder is a strong, highly accurate, extremely reliable 5-axis mechanism that meets WARDJet’s stringent requirements. Where some other manufacturers tend to control their tilting axis via a mechanical linkage (with its inherent backlash and mechanical play), WARDJet opted to directly couple their mechanism to the harmonic drive output flange and the rock-solid crossed roller bearing. The unparalleled backlash characteristics of the harmonic drive mechanism eliminate the slop and play inherent to other designs.

Below is a comparison chart of the WARDJet Infini Winder 5-axis cutting head, versus claims and statements of our competition. All competitor’s details and statements quoted are on the internet or available to the general public.

<table>
<thead>
<tr>
<th>Competitor</th>
<th>5-Axis Claims</th>
<th>WARDJet’s 5-Axis Facts</th>
</tr>
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<tr>
<td>Competitor A</td>
<td>&quot;...provides for up to 60 degrees of motion giving you the ultimate in accuracy, speed, and flexibility.”</td>
<td>Cut up to 90 degrees with the Infini Winder to give you full 3-dimensional capabilities. Up to 50% more cutting envelope than the competitors!</td>
</tr>
<tr>
<td>Competitor B</td>
<td>&quot;...is capable of a positioning accuracy of ± 0.09 degrees (± 6 arc minutes), making the accessory the most accurate articulated cutting jet of its kind in the industry.&quot;</td>
<td>(± 1 arc minute) Substantially more accurate than the competitor!</td>
</tr>
<tr>
<td>Competitor C</td>
<td>No claims or advertised specifications other than cut speed up to 400ipm which has nothing to do with 5-axis cutting.</td>
<td></td>
</tr>
<tr>
<td>Competitor D</td>
<td>&quot;...is capable of positioning accuracy to 0.2 degrees (± 12 arc minutes) with rapid acceleration and positioning speeds, making it the fastest, most accurate 5 axis waterjet cutting head available in abrasive waterjet cutting.”</td>
<td>(± 1 arc minute) Substantially more accurate than the competitor!</td>
</tr>
<tr>
<td>Competitor F</td>
<td>No claims or advertised specifications</td>
<td>The Infini Winder 5 Axis cutting head is able to rotate continuously without any cable wrap-up!</td>
</tr>
</tbody>
</table>

It is interesting to note that the WARDJet Infini Winder is engineered to be a quality product that is substantially more accurate than some manufacturers who claim to have “the most accurate system available”.

**BEVELS AND WELD PREPS**

5-axis cutting is the perfect solution for cutting bevels and weld preps in material. Software makes it fast and easy to program. Post processors are available for both 2D and 3D CAM software.
5-AXIS OVERVIEW

The Infini Winder is a precision 5-axis waterjet cutting mechanism where the angle to the material is defined by one axis and the clock angle to the profile is another. In this manner the programming for this design is very simple and the G-code to describe a beveled circle can be done in only 2 lines. Post processors are available for both 2D and 3D CAM software. Due to the nature of the Infini Winder mechanism, it is considered a fixed mechanical tool tip cutter. This means that the motion of the additional rotary axis does not affect the spatial position of the cutting point. This is superior to a kinematically modeled mechanism which must offset its X, Y, and Z position based on the angles of the 4th and 5th axis and can accumulate additional error if the positions of the rotary axis are not perfect (i.e. deflected from the forces of a high pressure coil).

A 5-axis cutting head can be used to cut 4-axis parts, where the bottom surface geometries are shifted a certain amount to produce the appropriate angle and the Z-axis remains at one height. This can be useful for applications like weld preparation where a bevel angle needs to be cut on all sides of a part that will later be welded. Of course, a 5-axis head can cut parts where the Z-axis is also moving along with all the other axis. This full 5-axis cutting could be used for cutting contours on various surfaces of formed parts.

PROGRAMMING CONSIDERATIONS

Because of the angles that can be cut, part programs may need to have additional cuts to free the part from the sheet. Attempting to slide a complex part at a severe angle from a plate can be difficult without appropriate relief cuts.
5-AXIS SAFETY

Safety of 5-axis cutting requires additional consideration. Safety guards should be in place to protect people around the machine should the cutting head move to an unexpected angle during cutting. Our safety guards include proximity switches to keep the machine from cutting when doors are open.

COMBINATION 5-AXIS HEIGHT SENSOR + CRASH SENSOR

Height Sensor (optional)
This feature can dramatically reduce the potential for broken nozzles by automatically adjusting the height of the cutting head to maintain a fixed distance between the nozzle and the material regardless of any variances in the material.

Crash Sensor (optional)
This accessory is intended to stop the motion of your machine if there is anything in the path of the cutting head that has the potential to break a nozzle or cause other serious damage.
Bring new life to your waterjet!

How would you like to have...

A fully networkable, PC based, Windows XP® controller with 15” touch screen and features including:

- Plate alignment
- Reads standard G&M code
- Ability to run your existing CNC programs
- Easy to operate visual display
- Access to spare parts stocked at WARDJet
- Software updates
- Direct link to technical support
- 1 year warranty
- Optional Wireless PDA Pendant (run your waterjet from your Windows® cellphone)

“We love it! Old programs, all files received from customers...everything runs seamlessly!”

- ACS Precision, Mercersburg, PA

Don’t buy a new waterjet when your well-built, existing waterjet system with a new WARDJet controller will give you the capabilities of a brand new WARDJet machine for a fraction of the cost!

Call now! (330) 677-9100

Visit us on the web! www.wardjet.com
In order to provide ongoing service and support to users of ALL waterjet systems, WARDJet offers retrofits of our XL Controller to nearly any waterjet machine. We offer you a 100% Turn-Key solution with our Ikuhlu motion control software and touchscreen interface. We offer service and support from highly qualified technicians who have many years of experience with a variety of waterjet cutting systems. Our controller allows you to extend the capabilities of your waterjet system to the latest technology with the easiest operator interface available! It also gives you the ability to expand in the future as your company grows. WARDJet wants to see you succeed!

WE RETROFIT:

2D, 3D and 5 axis systems. CHUKAR, Jet Edge, FLOW, DARDI, CALYPSO, Hydrojet, PAR, Progressive, ESAB.
Virtually any waterjet system!

Allen Bradley 8000 and 9230 / 9260 series controllers, Hiegerman, Siemens, FAGOR, Power Automation, FLOW, Burny, Beckhoff.
Virtually any cnc controller!

(330) 677-9100 - Call for more information!
WARDJet has a full in-house circuit board assembly line with CNC pick-and-place, reflow over, and wave solder capacity. As a result, we have complete control over our product while providing unlimited opportunities for innovation. Shortening our supply chain with a focus on backwards compatibility, new technology can be included in our products quickly without the need to exhaust old stock.
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**Phone:** (330) 677-9100
**Fax:** (330) 677-9121

**Department Extensions**

Sales: 6
Tech Support: 7
Spare Parts: 8
INTRODUCTION TO WARDJET

Richard Ward is the founder and president of WARDJet, which has been operating in the waterjet cutting industry since 1995. WARDJet offers over 15 different models of waterjets from small ballscrew driven waterjets to linear motion units with high accuracy that cut at 7,000 inches per minute. No matter what your waterjet need, we have a system that will work for you. WARDJet is also known for building custom engineered systems to meet unique needs.

WARDJet takes a different approach to much of what we do. In fact, up until 2003 we were one of the largest capacity waterjet job shops in the USA when the company elected to switch gears and focus on building new waterjets for the industry. In the years following, WARDJet has gained a strong worldwide presence with many machines exported annually. WARDJet also builds a number of products to improve waterjet cutting and reduce consumable costs, including the patented WARD Pro, a waterjet abrasive recycling system.

Born and raised in Zimbabwe, Richard Ward attended the University of Cape Town and began his career as a Civil Engineer. In 1991, he had the opportunity to come to the USA on a 2 year contract to manage a company so he moved his wife and two young children across the globe with only a suitcase each. After the contract was completed, Richard started his first company in his garage—one mile from where the present 220,000 square foot facility WARDJet operates. Richard holds several patents, and is actively involved in the business.

“I am having the time of my life at WARDJet, building waterjets alongside the most fantastic team of people anyone could wish for. Every single day we innovate, create, open doors and discover opportunities. We think outside the box. We keep excelling where others stop, sometimes because no one told us that it couldn’t be done! But words are never enough. Come and visit us and see why our customers trust us to partner with them as they grow in the waterjet world.”

-Richard Ward
WHY CHOOSE A WARDJET WATERJET?

If you want to cut a pipe, drill, tap, mark, dispense liquids, etch, countersink, put light surface finishes, edge finishes, add plasma, tool changers, bar code readers, laser sensors, height sensors, crash sensors, 5 axis AB cutting heads, 5-axis AC cutting heads, multiple 5 axis heads all on one cross beam, pre-programmed automatic spacing of multiple heads on one cross beam, use dual touch screens, use your cell phone as a wireless pendant – you can do it with a WARDJet. The list just doesn’t stop. Our motto truly is our aim.

WARDJet NOT JUST A WATERJET...

Sure we build fantastic waterjet cutting systems that have earned the respect of thousands of people, companies and customers all over the world. But, we are not satisfied with just having a great waterjet. We believe the future is being able to use a waterjet system as a CNC platform to grow and expand upon. We want our customers to dream about the additional things that could be done with a waterjet other than just waterjet cutting. We want to provide everything from a powerful, easy to use CNC controller packed with intelligent programming and intuitive software, to a machine built with the strength and rigidity needed to add any option you could imagine, all backed by a team of people who get excited when you ask if something off-the-wall can be done with one of our machines. That’s who WARDJet is.

Your waterjet cutting needs are important to us. We can assist you in almost any way as it pertains to waterjets. Having been in the waterjet business since 1992, the WARDJet team has hands-on, practical experience that is sure to benefit you.

As “Your Total Waterjet Solution”, we can help you make educated purchasing decisions when it comes to buying new or used equipment. We will share first-hand operating experiences with you which should reduce the learning curve that comes with any new piece of equipment. For those new to the waterjet industry, we help make it easier to start and grow a business by offering services such as CAD/CAM, market research, business plans for financing, training and hands-on waterjet cutting techniques courses. Our greatest reward is to see you succeed!

We look forward to working with you and helping you grow and excel with the technology of waterjet cutting.

Best Regards,
The WARDJet Team
You CAN recycle abrasive!
Let us prove it!
wardjet.com/wardpro

**ABRASIVE COST PER PART**

$\textbf{5.15}$ at $.25/lb  
Cut with 100% New Abrasive

$\textbf{0.62}$ at $.03/lb  
Cut with 100% Recycled Abrasive

Same part! • Same abrasive flow! • Same cut speed!

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<thead>
<tr>
<th></th>
<th>Cut Time</th>
<th>Flow Rate</th>
<th>Total Abrasive</th>
<th>Cost Per Pound</th>
<th>Total Abrasive Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 Mesh</td>
<td>15.26 min</td>
<td>1.35 lb/min</td>
<td>20.6 lbs.</td>
<td>$0.25</td>
<td>$5.15</td>
</tr>
<tr>
<td>Recycled</td>
<td>15.26 min</td>
<td>1.35 lb/min</td>
<td>20.6 lbs.</td>
<td>$0.03</td>
<td>$0.62</td>
</tr>
</tbody>
</table>

Waterjet Abrasive Recycling and Removal
Factoring Recycled Abrasive Cost

<table>
<thead>
<tr>
<th></th>
<th>Lifetime (Lbs abrasive output)</th>
<th>Lifetime (Hours)</th>
<th>Kw</th>
<th>Cost</th>
<th>Cost/Hour</th>
<th>Cost/Lb.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Screen</td>
<td>60000</td>
<td>400</td>
<td>N/A</td>
<td>$364.15</td>
<td>$0.91</td>
<td>$0.006</td>
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<tr>
<td>Secondary Screen</td>
<td>100000</td>
<td>667</td>
<td>N/A</td>
<td>$166.04</td>
<td>$0.25</td>
<td>$0.002</td>
</tr>
<tr>
<td>Electric</td>
<td>N/A</td>
<td>N/A</td>
<td>17</td>
<td>$0.18</td>
<td>$3.14</td>
<td>$0.021</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td>$4.30</td>
<td>$0.029</td>
<td></td>
</tr>
</tbody>
</table>

Assumes Average WARD Pro Output of 150 lbs/hr
Consumables Pricing Accurate as of 5/2/13. Prices Subject to Change.

How Much Can I Save By Recycling?
Your savings will depend on a number of factors, most important being how much abrasive you use and your current pricing of abrasive. With the WARD Pro, you are able to recover varying percentages of your abrasive. The more you recover, the more you save. Please note that as the recovery percentage increases, you will see a small decline in your hourly recycled abrasive output. Place your information in the calculator below to find how the patented WARD Pro can cut your abrasive costs.

How Do I Cut for Less?
It's simple: recycle and reuse your abrasive. After all, abrasive can make up to 50% of the costs of running an abrasive waterjet. The Patented WARD Pro allows you to reclaim upwards of 60% of your used abrasive. You paid good money for that abrasive. Stop throwing that money away.

With our abrasive removal system(AROS) that serves as the front end of the WARD Pro, time and man power needed to dig out your waterjet tank on a regular basis is minimized. Less downtime and more cutting means more profit.

How Can Recycled Abrasive Cut as Fast as New?
To be clear, there are differences in new abrasive when compared to recycled abrasive. As you can see from the chart below, both new and recycled abrasive are composed of certain percentages of various abrasive mesh sizes. What we find is that recycled abrasive tends to be composed of slightly finer mesh abrasive than new. Conventional wisdom would dictate that a finer mesh means you need to cut at a slower speed or increase your abrasive feed rate. In recycling of abrasive however, this is not the case.

![Abrasive Composition by Mesh Size](image-url)

---

Waterjet Abrasive Recycling and Removal
When abrasive is new, there is a certain percentage of other minerals or "filler" that is found. In the comparison images above, you can see these as the darker particles. After going through the cutting process, these softer minerals are shattered into extremely small particles that are filtered out at the first stage of the WARD Pro recycling process. The result is such that abrasive recycled with the WARD Pro system does not have that "filler" material present. This makes for abrasive more densely packed with the garnet that is doing the actual cutting. In fact, comparing at the same volume, recycled abrasive weighs more than new abrasive.

After more than 10 years of testing, we have seen no need for reduced cutting speed when using recycled abrasive.

**DOES RECYCLED ABRASIVE CUT AS WELL?**
**YOU BE THE JUDGE:**

Both of these parts were cut from the same 1" aluminum. They were cut at the same speed and with the same abrasive flow rate. As you can see, edge quality of both parts is the same.

Scan the **QR Code** to watch a video of these parts being cut at the same time.
CAN I RECYCLE MY ABRASIVE?
Whether or not you can recycle your abrasive is a question of the materials you cut. While most materials do not introduce particles or fibers that will hinder the recycling process into the water and abrasive, there are certain instances where recycling may not be possible.

THE NUMBERS
Typically, the WARD Pro can reclaim 50-65% of your used abrasive, making it as good as new.

1 pound of new abrasive averages $.25. 1 pound of used abrasive averages $.03. The $.03 covers the cost of WARD Pro consumables, power, and water. The cost difference is undeniable.

GO GREEN AND SAVE GREEN
“Going green” often costs companies money, but not with the WARD Pro. The WARD Pro has been engineered to assist you in cutting costs, but a nice side-effect is its help for the environment. While the WARD Pro does require fresh water for some of its functions, much of the water that is used is from your waterjet tank and is returned to the tank after use. Reusing your abrasive also reduces the debris that gets sent to landfills or is disposed of in other methods.

Send us your used abrasive, and we’ll test its recyclability for free! Contact our Sales department at sales@wardjet.com to find out how to get your abrasive tested.

YOU CANNOT RECYCLE IF YOU CUT:
• Using 90K PSI (Reduce your pressure to 60k and it will work)
• Large Volumes of Wood
• Large Volumes of Anything that Floats, has Fibers, or Melts
• Using Plastic Cutting Bricks as a Grating or Support Structure
• Large Volumes of Composites with a Melting Point Below 350 Degrees Fahrenheit (Most composites can be recycled)
• If you are unsure whether these apply to you or have a unique application you are unsure of, please contact WARDJet.
The WRS-3000 focuses on filtering spent cutting water of materials that specifically would harm intensifier pumps used in waterjet cutting. The filtered water leaving the WRS-3000 has a quality better than most tap water, thus increasing pump seal life and the life of your high pressure components.

- Reclaim used water for use in waterjet cutting
- Reclaim up to 99% of your water
- Higher efficiency filters
- Reuse of water makes it green and saves you money

**WHAT IS THE WRS-3000?**
WARDJet's approach to water recycling is a 3-phase process. The WRS-3000 is phase 2 in that process, designed specifically to remove suspended solids in the water. A chiller is included for both the cooling and cutting water. If you are currently using tap water to cool your pump, the chiller can eliminate this water requirement.

**WHY DO I NEED A WRS-3000?**
With rising water costs and increased regulations regarding water quality that can be sent to drain, a solution is needed to allow for proper disposal or better yet, reuse, of water to avoid extra costs. WARDJet developed the WRS-3000 as an alternative to expensive and time intensive methods of Water Recycling.

**IS THERE MUCH MAINTENANCE COST AND UPKEEP INVOLVED IN THE WRS-3000?**
No. Simple gauges and lights alert you when there is a need to change filters. These filters are easily available and extremely affordable to replace, especially compared to expensive de-ionization methods.

**HOW MUCH OF A DIFFERENCE WILL THE WRS-3000 MAKE?**
With the proper configuration, you should expect to reclaim up to 95% of your used water. If cutting with water only, you can expect to reclaim up to 99%.
Traditional Water Filtration
- Consumable generating system
- High operating cost
- Less efficient

Settling Tank
- Water continually moving
- Insufficient time for total settling of solids

Bag Filters
- Clog easily & quickly
- Frustrating - Devours filter bags
- High accumulated cost
  Ultra-fine filtration not practical

Deionization
- Monitoring critical
- Failure to service on time renders system useless
- Captive Audience - Shipping resin to and from supplier to recharge
  High Monthly Cost

Chiller
- Single stage
- Same water for cooling and cutting
- Inefficient cooling (No glycol benefits)

Pump
- Not Modular

Water Recycling
Why Choose WARDJet?

WARDJet’s WRS-3000
- Innovative
- Minimal consumables
- Low operating cost
- Simple

Sludge Hopper
- Easy to dispose of waste
- Out of system permanently
  No excess water

250 Gallon Storage
- Crystal clear 10 micron water
- No bags to change
  Unique WARDJet filtration process

Filters to 0.2 Microns
- Easy to monitor
- Easy to service
- Long life
- Ultra-fine

Dual Process Chiller
- 2 separate cooling circuits
  - water/glycol - cooling
  - clean water - cutting
  - Increased efficiency

Pump
- Modular

Optional Deionization
- May be needed in rare circumstances
- WARDJet has not needed to add since 2003

• Waterjet Abrasive Recycling and Removal
ACCURACY AND CALIBRATION

FARO LASER TRACKER
3D DYNAMIC CALIBRATION AND VERIFICATION OF ACCURACY

We believe it is imperative to use the best equipment available on earth to verify accuracy, placement and repeatability of positional tolerances on WARDJet waterjet cutting machines. The FARO laser tracker allows WARDJet waterjets with the X-Series controllers, to:

- Map and calibrate linear axis and confirm accuracy
- Map and calibrate actual position of the cutting head on a plane, eliminating any need to interpolate actual positional tolerances based on linear mapping per axis
- Volumetrically map and calibrate actual position of the cutting head in space. So if the cutting envelope is 12 feet x 8 feet with a 12” Z travel, it is possible to know the actual position of the cutting nozzle
- Volumetrically map and calibrate actual position of 5 axis cutting heads, including X, XX, Y, A and B axes.

Accuracy of WARDJet waterjets are guaranteed and verified using the very best calibration and verification equipment.

Optodyne Laser Interferometer
The laser interferometer is the ideal way to calibrate and verify accuracy per linear axis. Our laser interferometers are used to check and calibrate every machine prior to shipping.

Renishaw Ballbar
Circularity and squareness of all machines are verified and made available to our customers prior to shipping. Every WARDJet waterjet is verified again when it is installed in your facility with a ball bar by our certified technicians.

Are your machines accurate? We can tell you!
We also offer the service of verification of accuracy of any CNC machine in the field.
INTRODUCING THE LATEST WARDJET INNOVATION... THE EMERALD SERIES WATERJET!

After almost twenty years of industry experience creating the best quality waterjets on the market, WARDJet is proud to announce the value-engineered Emerald series. When compared to other low-cost waterjets, the Emerald stands alone. The durability and dependability of a WARDJet machine is unparalleled.

**EMERALD SERIES WATERJETS**

*Low-cost value-engineered Abrasive Water Cutting Systems*

Emerald 1515
(1.5 Meter x 1.5 Meter)

Emerald 1530
(1.5 Meter x 3.0 Meter)

*Ability to Feed Unlimited Length Sheets on Emerald Series Waterjets*

Emerald 1515
Front to back: 5 ft (1.5m) by Unlimited

Emerald 1530
Front to back: 10 ft (3m) by Unlimited
High Quality, 3232 ballscrews on both X and Y Axis

Lightweight Z-Carriage and Infini Hopper

Precision Ballscrew Drive System

Solidly constructed grate supports
EMERALD SERIES INCLUDED FEATURES

Made in America
Made exclusively in America from top to bottom, the Emerald is designed to offer many of the same features as larger, custom waterjets at an affordable price.

Access to Cutting Area
The Emerald sets itself apart from competitors by featuring greater accessibility - operators are able to load material through the table in both directions as well as work from either the front or back of the machine. Also, the Emerald design reduces the need for operators to climb on the table to load or unload material.

The Emerald 1515 allows for 10 feet of direct access and 10 feet of side access, while the Emerald 1530 increases that amount to 20 feet of direct access and 10 feet of side access.

Index larger sheets through the cutting area
With open front and back and sides, sheets 5’ wide by unlimited length can be feed through the cutting area of the Emerald. 10’ x unlimited on 1530.

Solid Construction
Although the Emerald series waterjets are a smaller size and lower price, the quality that customers come to expect from WARDJet is not compromised. The Emerald utilizes the proven technology of 3232 ball screws with 25mm linear rails to provide accuracy as good as our Z-series waterjets.

Easy-to-Use yet powerful controller interface (MMI)
The controller and MMI software on the Emerald are the same as they are on million dollar WARDJet machines trusted by aerospace companies and hundreds of other WARDJet customers around the world. The easy-to-use WARDJet MMI interface allows operators to learn the software and work on the machine with minimal training.

Remote Diagnostics/Remote Control
As with other WARDJet products, remote support comes standard in the event that assistance is needed to operate the waterjet.

Easy Installation – Do it yourself and save money
With minimal set up, an Emerald could be running the same day as it is delivered at your facility! The Emerald series waterjets are so easy to install that you could do it yourself (provided certain conditions are met).

WARDJet Analytics
Monitor what has been cut on your machine from any internet connected device.
EMERALD 1515

Footprint
2.74m x 2.29m (9’ x 7.5’) Gantry Only

X-Y Travel
+1.5m x 1.5m (5’ x 5’) with one carriage
+1.5m x 1.5m (5’ x 5’) with two carriages

Depth of tank
0.97m (3.17’)

EMERALD 1530

Footprint
4.57m x 2.29m (15’ x 7.5’) Gantry Only

X-Y Travel
+1.5m x 3.0m (5’ x 10’) with one carriage
+1.5m x 3.0m (5’ x 10’) with two carriages

Depth of tank
0.97m (3.17’)
A new addition to the Emerald Series of waterjets... the Emerald 0606 and 0612!

Although small in size, the dependability of the Emerald 0606 and 0612 is reflected in their sturdy design. Thick-walled steel tubing serves as the crossbeam of the waterjet which houses a ballscrew drive system. The tank, supports and grates are constructed the same as they are in much larger waterjet systems. In fact, the entire machine was welded, heat stress relieved, powder coated and milled as one piece which adds to its overall reliability. The Emerald 0606 and 0612 waterjets are also unique because they feature a cantilever-style arm on the X-Axis, unlike any other WARDJet waterjet.
EMERALD 0606

Footprint
1.49m x 1.49m (4.9' x 4.8') Gantry Only

X-Y Travel
+0.6m x 0.6m (2' x 2') with one carriage

Depth of tank
0.86m (2.83')

EMERALD 0612

Footprint
1.49m x 2.03m (4.9' x 6.7') Gantry Only

X-Y Travel
+0.6m x 1.2m (2' x 4') with one carriage

Depth of tank
0.86m (2.83')
G-SERIES
Abrasive Water Cutting Systems

Milling and Waterjet Combined in One System

This system really exemplifies our motto of being Not Just A Waterjet!

24,000 RPM 5-axis Milling Head
Infini Winder 5-axis Waterjet

Split Helical Pinions
GCM
Pinion
Comparison
Exploded
View of
GCM
Crossbeam
3D Model
GCM LARGE FORMAT WATERJET

The GCM is our largest waterjet yet, featuring both an Infini Winder 5-axis head and a 5-axis 24,000 RPM milling head for composite milling. Like our previous G-Series waterjets, the GCM has 5 feet of z-axis travel and is able to cut over the water table or over a part on the ground or a fixture. The versatility this machine provides in terms of cutting and milling of composites is amazing.

By combining both on a single, large format system, this allows for cutting and milling of composites without having to move the parts to a separate machine for milling. This helps to increase accuracy of the parts as well as saving valuable time setting up a second machine.

To increase flexibility, you'll notice that there is a tank under only a portion of the machine's massive cutting area. This allows for custom fixtures to be added to cut larger parts, taking full advantage of the GCM's 60 in. of Z travel.

All GCM's are built to custom sizes and specifications.
CNC 5-Axis Milling and Machining Options

5-axis CNC machining with 5 hp; 10 hp; 15 hp or 20 hp. Varying speeds from lower rpm to over 20,000 rpm. Tool changer – specify number of tools.

CMM – 3D Probe Option

Probes can be integrated with laser sensing allowing the gantry to be used as a CNC measuring device to check part size before and after machining.
This combination CNC 5 axis mill (up to 20 hp and 26,000 rpm) and 5 axis waterjet system is built to easily handle all those larger applications where waterjet cutting and CNC machining are required on the same part. With 5' (1.5m) of Z travel standard, 13' or 20'(4m or 6m) cross beam, unlimited length and built for multiple cutting heads and Z-carriages, the G-Series is ideal for aerospace, nuclear, wind and heavy engineering applications.

Unique to the G-Series is the ability to cut the full 5’ depth vertically up the side of a wall without fouling the Z-carriage body.

Heavy duty drive systems with zero backlash, split pinion and automatic lubrication. Z-carriage is ballscrew driven.

Standard Waterjet Cutting heads, 5-axis Cutting heads and Routers for milling are able to be installed.

Infini-Winder 5-axis cutting head with unlimited rotation (no wind up required).
ONE OF THE LARGEST WATERJETS IN NORTH AMERICA
As one of the largest waterjets ever installed in North America, the GX-4816 could be considered the most impressive WARDJet project to date.
The GX-4816 waterjet has a cutting envelope measuring 48 feet by 16 feet – one of the largest in the country! Other notable features of the G-4816 include 5 feet of Z-travel, a high rail gantry with a safety line for operators to use when performing maintenance, and a system of multiple AROS hoppers to remove abrasive from the massive waterjet tank.

All GCM’s are built to custom sizes and specifications.
Z-SERIES

Abrasive Water Cutting Systems

SHEET SIZE COMPATABILITY

<table>
<thead>
<tr>
<th>Sheet Size</th>
<th>Available Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.3m</td>
<td>2m: One 4'x8', One 2mx4m, 3m wide x unlimited, 4m wide x unlimited</td>
</tr>
<tr>
<td></td>
<td>4.6m: One 4'x8', One 2mx4m, 3m wide x unlimited, 4m wide x unlimited</td>
</tr>
<tr>
<td></td>
<td>6.4m: Two 4'x8', One 2mx4m, 3m wide x unlimited, 4m wide x unlimited</td>
</tr>
<tr>
<td>4.0m</td>
<td>2m: One 4'x8', One 2mx4m, 3m wide x unlimited, 4m wide x unlimited</td>
</tr>
<tr>
<td>2.5m</td>
<td>2m: Three 4'x8', One 2mx4m, 3m wide x unlimited, 4m wide x unlimited</td>
</tr>
<tr>
<td></td>
<td>6.4m: Five 4'x8', One 2mx4m, 3m wide x unlimited, 4m wide x unlimited</td>
</tr>
<tr>
<td>2.0m</td>
<td>4m: Seven 4'x8', Three 2mx4m, 3m wide x unlimited, 4m wide x unlimited</td>
</tr>
</tbody>
</table>

Available in standard and custom sizes.

ALSO AVAILABLE:

Z-45 four foot by five foot waterjet with a small footprint and great capabilities. Can index 4 foot sheets by unlimited lengths, 5-axis capable, and compatible with a wide range of accessories.
The Z-Series is the most versatile waterjet cutting system offered by WARDJet, providing customers the option to expand the tank depth, length, and width. With the addition of various accessories like taps, drills, cell phone pendant control, and cameras, the Z-Series has the flexibility to handle a wide variety of jobs. The robust frame and heavy duty construction make the Z-Series waterjet cutter a dependable and reliable machine for production floors. Some of the standard Z-Series tank and gantry sizes available from WARDJet are listed below.

Common Materials Cut on a Z-Series:
Sheet metal, aluminum, stone, tile, glass, wood, concrete, composites, etc.

GET MORE OUT OF YOUR WATERJET BY EXTENDING Z AXIS TRAVEL
WARDJet now offers a new way to increase the capabilities of your waterjet with the option for a 36” Z. This option raises the waterjet gantry by 3 feet, which allows operators the ability to cut much larger parts on the waterjet system. The 36 inch Z option is available on the Z-Series, R-Series, and previously installed machines. By retrofitting a 36 inch Z-Carriage onto your existing machine, you will be able to cut a greater variety of parts.

Another benefit to adding a 36” Z is increased flexibility with a 5-axis cutting head. When installed on a waterjet with 36 inch gantry, the 5-axis cutting head is mounted on the bottom of the Z-Carriage instead of the front. As a result, you are able to cut the entire 36” down the side of an object without having to stop because the Z-Carriage is in the way.
Z-SERIES FEATURES

SAFETY
Many safety features ensure safe operation for your people and business.

ACCURACY
Ball screw driven for accuracy, repeatability, and reliability.

INDEPENDENT DRIVE
Multiple z-carriages can be independently driven for mirrored cutting.

CALIBRATION
Laser calibration of all systems.

MULTIPLE CUTTING HEADS
Multiple cutting heads on one carriage or on independent z-carriages.

FULL RANGE OF MOTION
From small to unlimited length sheets.
TOLERANCE OF WARDJET Z-SERIES WATERJETS

Machine Positional Specifications (per linear axis at 68°F ± 3°F / 20°C ± 2°C)
• Linear positional accuracy in X and Y axes per axis: ± 0.003 in (actual previously achieved ± 0.0015 in)
• Linear repeatability in X and Y axes per axis: ± 0.001 in (actual previously achieved ± 0.0006 in)

WARDJET 100% GUARANTEE ON TOLERANCES

WARDJet makes every effort to ensure that our customers are completely satisfied prior to our machines leaving our facility. For this reason, we use laser interferometer technology to calibrate the final accuracy of each machine. This data is then available, upon request, to the end user prior to the machine shipping, giving the end user the right to refuse acceptance of the machine and receive a full refund, should it not meet the specified tolerances quoted. All 5 Axis units are calibrated using a FARO Laser Tracker.

ACCURACY

Accuracy of figures quoted are generally conservative. Actual linear positional results taken on the 12 foot of travel, including backlash, traveling 12 feet to the left and then 12 feet to the right (different on the Z-45) and returning to zero often reveal total deviation of approximately 0.002 in. However, to be conservative, WARDJet prefers to quote wider tolerances as standard (see prior). The actual laser calibration results will show the final accuracy of each machine. Should it be necessary to be guaranteed results closer than these specified, please contact us for clarification of your requirements and we will address this on an individual basis.

Free Abrasive

If a Z-Series waterjet is shipped within the United States, 2,200 lbs. of abrasive will be supplied free of charge.
Z-3064 Crossbeam with Infini Winder, 5-Axis Height/Crash Sensor, Infini Hopper, and High Pressure Gauge
The Z-45 was designed so that our customers could have a flexible unit, able to cut parts 4’ x 5’ in one piece, and to cut and feed through any length (even 20’ long) of material up to 5’ wide. When 2 heads are installed on independent carriages, the one head still has a cutting envelope of over 4’ x 4’ while the second head is parked. With 2 heads evenly spaced, each head has a cutting envelope of over 48” x 30”. This makes the Z-45 a highly versatile system, all in a small footprint of less than 8’ x 8’.

**Footprint**

- 81.88” x 76.71” Gantry Only

**X-Y Travel**

- 50” x 60” with one carriage

**Depth of tank**

- 35”

---

**Cutting Envelopes**

<table>
<thead>
<tr>
<th></th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Head</td>
<td>48” x 58” wide</td>
</tr>
<tr>
<td>5-Axis Head</td>
<td>39” x 42” wide</td>
</tr>
<tr>
<td>5-Axis Head</td>
<td>1.2m x 1.5m wide</td>
</tr>
</tbody>
</table>

*Cutting envelope may be reduced when adding a 5-Axis height sensor. This reduction can be eliminated with modifications to the grating system. Contact WARDJet for more details.*
Z-2043

The Z-2043 is a metric sized gantry. WARDJet offers and export version of this machine also.

**Footprint**
- 5.38m x 2.69m (17.65' x 8.82')
  - Gantry Only

**X-Y Travel**
- +2m x 4m (6.56' x 13.12') with one carriage
- +2m x 4.3m (6.56' x 14.1') with two carriages

**Depth of tank**
- 0.89m (2.92')

---

**Cutting Envelopes**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Single Head - 2m x 4m wide</th>
<th>Metric</th>
<th>Single Head - 2m x 4m wide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Head - 79&quot; x 157.5&quot; wide</td>
<td>Double Heads - 2m x 4.3m wide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Double Heads - 79&quot; x 169.5&quot; wide</td>
<td>5-Axis Head - 79&quot; x 157.5&quot; wide</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Cutting envelope may be reduced when adding a 5-Axis height sensor. This reduction can be eliminated with modifications to the grating system. Contact WARDJet for more details.*

*Footprint dimensions exclude 5-Axis safety guards*
The Z-2543 is a metric sized gantry. WARDJet offers and export version of this machine also.

**Footprint**
5.702m x 3.53m (18.7’ x 11.58’)
Gantry Only

**X-Y Travel**
+2.5m x 4m (8.2’ x 13.12’) with one carriage
+2.5m x 4.3m (8.2’ x 14.1’) with two carriages

**Depth of tank**
0.89m (2.92’)

---

**Cutting Envelopes**

<table>
<thead>
<tr>
<th>Single Head - 98.5” x 157.5” wide</th>
<th>Single Head - 2.5m x 4m wide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double Heads - 98.5” x 169.5” wide</td>
<td>Double Heads - 2.5m x 4.3m wide</td>
</tr>
<tr>
<td>5-Axis Head - 98.5” x 157.5” wide</td>
<td>5-Axis Head - 2.5m x 4m wide</td>
</tr>
</tbody>
</table>

Addition of second Z-Carriage will reduce the 5-Axis cutting envelope

---

*Cutting envelope may be reduced when adding a 5-Axis height sensor. This reduction can be eliminated with modifications to the grating system. Contact WARDJet for more details.

*Footprint dimensions exclude 5-Axis safety guards
WHY A Z-2543 INSTEAD OF A Z-2043?
You might be thinking “Why look at the Z-2543 that is 20” larger than the Z-2043 when I really only need a 4’ x 8’ or 6’ x 12’ machine?” Although these machines are intentionally designed to be very similar there are key differences that you may want to consider.

Capacity
While it appears that you have only added 20” more onto your travel, you have actually opened an unlimited number of doors. On a 4’ x 8’ or 6’ x 12’ machine you can only load one 4’ x 8’ sheet at a time to cut. Although on a Z-2043 you can efficiently unload it, reload the next sheet, clamp it and be ready to cut in minutes – it’s nothing like having multiple sheets loaded and cutting at the same time. With the Z-2543 you can take that 4’ x 8’ sheet and turn it 90 degrees. By using that extra 20” of space that you have you can now load THREE 4’ x 8’ sheets side-by-side on your table at the same time. It is also possible to load TWO 12’ x 4’ sheets side by side, one in the front of the tank and one in the back.

Growth
As your business grows so will this machine. With the freedom to add multiple Z-Carriages on the same crossbeam and run them all simultaneously, it’s like having multiple machines in one! This means that, as you need to increase your cutting capacity, you can do so by adding on to your existing Z-2543 instead of having to buy another complete system. You only give up 20” of floor space but gain 3 times the production capability. The Z-2043 has the same cross beam so it too can have multiple Z-Carriages.

Cost
The most amazing part about this machine is that it costs only slightly more than a Z-2043. So although you gain a tremendous amount of capacity, it only costs you a fraction of what an additional waterjet system would. Talk with other waterjet owners and you’ll see this is a great value for the investment. Generally you can get a new Z-2543 in the same amount of time as it would take to get a Z-2043. You’ll be up and running quickly and potentially capable of generating substantially more revenue when balanced with the appropriate pump capacity.

No matter which WARDJet machine you select, you’ll be impressed with the engineering, accuracy, service and support you will consistently receive. The Z-2043 is a great starting point for many new waterjet customers, and don’t forget it can always grow to become a Z-2543 down the road. Visit our website to read about the changes we can make to your Z-2043 to turn it into a Z-2543 whenever you’re ready!

Park your second cutting head in the 13th foot and still have full access to the entire table. Cut three 4’ x 8’ sheets or cut two 4’ x 12’ sheets.
Z-2546

This machine has an extended tank and crossbeam design to enable triple head cutting while still allowing for single head cutting of a full 8’ x 12’ sheet.

**Footprint**
- 5.702m x 3.83m (18.7' x 12.564’)
  - Gantry Only
**X-Y Travel**
- +2.5m x 4m (98.5” x 181”) with one carriage
- +2.5m x 4.6m (98.5” x 193”) with two carriages

**Depth of tank**
- 0.89m (2.92’)

---

*Footprint dimensions exclude 5-Axis safety guards

*Cutting envelope may be reduced when adding a 5-Axis height sensor. This reduction can be eliminated with modifications to the grating system. Contact WARDJet for more details.

*Footprint dimensions exclude 5-Axis safety guards
The Z-3043 allows for extended cutting area and greater versatility of use.

**Footprint**
5.69m x 3.95m (18.69' x 12.96') Gantry Only

**X-Y Travel**
+3.0m x 4.0m (10.08’ x 13.12’) with one carriage
+3.0m x 4.3m (10.08’ x 14.12’) with two carriages

**Depth of tank**
0.89m (2.92’)

---

The Cutting Envelopes chart shows the following:

- **Single Head** - 121” x 157.5” wide
- **Double Heads** - 121” x 169.5” wide
- **5-Axis Head** - 121” x 157.5” wide

**Metric**
- Single Head - 3m x 4m wide
- Double Heads - 3m x 4.3m wide
- 5-Axis Head - 3m x 4m wide

Addition of second Z-Carriage will reduce the 5-Axis cutting envelope.

---

*Cutting envelope may be reduced when adding a 5-Axis height sensor. This reduction can be eliminated with modifications to the grating system. Contact WARDJet for more details.

**Footprint dimensions exclude 5-Axis safety guards.
The Z-3064 is a metric sized gantry. This is the largest sized Z-Series waterjet available at WARDJet.

**Footprint**
8.03m x 3.95m (26.36' x 12.96') Gantry Only

**X-Y Travel**
+3.0m x 6.1m (10.08' x 20.08') with one carriage
+3.0m x 6.4m (10.08' x 21') with two carriages

**Depth of tank**
0.89m (2.92')

---

**Cutting Envelopes**

<table>
<thead>
<tr>
<th>Single Head</th>
<th>Double Heads</th>
<th>5-Axis Head</th>
</tr>
</thead>
<tbody>
<tr>
<td>121&quot; x 241&quot; wide</td>
<td>121&quot; x 252&quot; wide</td>
<td>121&quot; x 241&quot; wide</td>
</tr>
</tbody>
</table>

*Cutting envelope may be reduced when adding a 5-Axis height sensor. This reduction can be eliminated with modifications to the grating system. Contact WARDJet for more details.

**Metric**

<table>
<thead>
<tr>
<th>Single Head</th>
<th>Double Heads</th>
<th>5-Axis Head</th>
</tr>
</thead>
<tbody>
<tr>
<td>3m x 6.1m wide</td>
<td>3m x 6.4m wide</td>
<td>3m x 6.1m wide</td>
</tr>
</tbody>
</table>

Addition of second Z-Carriage will reduce the 5-Axis cutting envelope

**Footprint dimensions exclude 5-Axis safety guards.**

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WARDJet Waterjet Cutting Systems

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## R-SERIES

<table>
<thead>
<tr>
<th></th>
<th>R-1214</th>
<th>R-2014</th>
<th>R-3014</th>
<th>R-4014</th>
<th>CUSTOM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutting Envelope (FT)</td>
<td>12’ x 14’</td>
<td>20’ x 14’</td>
<td>30’ x 14’</td>
<td>40’ x 14’</td>
<td>made to order</td>
</tr>
<tr>
<td>Cutting Envelope (M)</td>
<td>3.7m x 4.3m</td>
<td>6.1m x 4.3m</td>
<td>9.1m x 4.3m</td>
<td>12.2m x 4.3m</td>
<td>made to order</td>
</tr>
<tr>
<td>Z-Axis Height</td>
<td>12” - 36”</td>
<td>12” - 36”</td>
<td>12” - 36”</td>
<td>12” - 36”</td>
<td>12” - 36”</td>
</tr>
</tbody>
</table>
R-SERIES

Abrasive Water Cutting Systems

**R-SERIES**

**Available in standard and custom sizes.**

---

### SHEET SIZE COMPATABILITY

<table>
<thead>
<tr>
<th>Length</th>
<th>14'</th>
<th>15'</th>
<th>16'</th>
<th>21'</th>
</tr>
</thead>
<tbody>
<tr>
<td>12'</td>
<td>Three 4’x8’, Three 4’x12’, Two 5’x10’, Two 6’x12’</td>
<td>Three 4’x8’, Three 4’x12’, Two 5’x10’, Two 6’x12’</td>
<td>Three 4’x8’, Three 4’x12’, Two 5’x10’, Two 6’x12’</td>
<td>Five 4’x8’, Four 4’x12’, Three 5’x10’, Three 6’x12’, One 8’x20’</td>
</tr>
<tr>
<td>20'</td>
<td>Six 4’x8’, Four 4’x12’, Three 5’x10’, Three 6’x12’, One 8’x20’</td>
<td>Six 4’x8’, Four 4’x12’, Three 5’x10’, Three 6’x12’, One 8’x20’</td>
<td>Six 4’x8’, Four 4’x12’, Three 5’x10’, Three 6’x12’, One 8’x20’</td>
<td>Eight 4’x8’, Four 4’x12’, Four 5’x10’, Four 6’x12’, Two 8’x20’</td>
</tr>
<tr>
<td>30'</td>
<td>Nine 4’x8’, Six 4’x12’, Five 5’x10’, Four 6’x12’, One 8’x20’</td>
<td>Ten 4’ x 8’, Six 4’x12’, Five 5’x10’, Four 6’x12’, One 8’x20’</td>
<td>Ten 4’ x 8’, Six 4’x12’, Five 5’x10’, Four 6’x12’, One 8’x20’</td>
<td>Fourteen 4’x8’, Eight 4’x12’, Seven 5’x10’, Six 6’x12’, Three 8’x20’</td>
</tr>
<tr>
<td>40'</td>
<td>Twelve 4’x8’, Nine 4’x12’, Seven 5’x10’, Six 6’x12’, Two 8’x20’</td>
<td>Thirteen 4’x8’, Nine 4’x12’, Seven 5’x10’, Six 6’x12’, Two 8’x20’</td>
<td>Thirteen 4’x8’, Nine 4’x12’, Seven 5’x10’, Six 6’x12’, Two 8’x20’</td>
<td>Eighteen 4’x8’, Twelve 4’x12’, Twelve 5’x10’, Nine 6’x12’, Four 8’x20’</td>
</tr>
</tbody>
</table>

---

### STANDARD SIZE CUTTING ENVELOPE

<table>
<thead>
<tr>
<th></th>
<th>R-1214</th>
<th>R-2014</th>
<th>R-3014</th>
<th>R-4014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Cutting Head</td>
<td>144” x 157.5”</td>
<td>240” x 157.5”</td>
<td>360” x 157.5”</td>
<td>480” x 157.5”</td>
</tr>
<tr>
<td>Two Cutting Heads</td>
<td>144” x 189.5”</td>
<td>240” x 169.5”</td>
<td>360” x 169”</td>
<td>480” x 169”</td>
</tr>
</tbody>
</table>

Available in standard and custom sizes.
GET MORE OUT OF YOUR WATERJET BY EXTENDING Z-AXIS TRAVEL
WARDJet now offers a new way to increase the capabilities of your waterjet with the option for a 36” Z. This option raises the waterjet gantry by 3 feet, which allows operators the ability to cut much larger parts on the waterjet system. The 36 inch Z option is available on the Z-Series, R-Series, and previously installed machines. By retrofitting a 36 inch Z-Carriage onto your existing machine, you will be able to cut a greater variety of parts.

Another benefit to adding a 36” Z is increased flexibility with a 5-axis cutting head. When installed on a waterjet with 36 inch gantry, the 5-axis cutting head is mounted on the bottom of the Z-Carriage instead of the front. As a result, you are able to cut the entire 36” down the side of an object without having to stop because the Z-Carriage is in the way.

Helical Rack & Split Pinion Drive System
High precision, helical rack and split pinions to achieve longer travel distances with zero backlash.

Free Abrasive
If a R-Series waterjet is shipped within the United States, 2,200 lbs. of abrasive will be supplied free of charge.
RR-4016

**Footprint**
295" x 638"

**X-Y Travel**
480" x 192" with one carriage
480" x 203.5" with two carriages

**Depth of tank**
35"

---

R-3015

**Footprint**
264" x 494"

**X-Y Travel**
360" x 180" with one carriage
360" x 191.5" with two carriages

**Depth of tank**
35"
R-4014

Footprint
249” x 648”

X-Y Travel
480” x 157.5” with one carriage
480” x 169” with two carriages

Depth of tank
35”

R-3014

Footprint
249” x 502”

X-Y Travel
360” x 157.5” with one carriage
360” x 169” with two carriages

Depth of tank
35”
<table>
<thead>
<tr>
<th></th>
<th>L-3025</th>
<th>L-3018</th>
<th>CUSTOM</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUTTING ENVELOPE (FT)</td>
<td>10’ x 8’</td>
<td>10’ x 6’</td>
<td>made to order</td>
</tr>
<tr>
<td>CUTTING ENVELOPE (M)</td>
<td>3m x 2.5m</td>
<td>3m x 1.8m</td>
<td>made to order</td>
</tr>
<tr>
<td>INCHES PER MINUTE</td>
<td>7,000ipm</td>
<td>7,000ipm</td>
<td>up to 7,000ipm</td>
</tr>
</tbody>
</table>
The L-Series waterjets feature tanks specifically designed for the water-only application. Since cutting with water only is typically high volume at an ultra-high speed, the tanks of the L-Series are engineered to be extremely durable and designed for easy water drainage, collection and clean up.

Some of the main features include:

• Stainless steel lined tank
• Chain external to the tank
• Easy to tension chain with no tracking
• Drain sump external to tank
• Easy to clean
• Automatic washers inside tank available as an option
• Stainless deflectors under chain available as an option

WARDJet also specializes in custom waterjets. Many of the standard WARDJet machines have been conceptualized and produced based on the needs of a specific customer looking for a waterjet solution for a unique application. Contact WARDJet if the L-3025 or L-3018 water-only waterjets are not the perfect fit for your application and we'll work together to design a waterjet that meets your needs.
## L-SERIES SPECIFICATIONS

<table>
<thead>
<tr>
<th></th>
<th>L-3025</th>
<th>L-3018</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cutting Envelope</strong></td>
<td>10' x 8' (3m x 2.5m) with one standard head</td>
<td>10' x 6' (3m x 2.5m) with one standard head</td>
</tr>
<tr>
<td></td>
<td>10' x 8.5' (3m x 2.6m) with two standard heads</td>
<td>10' x 6.5' (3m x 2.6m) with two standard heads</td>
</tr>
<tr>
<td><strong>Z-Axis</strong></td>
<td>12&quot; (300 mm)</td>
<td>12&quot; (300 mm)</td>
</tr>
<tr>
<td><strong>Drive System</strong></td>
<td>Linear motors (X, X2, Y); Acme ball screw on Z</td>
<td>Linear motors (X, X2, Y); Acme ball screw on Z</td>
</tr>
<tr>
<td><strong>Traverse speed</strong></td>
<td>Up to 7,000 ipm (177,800 mm/min)</td>
<td>Up to 7,000 ipm (177,800 mm/min)</td>
</tr>
<tr>
<td><strong>Lineal Positioning</strong></td>
<td>+/- 0.003&quot; (+/- 0.075 mm)</td>
<td>+/- 0.003&quot; (+/- 0.075 mm)</td>
</tr>
<tr>
<td><strong>Accuracy, per axis</strong></td>
<td>+/-0.001&quot; (+/- 0.025 mm)</td>
<td>+/-0.001&quot; (+/- 0.025 mm)</td>
</tr>
<tr>
<td><strong>Repeatability</strong></td>
<td>+/-0.001&quot; (+/- 0.025 mm)</td>
<td>+/-0.001&quot; (+/- 0.025 mm)</td>
</tr>
<tr>
<td><strong>Encoder</strong></td>
<td>5 micron (1 micron optional)</td>
<td>5 micron (1 micron optional)</td>
</tr>
<tr>
<td><strong>5-Axis</strong></td>
<td>Optional, multiple 5-axis also available</td>
<td>Optional, multiple 5-axis also available</td>
</tr>
<tr>
<td><strong>Material Handling Options</strong></td>
<td>Programable chain conveyors,</td>
<td>Programable chain conveyors,</td>
</tr>
<tr>
<td></td>
<td>Photo eyes,</td>
<td>Photo eyes,</td>
</tr>
<tr>
<td></td>
<td>Pinch feed roller (integrated or moveable),</td>
<td>Pinch feed roller (integrated or moveable),</td>
</tr>
<tr>
<td></td>
<td>Extended loading and unloading areas,</td>
<td>Extended loading and unloading areas,</td>
</tr>
<tr>
<td></td>
<td>Squaring guides for loading, encoder wheels,</td>
<td>Squaring guides for loading, encoder wheels,</td>
</tr>
<tr>
<td></td>
<td>Alternate materials for conveyor based upon application</td>
<td>Alternate materials for conveyor based upon application</td>
</tr>
<tr>
<td><strong>Cutting media</strong></td>
<td>Water-only or abrasive</td>
<td>Water-only or abrasive</td>
</tr>
<tr>
<td><strong>Options</strong></td>
<td>Multiple heads</td>
<td>Multiple heads</td>
</tr>
<tr>
<td></td>
<td>5-Axis heads</td>
<td>5-Axis heads</td>
</tr>
<tr>
<td></td>
<td>Ink jet printer</td>
<td>Ink jet printer</td>
</tr>
<tr>
<td></td>
<td>Alignment camera</td>
<td>Alignment camera</td>
</tr>
<tr>
<td></td>
<td>Android Remote Pendant</td>
<td>Android Remote Pendant</td>
</tr>
<tr>
<td></td>
<td>CE-Compliant Wired Remote Pendant</td>
<td>CE-Compliant Wired Remote Pendant</td>
</tr>
<tr>
<td></td>
<td>CE-Compliant Wireless Remote Pendant</td>
<td>CE-Compliant Wireless Remote Pendant</td>
</tr>
<tr>
<td></td>
<td>CE-Compliant system</td>
<td>CE-Compliant system</td>
</tr>
<tr>
<td><strong>Controller</strong></td>
<td>WARDJet XL</td>
<td>WARDJet XL</td>
</tr>
<tr>
<td></td>
<td>Optional WARDJet X-Classic</td>
<td>Optional WARDJet X-Classic</td>
</tr>
<tr>
<td><strong>Pump Options</strong></td>
<td>60,000 PSI with 30, 50, 60, 75, 100, 150 HP</td>
<td>60,000 PSI with 30, 50, 60, 75, 100, 150 HP</td>
</tr>
<tr>
<td></td>
<td>Or supply your own pump</td>
<td>Or supply your own pump</td>
</tr>
<tr>
<td></td>
<td>Air-Over-Oil Coolers</td>
<td>Air-Over-Oil Coolers</td>
</tr>
<tr>
<td></td>
<td>Chillers</td>
<td>Chillers</td>
</tr>
<tr>
<td></td>
<td>Redundant intensifiers</td>
<td>Redundant intensifiers</td>
</tr>
<tr>
<td><strong>Diagnostics</strong></td>
<td>Remote Control/Remote Diagnostics with internet connection to the controller</td>
<td>Remote Control/Remote Diagnostics with internet connection to the controller</td>
</tr>
<tr>
<td><strong>Programming Software</strong></td>
<td>WARDJet Analytics to track daily usage</td>
<td>WARDJet Analytics to track daily usage</td>
</tr>
<tr>
<td><strong>Options</strong></td>
<td>WARDDCAM included</td>
<td>WARDDCAM included</td>
</tr>
<tr>
<td></td>
<td>IGEMS CAD/CAM optional</td>
<td>IGEMS CAD/CAM optional</td>
</tr>
<tr>
<td></td>
<td>Or use your own CAM software</td>
<td>Or use your own CAM software</td>
</tr>
</tbody>
</table>
The L-3025 waterjet features the highest cutting speed of any water-only waterjet at WARDJet, Inc. With an extremely robust frame, the L-3025 allows for the addition of many heavy duty options, such as 5-axis cutting heads, cameras, and height sensors. Increase water-only production on your L-3025 waterjet even further by including one of the many material handling options listed below.

MATERIAL TO CUT ON AN L-3025
The L-3025 is recommended for cutting rubber, foam, plastics, insulation, sheet rock, cloth, leather, food, fiberglass, cardboard, acrylics, wood, gaskets, paper, bags, sponges, wallpaper, and many more.

<table>
<thead>
<tr>
<th>L-3025 WATERJET SPECS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutting Envelope</td>
<td>8’ x 10’ (2.5m x 3m) with one standard head</td>
</tr>
<tr>
<td></td>
<td>8.5’ x 10’ (2.6m x 3m) with two standard heads</td>
</tr>
<tr>
<td>Z-Axis</td>
<td>12” (300 mm)</td>
</tr>
<tr>
<td>Drive System</td>
<td>Linear motors (X, X2, Y); Acme ball screw on Z</td>
</tr>
<tr>
<td>Traverse speed</td>
<td>Up to 7,000 ipm (177,800 mm/min)</td>
</tr>
<tr>
<td>Lineal Positioning Accuracy, per axis</td>
<td>+/- 0.003” (+/- 0.075 mm)</td>
</tr>
<tr>
<td>Repeatability</td>
<td>+/-0.001” (+/- 0.025 mm)</td>
</tr>
<tr>
<td>Encoder</td>
<td>5 micron (1 micron optional)</td>
</tr>
<tr>
<td>5-Axis</td>
<td>Optional, multiple 5-axis heads also available</td>
</tr>
<tr>
<td>Material Handling Options</td>
<td>Programmable chain conveyors,</td>
</tr>
<tr>
<td></td>
<td>Photo eyes,</td>
</tr>
<tr>
<td></td>
<td>Pinch feed roller (integrated or moveable),</td>
</tr>
<tr>
<td></td>
<td>Extended loading and unloading areas,</td>
</tr>
<tr>
<td></td>
<td>Squaring guides for loading,</td>
</tr>
<tr>
<td></td>
<td>Encoder wheels,</td>
</tr>
<tr>
<td></td>
<td>Alternate materials for conveyor based upon application</td>
</tr>
</tbody>
</table>
L-3025

WARDJet Waterjet Cutting Systems

Scan code to watch videos of the L-Series waterjets
The L-3018 water-only waterjet boasts the same astonishing cutting speed as the L-3025 at a slightly reduced cutting envelope and footprint. The L-3018 is also capable of handling multiple cutting heads or 5-axis cutting heads on the same cross beam. Add other features like optical eyes, guillotine doors, and chain-fed loading tables to make the L-3018 a fully automated system.

MATERIAL TO CUT ON AN L-3018
The L-3018 is recommended for cutting rubber, foam, plastics, insulation, sheet rock, cloth, leather, food, fiberglass, cardboard, acrylics, wood, gaskets, paper, bags, sponges, wallpaper, and many more.

<table>
<thead>
<tr>
<th>L-3018 WATERJET SPECS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutting Envelope</td>
</tr>
<tr>
<td>10’ x 6’ (3m x 1.8m) with one standard head</td>
</tr>
<tr>
<td>10’ x 6’ (3m x 1.8m) with two standard heads</td>
</tr>
<tr>
<td>Z-Axis</td>
</tr>
<tr>
<td>12” (300 mm)</td>
</tr>
<tr>
<td>Drive System</td>
</tr>
<tr>
<td>Linear motors (X, X2, Y); Acme ball screw on Z</td>
</tr>
<tr>
<td>Traverse speed</td>
</tr>
<tr>
<td>Up to 7,000 ipm (177,800 mm/min)</td>
</tr>
<tr>
<td>Lineal Positioning Accuracy, per axis</td>
</tr>
<tr>
<td>+/- 0.003” (+/- 0.075 mm)</td>
</tr>
<tr>
<td>Repeatability</td>
</tr>
<tr>
<td>+/-0.001” (+/- 0.025 mm)</td>
</tr>
<tr>
<td>Encoder</td>
</tr>
<tr>
<td>5 micron (1 micron optional)</td>
</tr>
<tr>
<td>5-Axis</td>
</tr>
<tr>
<td>Optional, multiple 5-axis heads also available</td>
</tr>
<tr>
<td>Material Handling Options</td>
</tr>
<tr>
<td>Programmable chain conveyors,</td>
</tr>
<tr>
<td>Photo eyes,</td>
</tr>
<tr>
<td>Pinch feed roller (integrated or moveable),</td>
</tr>
<tr>
<td>Extended loading and unloading areas,</td>
</tr>
<tr>
<td>Squaring guides for loading,</td>
</tr>
<tr>
<td>Encoder wheels,</td>
</tr>
<tr>
<td>Alternate materials for conveyor based upon application</td>
</tr>
</tbody>
</table>
Scan code to watch videos of the L-Series waterjets
## J-SERIES

### Cutting Envelope (FT)

<table>
<thead>
<tr>
<th></th>
<th>J-138</th>
<th>J-108</th>
<th>CUSTOM</th>
</tr>
</thead>
<tbody>
<tr>
<td>FT</td>
<td>12’ x 8’</td>
<td>10’ x 8’</td>
<td>made to order</td>
</tr>
<tr>
<td>FT</td>
<td>4m x 2.4m</td>
<td>3m x 2.4m</td>
<td>made to order</td>
</tr>
<tr>
<td>INCHES PER MINUTE</td>
<td>2,500ipm</td>
<td>2,000ipm</td>
<td>up to 2,000ipm</td>
</tr>
</tbody>
</table>
J-SERIES TANK DESIGN FEATURES

The J-Series waterjets also feature tanks specifically designed for the water-only application. Since cutting with water only is typically high volume at a higher speed than cutting with abrasive, the tanks of the J-Series are engineered to be durable, effective and easy to clean out.

Some of the main features include:

- Stainless steel lined tank
- Chain external to the tank
- Easy to tension chain with no tracking
- Drain sump external to tank
- Easy to clean
- Automatic washers inside tank available as an option
- Stainless deflectors under chain available as an option

CUSTOM J-SERIES WATERJET

WARDJet also specializes in custom waterjets. Many of the standard WARDJet machines have been conceptualized and produced based on the needs of a specific customer looking for a waterjet solution for a unique application. Contact WARDJet if the J-138 or J-108 water-only waterjets are not the perfect fit for your application and we’ll work together to design a waterjet that meets your needs.
## J-SERIES SPECIFICATIONS

<table>
<thead>
<tr>
<th></th>
<th>J-138</th>
<th>J-108</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cutting Envelope</strong></td>
<td>12’ x 8’ (3.6m x 2.4m)</td>
<td>10’ x 8’ (3m x 2.4m)</td>
</tr>
<tr>
<td><strong>Z-Axis</strong></td>
<td>12” (300 mm)</td>
<td>12” (300 mm)</td>
</tr>
<tr>
<td><strong>Drive System</strong></td>
<td>Belt drive (X, X2, Y); Acme ball screw on Z</td>
<td>Belt drive (X, X2, Y); Acme ball screw on Z</td>
</tr>
<tr>
<td><strong>Traverse speed</strong></td>
<td>Up to 3,000 ipm (76,000 mm/min)</td>
<td>Up to 3,000 ipm (76,000 mm/min)</td>
</tr>
<tr>
<td><strong>Lineal Positioning</strong></td>
<td>+/- 0.010” (+/- 0.25 mm/min)</td>
<td>+/- 0.010” (+/- 0.25 mm/min)</td>
</tr>
<tr>
<td><strong>Accuracy, per axis</strong></td>
<td>+/-0.005” (+/- 0.13 mm/min)</td>
<td>+/-0.005” (+/- 0.13 mm/min)</td>
</tr>
<tr>
<td><strong>Repeatability</strong></td>
<td>+/-0.005” (+/- 0.13 mm/min)</td>
<td>+/-0.005” (+/- 0.13 mm/min)</td>
</tr>
<tr>
<td><strong>Encoder</strong></td>
<td>Rotary</td>
<td>Rotary</td>
</tr>
<tr>
<td><strong>5-Axis</strong></td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Material Handling Options</strong></td>
<td>Programmable chain conveyors, Photo eyes, Pinch feed roller (integrated or moveable), Squaring guides for loading, encoder wheels, Alternate materials for conveyor based upon application</td>
<td>Programmable chain conveyors, Photo eyes, Pinch feed roller (integrated or moveable), Squaring guides for loading, encoder wheels, Alternate materials for conveyor based upon application</td>
</tr>
<tr>
<td><strong>Cutting media</strong></td>
<td>Water-only</td>
<td>Water-only</td>
</tr>
<tr>
<td><strong>Controller</strong></td>
<td>WARDJet XL, Optional WARDJet X-Classic</td>
<td>WARDJet XL, Optional WARDJet X-Classic</td>
</tr>
<tr>
<td><strong>Pump Options</strong></td>
<td>60,000 PSI with 30, 50, 60, 75, 100, 150 HP Or supply your own pump, Air-Over-Oil Coolers, Chillers, Redundant intensifiers</td>
<td>60,000 PSI with 30, 50, 60, 75, 100, 150 HP Or supply your own pump, Air-Over-Oil Coolers, Chillers, Redundant intensifiers</td>
</tr>
<tr>
<td><strong>Diagnostics</strong></td>
<td>Remote Control/Remote Diagnostics with internet connection to the controller</td>
<td>Remote Control/Remote Diagnostics with internet connection to the controller</td>
</tr>
<tr>
<td><strong>Programming Software Options</strong></td>
<td>WARDJet Analytics to track daily usage, WARDCAM included, IGEMS CAD/CAM optional, Or use your own CAM software</td>
<td>WARDJet Analytics to track daily usage, WARDCAM included, IGEMS CAD/CAM optional, Or use your own CAM software</td>
</tr>
</tbody>
</table>
The J-138 water-only waterjet is excellent for shops where yields are high and tolerances are more forgiving. The J-138 waterjet has increased cutting speeds from traditional abrasive waterjets and features a chain belt to maximize production. The J-Series are WARDJet's economy water-only systems and are capable of many upgrades to automate production.

MATERIAL TO CUT ON AN J-138
The J-138 is recommended for cutting rubber, foam, plastics, insulation, cake, sheet rock, cloth, leather, food, fiberglass, cardboard, acrylics, wood, gaskets, paper, bags, sponges, wallpaper, and many more.

<table>
<thead>
<tr>
<th>J-138 WATERJET SPECS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutting Envelope</td>
<td>12' x 8' (3.6m x 2.4m) with one standard head</td>
</tr>
<tr>
<td></td>
<td>12' x 8' (3.6m x 2.4m) with two standard heads</td>
</tr>
<tr>
<td>Z-Axis</td>
<td>12&quot; (300 mm)</td>
</tr>
<tr>
<td>Drive System</td>
<td>Belt drive (X, X2, Y); Acme ball screw on Z</td>
</tr>
<tr>
<td>Traverse speed</td>
<td>Up to 3,000 ipm (76,000 mm/min)</td>
</tr>
<tr>
<td>Lineal Positioning Accuracy, per axis</td>
<td>+/- 0.010&quot; (+/- 0.25 mm/min)</td>
</tr>
<tr>
<td>Repeatability</td>
<td>+/- 0.005&quot; (+/- 0.13 mm/min)</td>
</tr>
<tr>
<td>Encoder</td>
<td>Rotary</td>
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<tr>
<td>5-Axis</td>
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<tr>
<td>Material Handling Options</td>
<td>Programmable chain conveyors,</td>
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<tr>
<td></td>
<td>Photo eyes,</td>
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<td>Pinch feed roller (integrated or moveable),</td>
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<td>Extended loading and unloading areas,</td>
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<td></td>
<td>Squaring guides for loading,</td>
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<tr>
<td></td>
<td>Encoder wheels,</td>
</tr>
<tr>
<td></td>
<td>Alternate materials for conveyor based upon application</td>
</tr>
</tbody>
</table>
J-138 WATER-ONLY WATERJET

Scan code to watch videos of the J-Series waterjets
The J-108 waterjet can increase production on your floor by including on-loading and off-loading tables and a chain belt system. A unique baffle grate helps to eliminate wear on the stainless steel lined tank and expels mostly steam instead of collecting water. With a slightly reduced cutting envelope compared to the J-138, this machine offers outstanding automation of processes for any company.

**MATERIAL TO CUT ON AN J-108**
The J-108 is recommended for cutting rubber, foam, plastics, insulation, cake, sheet rock, cloth, leather, food, fiberglass, cardboard, acrylics, wood, gaskets, paper, bags, sponges, wallpaper, and many more.

<table>
<thead>
<tr>
<th>J-108 WATERJET SPECS</th>
<th></th>
</tr>
</thead>
</table>
| **Cutting Envelope** | 10’ x 8’ (3m x 2.4m) with one standard head  
                        | 10’ x 8’ (3m x 2.4m) with two standard heads |
| **Z-Axis**           | 12” (300 mm) |
| **Drive System**     | Belt drive (X, X2, Y); Acme ball screw on Z |
| **Traverse speed**   | Up to 3,000 ipm (76,000 mm/min) |
| **Lineal Positioning Accuracy, per axis** | +/- 0.010” (+/- 0.25 mm/min) |
| **Repeatability**   | +/-0.005” (+/- 0.13 mm/min) |
| **Encoder**          | Rotary |
| **5-Axis**           | N/A    |
| **Material Handling Options** | Programmable chain conveyors,  
                               | Photo eyes,  
                               | Pinch feed roller (integrated or moveable),  
                               | Extended loading and unloading areas,  
                               | Squaring guides for loading,  
                               | Encoder wheels,  
                               | Alternate materials for conveyor based upon application |
At WARDJet, we’re constantly creating new technologies and innovations. What drives us to do this? Customers with unique applications that require better solutions than what is already available drive us to see difficult situations as opportunities to revolutionize and innovate.

Absolutely everything we do has a custom feel to it. Small adjustments here and there are made for every customer. Since every customer has a different application we customize and optimize our waterjets to fit you instead of you having to fit your waterjet.

The Z-3064 offers many of the same advantages of the flagship Z-2543 waterjet with an extended cutting area and extra strength beams and ballscrews. As the largest Z-Series ever manufactured at WARDJet, the Z-3064 features a cutting envelope of 21 feet by 10 feet.
JX-7025 HIGH-SPEED WATER ONLY LARGE FORMAT WATERJET
This waterjet is 85' x 14' with its integrated shuttle table system. Features an extra-large cutting envelope, integrated shuttle table system, and an automatic shuttle table locking system.

RX-3015 SPLIT TANK LARGE FORMAT WATERJET WITH CATWALK
This R-3015 split tank, large format waterjet is set up for cutting specific parts on one half of the table and for standard cutting on the other. It is also equipped four with independently driven cutting heads for mirrored cutting.

36 INCH Z TRAVEL ON A Z-SERIES WATERJET
This Z-Series waterjet allows for 36 inches of Z-Axis travel. Not only does this system allow for additional travel but it includes a 5-axis waterjet cutting head, the X-Classic controller, and 5-axis safety features.

PLASMA CUTTER RETROFIT WITH SIX INDEPENDENTLY MOVING WATERJET CUTTING HEADS
This plasma cutter has the longest custom made cross beam we’ve ever built. The controller is integrated into the current systems enclosure and has 6 independently moving heads for mirror cutting.
CUSTOM WATERJETS

ZX-813 WITH SHUTTLE TABLES & Z-CARRIAGE MOUNTED PRINTER
This Z-Series machine allows for a time consuming loading process on one table while cutting on the other. With a z-carriage mounted printer it can print part numbers and critical information directly on the material.

ZXL-45 WITH ROTARY AXIS
This ZXL-45 features a rotary axis, allowing for the rotation of the material 360 degrees for the cutting of round or oddly shaped material.

ZX-2546 WITH CUSTOM EXTERNAL LOADING PLATFORMS AND 6 CUTTING HEADS
This 6 head 2.5 by 4.6 meter waterjet has three custom external loading platforms for the loading of materials and offloading of parts in a quick and efficient way.

ZX-3043 LARGE FORMAT WATER-JET WITH SHUTTLE TABLES
This Z-Series waterjet has been designed with shuttle tables to optimize the loading and off-loading of parts. While one load of material is being cut the other can be offloaded, reducing downtime significantly.
Plumbing for 15 waterjet cutting heads on one Z-Series waterjet.

High pressure plumbing for robotic arm.

Standard z-carriage with drill, tap, and height sensor installed.

Custom made grates fabricated by our automated welbot for speedy production.
## WATERJET CONTROLLERS

### X-Classic Controller
- Programmable Axis: 8 to 32
- Touch-screen: 2
- Membrane Panels: Up to 10
- Fully Customizable Screens: Unlimited
- 100% Remote Access: Yes
- Built in Camera: Yes
- Wireless Pendant: Optional
- Run 5-Axis Head: Optional
- Programmable Z: Optional
- Pipe Indexer: Optional
- Consumable Tracking: Yes
- Multiple Job Homes: Unlimited
- Most Parts Available Direct (not forced to go through WARDJet): Yes
- *Unlimited Software Upgrades: Yes
- Automatic Head Spacing: Yes
- Email Notification: Yes

### XL-Controller
- Programmable Axis: 4 to 8
- Touch-screen: 1
- Membrane Panels: Up to 4
- Fully Customizable Screens: Limited
- 100% Remote Access: Yes
- Built in Camera: Yes
- Wireless Pendant: Optional
- Run 5-Axis Head: Optional
- Programmable Z: Optional
- Pipe Indexer: Optional
- Consumable Tracking: Yes
- Multiple Job Homes: Unlimited
- Most Parts Available Direct (not forced to go through WARDJet): Yes
- *Unlimited Software Upgrades: Yes
- Automatic Head Spacing: Yes
- Email Notification: Yes
X-SERIES CONTROLLER SPECIFICATIONS

Computer
- Windows 7 Professional
- CPU = 3.2GHz Quad Core (AMD A Series)
- 4GB RAM DDR3 1600MHZ
- 120GB SOLID STATE DRIVE
- Internal Temperature Sensors
- Gigabit Ethernet Card
- Wireless 802.11N Card
- Two 15" touch-screens (One with XL)
- 4 external USB ports and 2 external USB 3.0 ports (USB 3.0 only on X-Classic) offer unlimited expandability (e.g. keyboard, mouse, etc.)

Controller
- Servo cycle = 0.4 ms
- Standard number of true CNC axes – 8 (4 with XL)
- Modular components for easy maintenance and reduced down time
- All cables and wires in watertight enclosure
- Standard hardware switches as well as touch screen control for Water ON/OFF, Abrasive ON/OFF, Jog Controls, Go, Stop, Reverse, and Jump!
- Standard Feed Rate Override Knob
- Membrane switch pads control ON/OFF of cutting heads with light up LED activation notification
- Up to 7 head functionality (3 with XL)
- Hardware E-Stop located on control console
- Heavy-Duty Water-Tight Steel Construction
- Built in Web Cam Standard
- USB Ports on console
- Software Touch- Screen Keyboard
- Bar code reading and printing available
- Wireless Mouse included standard
- Wireless Keyboard included Standard
- Audio headset and microphone included standard
- Simple main wiring consisting of 1 power cord and 1 network cable

EXPANDABLE CAPABILITIES
As the possibilities rapidly expand with waterjet cutting, so does the need to have a controller that is able to grow in a virtually unlimited way. WARDJet wanted to be able to offer multiple 5 axis cutting on one waterjet system. We wanted to have software that was completely under the control of WARDJet and be able to expand and grow as fast as we needed. We wanted to have unlimited access to technology and the ability to send and collect and manage data, and be able to answer “YES” to any features – or almost anything – our partners ask of us as they grow and expand. The WARDJet X-Classic controller does just this and much more. A quick glance at some of the options and features of the controller will leave you impressed – and if you were to come and operate the controller, you would be stunned at how easy it is to use, and yet possibly still be the most powerful unit you have ever worked with. Even we are impressed with ourselves!
CONTROLS
• Hardware switches as well as touch screen control for Water ON/OFF, Abrasive ON/OFF, Jog, Go, Stop, Reverse, Jump!
• Membrane switch pads control ON/OFF of cutting heads with light-up LED activation notification
• Up to 4 head functionality standard
• Feed-Rate Override
• E-Stop located on control console

FUNCTIONALITY
• Plate Alignment – pick 2 points and line up your plate
• Indexing capability to cut large parts (e.g. 20’ x 10’ on a 6’ x 13’ table). Cut first portion of part program, move material, easily pick up the position of next program and cut!
• Controller shows how much time is left to complete the program
• Percentage bar shows status of job progress
• Monitoring of consumable use and hours of operations (orifice, nozzle, seats, etc.)
• True multi-tasking control
• Interrupt jobs and restart them again later
• Retrace an entire program
• Unlimited Go To function – Start a program anywhere by simply touching the part on the touch-screen at the location you wish to start cutting
• Enter and save unlimited home positions
• Enter absolute or incremental data and coordinates
• PC Monitoring is standard with the system giving email and pop-up notification of activities
• Z-Carriages can be programmed to move relative to each other on the cross beam

5-AXIS CAPABILITY
• 5 Axis cutting head available – easy retrofit onto all existing WARDJet waterjets
• Will cut up to 48 degrees to give you a 45 degree weld prep
• Compact design to give you the most amount of usable table space
• Programmable with built in CAD/CAM software
• Taper compensation
• Multiple 5 axis heads can cut simultaneously

POWERFUL CAD/CAM SOFTWARE
• The X-Classic Controller includes CAD/CAM software for easy access at the machine. CAD/CAM software is also supplied to be run from any desktop PC or laptop
• Controller accepts most CAD files (DXF,DWG...)
• Quick DXF to PART conversion at controller with WARDJet’s 'one touch' feature
• Extensive shape library standard with CAD/CAM software
XL CONTROLLER RETROFITS

The WARDJet XL controller is an affordable, easy-to-use option with many of the advanced features and functionality found on the X-Classic controller.

One of the best things about the XL is that it was designed specifically with all existing waterjet owners in mind. Nearly every waterjet in the world can be upgraded to have the full capability of a WARDJet XL Controller.

In order to provide ongoing service and support to users of ALL waterjet systems, WARDJet offers retrofits of our XL Controller to nearly any waterjet machine. We offer you a 100% Turn-Key solution with our Ikuhlu motion control software and touchscreen interface. We offer service and support from highly qualified technicians who have many years of experience with a variety of waterjet cutting systems. Our controller allows you to extend the capabilities of your waterjet system to the latest technology with the easiest operator interface available! It also gives you the ability to expand in the future as your company grows. WARDJet wants to see you succeed!

We retrofit:
2D, 3D and 5 axis systems.
CHUKAR, Jet Edge, FLOW, DARDI, CALYPSO, Hydrojet, PAR, Progressive, ESAB, virtually any waterjet system!

Allen Bradley 8000 and 9230 / 9260 series controllers, Hiegerman, Siemens, FAGOR, Power Automation, FLOW, Burny, Beckhoff, virtually any cnc controller!

WARDJET-CALYPSO RETROFIT CIRCUIT BOARD

From Calypso to WARDJet in just a few minutes! WARDJet’s Calypso Retrofit Circuit Board is easy to install. Call for more information! (330) 677-9100
CNC CONTROLLER SOFTWARE

FREE SOFTWARE UPGRADES - Ikuhlu Controller software is continually improved and added to. Your installation can be configured to automatically check the web for updates and automatically install them.

REMOTE DIAGNOSTICS - Tech support and diagnostic troubleshooting can be done anywhere in the world that has an internet connection. Control of the machine can be handed over to the technician for diagnostics testing. An optional web cam means you can get help face to face over the web.

CELLPHONE PENDANT - Control jog, Z-height, feed rate and cutting speed all from your Android device. Set up and linking to your machine is as easy as taking a picture with your phone. Once installed, you can start and stop programs right from your phone or tablet. WARDJet is continuing to add features to the software and continuous updates will make sure you are getting the most out of your WARDJet! The Pendant software is available for free on the Android Market.

CONSUMABLE MANAGEMENT - A variety of consumable items can be tracked in real-time on the controller. Each consumable is linked to a certain machine action and calculated by time, cycles, or both. Now you can get accurate information about the life of your consumable, as well as do efficient preventative maintenance without wasting time or materials. The number of independent consumables that can be tracked is not limited.

G+M TRANSLATION - The controller accepts standard G-Code parts, so you're not locked into any specific software package to create parts for your machine. You can use the default M codes to cycle outputs on or off. If you prefer to use the standard G+M codes from your current CAM software or another waterjet, you can use the built in translation files. These allow you to run existing code without having to post-process them again.

GANTRY MONITOR - Squareness of a gantry system is critical to cutting accurate parts. The XL Controller ensures squareness off of two independent home switches on the gantry axes. At the end of each homing cycle, the gantry axes are realigned to their calibrated state. From that time on, the system is continuously monitoring the travel of the motors. The operator is notified on-screen if the gantry motors ever become misaligned.

E-MAIL NOTIFICATION - The controller can be configured to send out e-mail notification after the completion of a part. It ties into your facilities e-mail server, or acts as its own server. E-mails include an image of the part that was cut, along with who cut it and the amount of time it took to cut.

PROGRAM LOOK-AHEAD - For dynamic smoothing and acceleration correction.
TIME ESTIMATION - As part programs are loaded into the controller the G-Code is analyzed to get a time estimate. While a part cuts, the total time remaining is displayed, along with a progress bar that fills up as you cut. This information is available anywhere that you go throughout the program and on the PDA wireless pendant, so you'll always know when a part is about to finish.

![Time Estimation Screen](image)

REVERSE FUNCTION - Trace back through the program to recut a portion of your part. Reverse will trace back an unlimited amount.

![Reverse Function Screen](image)

USER PASSWORDS - Each user receives a unique password, and can be put into one of three user levels (Operator, Power Operator or Administrator). Each user level can have its permissions easily changed by an administrator. The ability to add/remove part programs, edit part programs, enter maintenance information, change parameters, etc. can be adjusted, to allow your operators as much or as little freedom as you wish. While logged in, the program tracks how many parts were cut, what maintenance was done, and what faults occurred for a given user. All of this data is logged into a text file.

![User Passwords Screen](image)

JUMP TO PIERCE POINT - Pierce point mode allows you to select the beginning of a contour by touching the screen near the point where you started. The program will execute from this point.

![Jump to Pierce Point](image)

UNLIMITED GO TO FUNCTION - Start a program anywhere by simply touching the part on the touch screen at the location you wish to start cutting. You can also enter absolute or incremental data and coordinates.

![Unlimited Go to Function](image)

Interrupt Jobs - And restart them again later.
JUMP TO ANYWHERE - Touch the screen near the geometry that you want to start cutting at. Part cutting will resume cutting near the point selected on screen.

INDEXING CAPABILITY - To cut large parts (e.g. 20’x10’ on a 6’x13’ table). Cut the first portion of part program, move material, easily pick up the position of next program and cut!

USE THE WATERJET TABLE AS A DIGITIZER – Teach Parts using the built-in “Teach” mode. This effectively turns the machine into a giant digitizer the size of the waterjet table. Just use the controller’s jog controls to “trace” your template, point by point, to create CNC files right at the controller! Drawing curves and lines are fast and simple - no need to use CAD/CAM software.

PART ROTATION - Pick 2 points and line up your plate.
RULER - Measure parts and sheets on screen on the fly.
AS-SERIES PUMPS

Whatever your cutting application, there's a WARDJet AS-Series intensifier pump designed to meet your needs. WARDJet offers a full range of reliable, efficient waterjet intensifier pumps for around-the-clock operations, small prototype jobs, and every application in between. You'll find pumps engineered to meet the demands of multiple head abrasive cutting, as well as those that are ideal for water-only cutting. All WARDJet pumps are engineered to be easy to operate and maintain.

ADVANCED INTENSIFIER TECHNOLOGY

RELIABLE HIGH PRESSURE ENDS
Durable threaded rod design simplifies high pressure end removal for quick seal maintenance. Non-threaded cylinder design increases reliability.

EXTENDED SEAL LIFE
Large diameter ceramic plunger produces more water per stroke with reduced friction yielding maximum seal life.

SMOOTH SHIFTING
Advanced electronics provide smooth, more reliable shifting for optimum cut quality. In addition shift times are monitored for intensifier performance.

STREAMLINED MAINTENANCE
Check valve utilizes a screwless, low-pressure poppet design to enable quick evaluation of key contact surfaces. Feature allows for fast component replacement.

SIMPLIFYING ACCESS
The hydraulic rod seals and plunger bearing are readily accessed from the outside of the hydraulic end cap.

IMPROVED COMPONENT LIFE
Hydraulic center section features an advanced piston design which minimizes seal wear and improves component life.
AS-SERIES PUMPS FEATURES

WARDJET CONTROL CENTER - A touch screen panel guides the operator through operation, troubleshooting, and maintenance logs.

BUILT TO LAST - The combination of intelligent engineering and quality manufacturing add up to a pump that delivers maximum longevity and reliability.

ADDED VERSATILITY - Equipped with high and low pressure settings (ideal for piercing brittle materials).

ENHANCED HYDRAULIC CIRCUIT - Kidney loop circulates oil through a heat exchanger and oil filter, away from intensifier pulsations. When the pump is in standby, the oil is cool. (Available on 50+hp pumps)

EFFICIENT PRESSURE GENERATION - High efficiency TEFC motors deliver reliable power with minimal electric consumption. Wye-Delta soft start reduces inrush current for 50+ hp pumps.

SUPERIOR CUT QUALITY - Single large volume attenuator provides even output pressure to ensure optimal edge quality.

SMOOTH HIGH PRESSURE WATER - Pressure-Compensated hydraulic pumps and exclusive electronic shift technology maintain smooth ultra-high pressure water at the cutting heads.

ADVANCED INTENSIFIER MANAGEMENT (AIM) - Built-in troubleshooting charts and detailed intensifier graphics provide rapid access to diagnostics and maintenance logs.

OPERATION CONVENIENCE - Panel-mounted display pressure gauges allow easy monitoring of inlet water filters and hydraulic performance.

MAXIMUM CUTTING PERFORMANCE - An inlet water filter system removes impurities to maximize cutting head performance. Boost pumps increase inlet water flow for 50+ HP pumps.

REMOTE OPERATION - Key switch enables all pump features to be operated and monitored at either the pump or remotely from a CNC controller.

SAFE OPERATION - Safety dump valve relieves system pressure in case of a shutdown.

MICRO-SD CARD READER - Transfer pump maintenance and alarm logs quickly and easily. Download the latest WARDJet system software updates.

PASSWORD PROTECTED - Protect your pump settings and configuration to prevent editing by unauthorized personnel.

OPTIONAL ETHERNET INTERFACE - Transfer data between your WARDJet system and a network or PC. This option allows advanced remote control and remote troubleshooting.

MORE INTUITIVE THAN EVER - Easy-to-understand graphics guide the operator through the steps necessary to operate and maintain the pump.

OPERATION MADE EASY - The Quick Help feature provides fast answers when they’re needed most. No more searching for system manuals for basic information.

Advanced Intensifier Technology™ (AIT) - AIT is our exclusive technology and an integral part of the AS-Series pumps. Our unparalleled user-oriented innovations facilitate longer maintenance intervals and rapid component replacement. AIT represents the latest in high pressure intensifier design that delivers increased reliability and efficiency.
## PUMP SPECIFICATIONS

<table>
<thead>
<tr>
<th></th>
<th>A-6030</th>
<th>MATRIX-50</th>
<th>AS-6050</th>
<th>AS-6060</th>
<th>AS-6075</th>
<th>AS-6100</th>
<th>AS-6150</th>
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<td>60 Hz</td>
<td>50 Hz</td>
<td>60 Hz</td>
<td>50 Hz</td>
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<td>400</td>
<td>208-230/460/575</td>
<td>380</td>
<td>240/480</td>
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<td>73</td>
<td>137-124/63/50</td>
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<td><strong>Physical</strong></td>
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<td><strong>Width, in (mm)</strong></td>
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<td>34 (864)</td>
<td>40 (1016)</td>
<td>40 (1016)</td>
<td>40 (1016)</td>
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<td>76 (1930)</td>
<td>76 (1930)</td>
<td>76 (1930)</td>
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Visit WARDJet.com/pumps for additional details.
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<td>2.1 (7.95)</td>
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<td>2.2 (8.33)</td>
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<td>3.0 (11)</td>
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<td>3.2 (12.1)</td>
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Visit WARDJet.com/pumps for additional details.
Optional enhancements to your WARDJet Waterjet System are available to assist in increased production and efficiency. We would recommend considering these options and would like to discuss them further with you as to how they could benefit your application. Please call with any questions.

Grates for your WARDJet Machine are your choice based on your specific application. We offer 4 different types of grating systems to fit nearly every application. Pricing is based on a complete set of grates, however the grate designs allow multiple types of grates to be used within the same tank. Any of these grates can be placed side by side with any other type of grate. For example one end of your tank could use water-only grates and the other could have modular grates for any abrasive cutting you do.

**GRATING OPTIONS**

**WARDJET PROPRIETARY MODULAR JOB SHOP GRATE SYSTEM**
Grates are made up of 4” x 4” squares 5” deep - all welded. Allows easy clamping and fixturing anywhere in the cutting area. Drawings can be provided for the grate should you wish to make them up yourself. The unassembled slats can also be provided ready to be welded together by your company.

**WARDJET PROPRIETARY MODULAR HEAVY DUTY GRATE SYSTEM**
Grates are ½” thick x 5” deep – all welded. Drawings can be provided for the grate should you wish to make them up yourself.

**WARDJET WATER-ONLY MODULAR PLASTIC BRICK GRATES**
The unique design of the plastic bricks drains water away from the cutting area while preventing backsplash during cutting. The specially designed polypropylene materials prevent loss of shape or delaminating of the plastic bricks.

**WARDJET PROPRIETARY MODULAR CONCRETE GRATES**
Each section is 26” x 72”. These are an ideal choice for tile or granite slabs. Provides full support for material and allows for cutting of small parts without them falling into the tank. These durable grates can be screeded over with a sand cement grout at week’s (or day’s) end to be completely restored allowing them to effectively have an unlimited life.

**IN-HOUSE MANUFACTURING**
Our grates are manufactured in-house, allowing us the flexibility to build custom grate sizes for any waterjet! If you have a particular or unique application, we can provide any size.
INFINI WINDER 5-AXIS CUTTING HEAD

This option allows you to cut in full 3D from 0° vertical to 90° horizontal with a capacity of 12” to 24” vertical travel on the Z-axis. With positioning accuracies of ± 0.033 degrees (± 2 arc minutes) the Infini Winder is the most accurate 5-Axis cutting head of its kind in the waterjet cutting industry. Allows the programming of bevels on parts. Depending on the waterjet system, speeds can be up to 2,000 in/min.

The Infini Winder allows for continuous rotational movement without the need to program un-wrapping of cables.

Infini Winder 5-axis Cutting Head Manufactured under license from Techni Waterjet Pty Ltd of US Patent No. 8540552

COMBINATION 5-AXIS HEIGHT SENSOR - CRASH SENSOR

Height Sensor (optional)
This feature can dramatically reduce the potential for broken nozzles by automatically adjusting the height of the cutting head to maintain a fixed distance between the nozzle and the material regardless of any variances in the material.

Crash Sensor (optional)
This accessory is intended to stop the motion of your machine if there is anything in the path of the cutting head that has the potential to break a nozzle or cause other serious damage.

ADDITIONAL CUTTING HEAD ON ADDITIONAL Z-CARRIAGE

The addition of an independent cutting head allows for an easy adjustment between the distances of the two heads. This option will double your production by giving you 2 parts cut at the same time. If this option is selected the second set of bearings listed above are already included in this price.

WARDJET PENDANT SOFTWARE

Control jog, Z-height, feed rate and cutting speed all from your Android device. Set up and linking to your machine is as easy as taking a picture with your phone. Once installed, you can start and stop programs right from your phone or tablet. WARDJet is continuing to add features to the software and continuous updates will make sure you are getting the most out of your WARDJet! The Pendant software is available for free on the Android Play Store.
[1] HEIGHT SENSORS – FOR EACH CUTTING HEAD
This feature can dramatically reduce the potential for broken nozzles by automatically adjusting the height of the cutting head to maintain a fixed distance between the nozzle and the material regardless of any variances in the material.

[2] PNEUMATIC DRILL WITH PROTECTIVE COVER
The WARDJet Pneumatic Drill allows a hole to automatically be drilled through the material. Once the hole is drilled the waterjet will then (with help from our CAD/CAM program) automatically start the cut inside the pre-drilled hole.

[3] PNEUMATIC TAPPING TOOL WITH PROTECTIVE COVER
The WARDJet Pneumatic Tapping Tool allows holes cut with the waterjet or with the Pneumatic Drill to be automatically threaded by the machine without ever having to take your material off the table.

[4] PNEUMATIC REAMER WITH PROTECTIVE COVER
When cutting large numbers of holes, it could be a lot quicker to cut the hole with the waterjet to close tolerances, and then use a reamer to bring the hole to final size. The WARDJet Pneumatic Reamer can be automatically configured to do this with ease.

LIVE REMOTE PROGRAMMING CAMERA
Accurately and quickly line up the edge of a sheet to minimize scrap, locate off of the center of a hole or other feature for cutting geometries in a pre-cut part, digitize a large part when a DXF or DWG file isn’t available, locate off of two holes in a large sheet if you are indexing a plate that is larger than the cutting area through the machine.

PROGRAMMABLE Z-AXIS
This option (standard on the X-Classic) allows you to program the height of the cutting head along with the shape being cut in the X and Y direction. So you could program to cut a shape and at the same time, travel up and over the part, for example cutting a shape into a ball.

INKJET PRINT HEAD
With an inkjet printhead running along side your cutting head you can print part numbers and critical information directly on your material. This printer is mounted on the z-carriage along side the waterjet cutting head. This way you can cut and print in one complete, streamlined process.
VARIABLE SPEED MINI-HOPPER UPGRADE

The WARDJet variable speed mini-hopper now allows the abrasive flow to be reduced automatically from within the software and program. This option is ideal when cutting stone, glass, ceramic tiles, laminates, phenolics, lexan, acrylic, composites, carbon fiber or any material that is fragile, brittle or is difficult to pierce, a low-pressure pierce is critical to reduce the risk of damage to the material in the pierce procedure.

INFINI HOPPER UPGRADE

- 9 feed rate presets
- Low pressure preset
- Automatic feed rate settings

The Infini Hopper is beneficial to companies running different nozzle combinations and need to change abrasive feed rates quickly.

For example:

<table>
<thead>
<tr>
<th>Material</th>
<th>Orifice/Nozzle</th>
<th>Abrasive Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thin</td>
<td>0.010”/0.030”</td>
<td>0.7 lbs/min</td>
</tr>
<tr>
<td>Thick</td>
<td>0.014”/0.040”</td>
<td>1.3 lbs/min</td>
</tr>
<tr>
<td>Very Thick</td>
<td>0.016”/0.040”</td>
<td>1.5 lbs/min</td>
</tr>
</tbody>
</table>

These abrasive flow settings can all be pre-programmed in the Infini Hopper. When the operator changes the orifice/nozzle combination, they can also quickly change to the appropriate setting on the Infini Hopper. A low pressure abrasive feed rate is also available when piercing fragile materials like glass or composites. When the pump goes into low pressure, the Infini Hopper automatically uses the low pressure abrasive feed rate (Requires Remote Pump On/Off option).

LAPTOP WITH IKUHLU CONTROLLER SOFTWARE

Accidents happen. Should something catastrophic happen to the Man-Machine Interface (X-Classic or XL) of your machine, you can use a laptop preloaded with the Ikuhlu controller software to run your machine until the MMI is repaired. Simply unplug the standard network cable from the MMI that is not working and plug it into your laptop and continue using your waterjet with minimal inconvenience.

INDEPENDENTLY DRIVEN CUTTING HEADS

Each cutting head is independently controlled by its own AC servo motor which allows for independent movement as well as easy to set up mirror cutting. Cut your parts in half the time without sacrificing edge and cut quality!

ADJUSTABLE CUTTING HEAD SPREADER

The adjustable spreader option allows for incredible flexibility in cutting multiple parts at the same time. Simply slide the heads to your desired spacing and lock them in place. Cut with one head or multiple combinations with individual water shutoffs.
2300 LB CAPACITY BULK FEED HOPPER
An 1100 lb (~10 cu ft) hopper is supplied standard with all WARDJet waterjets. This is larger than what you will find with most other machines. This size allows an operator to run the machine for an entire 8 hour shift without having to add abrasive (13 hours at 1.4 lbs of abrasive per hour with one 14/40 or two 10/30 cutting heads and a 50HP pump). Some customers however prefer to have a larger bulk feed hopper supplied with their waterjets, as they will be running 24 hours per day, with multiple heads, or with over 100 HP. If this is the case, you may want to consider using the larger 2300 lb bulk feed hopper and loading the hopper with 2200 lb bulk bags. Additional options to the bulk feed hoppers include low-level sensors to alert you when abrasive is low and custom color paint.

4400 LB CAPACITY BULK FEED HOPPER
An 1100 lb (~10 cu ft) hopper is supplied standard with all WARDJet waterjets. An even larger bulk feed hopper is also available. Additional options to the bulk feed hoppers include low-level sensors to alert you when abrasive is low, and custom color paint.

AIR COOLED PORTABLE CHILLER
Some waterjet facilities have a need to reuse the water that is used as cooling water in the intensifier. A chiller is an excellent way to do this. It will set up a closed loop system for the cooling water. It has been our experience that the use of 65°F cooling water is sufficient for this application and that the chillers will be operated in a space with 95°F ambient or cooler.

NEW PUMPS
Available in 30 HP, 50 HP, 75 HP, 100 HP and 150 HP. All new pumps are supplied with a full manufacturer’s warranty.

USED PUMPS
Used pumps of various HP and model are available from time to time. Please inquire about used pump availability and prices if this is of interest. There are no warranties on used pumps.
PUMP TOOL KIT
Components will vary based on pump selected. The kits include specialized tools for doing maintenance work on the pump.

SPARE PARTS STARTER KIT
Parts will vary based on pump chosen. It is highly recommended that spare nozzles, orifices and seal kits be ordered prior to installation. You determine the number of spare parts you would like ordered.

REMOTE PUMP ON/OFF CAPABILITIES WITH DUAL PRESSURE SWITCHING
This option allows the pump to be switched on and off from within the program and activated from the controller. It also allows a high pressure and low pressure setting to be activated from within the software. This is the ideal for automatic low pressure piercing. (Subject to availability on pump selected – not available on used pumps)

208-230-380 VOLT CONVERSION
Available on new pumps.

DON’T SEE WHAT YOU’RE LOOKING FOR?
We are in the business of custom built manufacturing systems and we love a challenge!
Our engineers and programmers are continually working on new solutions for the most extreme and unique applications. Don’t be afraid to contact us with your query.
Call us and ask! (330) 677-9100
PARTS & CONSUMABLES

LARGE SELECTION OF PARTS FOR MOST MAKES AND MODELS

WARDJet provides a large selection of parts including everything you need to keep your waterjet running at high performance. We supply parts for WARDJet waterjets and also for most makes and models of waterjets.

We want to be your one-stop parts supplier. WARDJet uses the same part numbers as the original part manufacturer, thereby simplifying your order.

WARDJet's employees will help you succeed in your business even if you didn't obtain a waterjet from us. When parts are needed, our expertise, attention to detail and expansive knowledge base will assist you in your future endeavors.

ORDER WATERJET PARTS ONLINE

- Customer specific profiles displaying the most commonly used consumables and parts.
- Simple to use interface makes ordering parts easy.
- Order right from your controller.
- Never order the wrong parts again. Our database determines exactly what you need for your specific system and helps you choose.

CUSTOMER SPECIFIC PARTS LISTS

Every WARDJet customer receives a convenient parts list that is specific to their waterjet, pump or recycling system. These lists make it easy to know at-a-glance what consumables and parts you need.

Call now to order Waterjet Parts 1-330-677-9100 (8 a.m. to 5 p.m. EST)
WARDJET SOFTWARE OPTIONS

WARDCAM is a powerful yet simple package for quickly turning DXF files into CNC code for the waterjet. WARDCAM removes the complexity of many CAD/CAM packages by utilizing context sensitive menus to walk you through the process.

**Easy To Use**
Easy To Use, Clutter Free Interface, Context Sensitive Menus. WARDCAM’s step by step process makes it faster and easier so you can focus more on cutting.

**Multiple Files**
Open multiple files with tabbed navigation

**Fast Forward**
Fast forward through the whole process and go straight to posting your CNC file and Job Report

**Layers**
Hide and reveal layers of your part. This is particularly useful for hiding guide marks or measurements from your original file. Once hidden contours will not be cut.

**Partial Cut Qualities**
Choose different cut qualities for specific sections of a contour.

**Visual Tool Offset**
The visual representation of your tool offset makes it easy for you to see exactly where you will cut. This also makes it easier for you to see if your contour is too small for your tool to fit.

**Intelligent Error Checking**
Any stray contour, open contours or points will remain the color gray. This is useful if you weren’t able to see it before and need to delete it. In addition it makes it easier for you to see open contours for marking slit cuts and etching.

**Bevels**
Custom bevel settings with a preview image so you can easily see what the bevel will look like.

**Customizable Post Processors**
You have the ability to fully customize your post process.

**CNC & Job Reports**
Create CNC File with standard G+M code & create Job Reports
DXF
Accepts standard dxf files from any CAD/CAM software

Point Functions
Mark points for functions like Abrasive Pierce, Drill, Tap, Stop & User Defined functions.

Open Contour Cutting
Cut any open contour and the Cut Quality of your choice.

Cut Order
Easily adjust contour cut order. Delete single contours, move cuts up or down in the line or if you really need to delete all and start from the beginning.

Marking
Marking, Etching, Slit Cutting

Custom Start Points
Set your start point wherever you like with snap options; Part Bounds, End Points, Mid Points and center Points.

Custom Cut Quality & Leads
Choose different Cut Qualities and Leads for your contours.

Material Database & Machine Database
With the Material & Machine Databases you have practically unlimited control over what materials and cutting systems your programming recognizes.

Automatic Feed Rate Calculation
Feed Rate Calculator in Material DB will adjust settings automatically based on machineability. You can also manually adjust if you know the material you are working with.

More Information and Videos
@ wardjet.com/wardcam
**IGEMS CAD/CAM SOFTWARE**

**FULL CAD/CAM NESTING PACKAGE**

This option provides you with the software’s complete nesting capabilities. This can be an extremely powerful feature to reduce the amount of wasted material, and additional loading/unloading time. It provides automatic true shape nesting of irregular parts, supports almost every kind of geometry, and can nest simple entities like lines, arcs, regions and circles. Software training videos are available and offered free of charge with every machine purchase. A full demonstration of this software’s capabilities is available via WebEx® with a WARDJet staff member anytime. Price includes one-year software maintenance package.

**CAD/CAM TILE NEST PACKAGE**

Tile Nest was developed specifically for customers cutting tile inlays. The module automatically separates geometry, nests and creates a CNC file helping to save the user a lot of time in CAD and programming work. Tile Nest separates the pieces by color and nests them onto tiles in order to minimize the number of tiles needed. A special CAM command can automatically generate a tool-path that will be made in such a way that there will be only one CNC file for each color.

**CAD/CAM SINGMAKER PACKAGE**

This option provides you with sign making capabilities including TTF, CXF and SHX font support and raster to vector conversions. A full demonstration of this software’s capabilities is available via WebEx® with a WARDJet staff member anytime.
CAD/CAM RASTER TO VECTOR SOFTWARE
This option provides you with sign making capabilities including TTF, CXF and SHX font support and image to vector conversions. A full demonstration of this software’s capabilities is available via WebEx® with a WARDJet staff member anytime.

FLOATING NETWORK LICENSE FOR CAD/CAM SOFTWARE
The CAD/CAM software licenses come standard as a USB key that must be plugged into your computer for the software to run. The floating network license lets you install the software license on a server for networked computers to access and share. The number of licenses purchased will determine the number of computers that can access the software at any one time.

ADDITIONAL CAD/CAM SOFTWARE LICENSE
One license for our CAD/CAM Software comes standard with a purchase of a WARDJet waterjet. Additional licenses are available for an additional cost.

VIDEO CONFERENCING WITH WARDJET XL CONTROLLER
With the XL controller, a video camera is optional, but gives 100% remote access just like the X-Classic Controller. The camera with the Burny LCD 10 is not attached to the controller itself, but rather works and operates through a laptop or computer. This option allows 2 way communication via live video enabling assistance between WARDJET and the on site location of the waterjet.
“It’s like having a team of experts in the back room of my shop that I can call on at any time no matter what my questions are. All I do is touch an icon on my screen and there they are!”

EXTENDED SUPPORT HOURS
WARDJet offers extended support hours to all of its new and existing customers. On top of the 24 hour support there is a F.A.Q. section of the website with a Video Library, manuals, layouts, schematics, guides and more to help you keep things running smoothly.

At WARDJet we take Tech Support seriously. We have put great effort into making our website an essential tool for keeping your waterjet running in top shape.

We are continually working to provide you with the resources you need to keep your machine running at its best. We provide you with personal attention, dozens of experts only seconds away and instant live video conferencing.
DOWNLOAD MANUALS, LAYOUTS, SCHEMATICS & SOFTWARE
Find exactly the details, information, and tools you’re looking for.

TECHNICAL SUPPORT VIDEOS
We already have many solutions demonstrated in our technical support videos. Our videos and documentation are very informative and helpful in servicing, installing and repairing your machine.

FREQUENTLY ASKED QUESTIONS (FAQ)
Browse through our Frequently Asked Questions first to see if your question has previously been answered and resolved.

SPEEDY SUPPORT REQUEST SYSTEM
Fill out our technical support request form for your WARDJet waterjet or WARD recycling unit. Doing this helps us stay organized and make sure every customer is given their fair share of our time.

ALL OF THIS IS AVAILABLE ON OUR WEBSITE AT WARDJET.COM
WARDJET MANUALS

Easy to understand
Detailed

Learn the full capabilities of your machine

Quick guides - step-by-step instructions for common procedures

Conveniently downloadable
Viewable on X-Series Controllers

Dedicated writing staff
Regularly updated

Information provided by expert staff

High quality, full color photos - making buttons, screens, parts, etc. easy to identify
www.waterjetuniversity.com

The WARDJet Waterjet University™ is the place to find answers for all of your waterjet cutting questions. Discover everything you’ve ever wanted to know about waterjet cutting - from pump and gantry design, waterjet applications, comparisons with other cutting technologies and more! More information is added on a regular basis, so check back often!

INTRODUCTION TO WATERJET CUTTING

Chapter 1 – Waterjet Cutting Characteristics
Chapter 2 – Waterjet Relationship Parameters
Chapter 3 – How High Pressure Pumps Work
Chapter 4 – Why Water Quality is Important
INTRODUCTION TO WATERJET CUTTING
As one of the fastest growing machine tool industries, water jet cutting has proven to save time and money on countless applications such as metal cutting and stone cutting. See the advantages of water jet cutting and view our photo album of different uses for the tool. Whether it’s cutting sheet metal, titanium, granite, marble, or steel - water jet might be the answer for you.

BENEFITS OF WATERJET CUTTING
Let’s Take a Look... Waterjet cutting is best described as an accelerated erosion process that we are controlling. For this reason, waterjet can cut or erode through virtually any material known, making it one of the most versatile machines available.

As one of the fastest growing machine tool industries, waterjet cutting has proven to save time and money on countless applications. Please take a look at the advantages below to see if waterjet could be for you.

TOLERANCES
Tolerances tighter than +/- 0.005” are achievable, especially in thinner materials such as 1” stainless steel. However, high tolerances come with a price, sometimes up to 500% higher than if the same part had been specified with a tolerance of +/- 0.015”. By being more flexible with tolerances, prices will plummet as cutting speeds increase. Waterjet cutting has the ability to vary tolerances in different locations on a part, ensuring the best pricing and quality.

THICKNESS AND KERF
Materials ranging from 10” stainless steel to 0.010” acrylics can be cut by waterjet, making it a very versatile tool. Stacking of very thin materials to increase productivity is possible. Kerf ranges from 0.020” to 0.050”.

TAPER AND EDGE FINISH
Taper and edge finish are directly related to cut speed. The greater the speed, the more taper and the coarser the edge finish. As the waterjet slows down, taper can be eliminated and the finish of about 120 achieved. Again, slower means an increase in time...and price. For a finer edge finish, use a finer abrasive.

NO HEAT AFFECTED ZONE (HAZ)
Waterjet cutting is a natural erosion process involving no chemicals or heat. Because of this, warping and distortion typically associated with laser, plasma and oxy-fuel cutting is eliminated, therefore minimizing the need for secondary processing.

NESTING AND COMMON LINE CUTTING
Unlike laser, plasma and oxy-fuel cutting, waterjet lends itself to common line cutting. WARDJet offers optional state-of-the-art nesting software, allowing you to nest multiple shapes together and cut them with multiple heads. Tracking of remnants and nesting into these odd shapes later, helps save precious material and can contribute toward reducing your operating costs.

WATERJET IN ANY INDUSTRY
The versatility of the waterjet allows it to be used in nearly every industry. There are many different materials that the waterjet can cut. Some of them have unique characteristics that require special attention when cutting.

Please feel free to contact us at (330) 677-9100 if you have questions about specific cutting applications.
CHAPTER 1 – WATERJET CUTTING CHARACTERISTICS

OVERVIEW

For successful abrasive waterjet cutting, there are several factors at the cutting head that determine the precision and quality of the waterjet stream and will affect the quality of part you are able to cut with an abrasive waterjet. There are other factors that will go into cutting a precise and accurate part (machine design, controls, software and high-pressure pump) that will be discussed in other chapters. This chapter will focus on the cutting head and the waterjet as it interacts with the work piece.

HIGH-PRESSURE WATER CUTTING

Water is pressurized to very high pressures, in excess of 50,000 psi. This pressurization is accomplished with the use of pumps of various designs, discussed in chapter 3 “How It Works”.

The high pressure water is transported through a series of stainless steel tubes to a cutting head. Depending upon the material being cut, the cutting head can be either a “pure water cutting head” or an “abrasive cutting head.”

In the cutting head, the high pressure water is forced through a small diameter orifice. The diameter of this orifice is anywhere from 0.004” to 0.020”. This step converts the pressure of the waterjet stream into speed. Coming out of the orifice, the waterjet stream is moving at 2200 mph or faster. Higher pressure results in higher speed. Smaller diameter orifices yield a faster waterjet stream, but also a stream with less kinetic energy since there is not as much water.

In a pure water cutting head, the water immediately exits the cutting head after passing through the orifice. The speed and power of the waterjet stream is enough to cut soft or thin materials like foam, rubber, soft wood, plastics, carpet, food, car headliners, circuit boards and more.

In an abrasive cutting head, a very hard abrasive, typically garnet is fed into the waterjet stream. The abrasive particles are accelerated to near the speed of the waterjet stream. This gives the abrasive particles much power. The abrasive waterjet stream now travels down through an abrasive nozzle, or mixing tube, approximately 3 inches long with an inner diameter of between .030" and 0.050”. The abrasive waterjet exits the abrasive nozzle and will cut hard materials like metals, stone, acrylic, ceramic, composites, phenolics and porcelain.

A CNC control will move the cutting head in up to 6 axes of motion to cut the targeted work piece.
FACTORS AFFECTING PRECISION & QUALITY OF THE WATERJET AT THE CUTTING

1 – Abrasive mixing tube length
A longer abrasive mixing tube (a.k.a. abrasive nozzle) produces a more coherent waterjet stream. The optimum mixing tube length is 3” – 4” (75 mm – 100 mm).

2 – Alignment of components
The orifice, mixing chamber and abrasive nozzle must be precisely machined and fit perfectly together to avoid damage of consumables by the waterjet stream.

3 – Precise orifice
The inside of the abrasive nozzle must be machined to ensure perfect alignment with the waterjet stream. See “Waterjet stream’s effect on accuracy” section of this chapter for more information.

4 – Diameter of stream
A small diameter waterjet stream, as produced by a .010” (0.25 mm) orifice produces an efficient, high-quality stream. As a trade-off, cutting speeds are slower than when using a 0.014” (0.36 mm) or larger orifice, since less water and abrasive are used. See Chapter 2 “Relationship Parameters" for more information on orifice selection.

5 – Low, controlled stand-off from work
Maintaining a close distance between the nozzle and the work piece, between 0.040” and 0.060” (1.0 – 1.5 mm), is critical for producing accurate parts while also getting the maximum efficiency from the waterjet. Cutting closer to the material limits the amount of atmosphere that the jet has to travel through before reaching the work piece. This limits the expansion of the waterjet stream, since as the jet expands, the effective power of the jet is reduced. Cutting speeds will need to be reduced to compensate. If the distance between the nozzle and the work piece is increased by ¼”, cutting speeds must be reduced by approximately 20% to achieve similar results with respect to tolerance and edge quality. Cutting under water with CNC height control will allow for ultimate control of the waterjet stream.
CREATION OF THE ABRASIVE WATERJET STREAM

Following is a description of how the abrasive waterjet stream is created in the cutting head. The numbers indicated below refer to the numbers in Figure 2 above.

1 – Water pressurized at 50,000 psi or greater enters the cutting head at relatively slow speed, in the order of a few feet per second. (See “How It Works” for more information on how this water pressure is created and transmitted to the cutting head.)

2 – The water is forced through an orifice that has a small diameter orifice, anywhere from 0.004” to 0.045” depending upon the application. These orifices are made of extremely hard material, such as diamond, sapphire or ruby. This step converts the water stream from a high pressure stream to a high velocity stream. At this point the water is moving in excess of 2200 miles per hour (3657 kilometers per hour).

3 – The high velocity of the jet creates a Venturi effect, or vacuum, in the mixing chamber located immediately beneath the orifice. Abrasive, typically garnet is metered from a mini-hopper through a plastic tube down to the cutting head and is sucked into the waterjet stream in the mixing chamber. Cutting speed will increase with more abrasive until a saturation point is reached where speed starts to decrease. If the abrasive amount is increased too high, ultimately the mixing tube will clog.

One of the exciting advancements in waterjet cutting in the past few years is the appearance on CNC- controlled abrasive metering systems. These systems precisely control the amount of abrasive that is allowed to flow to the cutting head. During the piercing process, cutting pressure and abrasive amount are reduced and the cutting head makes small, circular motions in the X and Y axes. This piercing procedure allows for difficult applications, such as piercing of glass and stone, to be processed with relative ease.

4 – The abrasive is fully mixed in the waterjet stream and is accelerated to approximately the speed of the waterjet stream. This step does steal some energy from the waterjet stream, slowing it down slightly.

5 – The abrasive waterjet stream exits the mixing tube with extreme speed and power. The abrasive erodes the material to be cut. The process is referred to as “abrasive waterjet cutting” because it is the abrasive that is actually doing the cutting. The water’s role is simply to give speed and power to the abrasive. In pure waterjet cutting, used for soft materials like foam and food, the force of the waterjet stream alone is enough to cut the material and abrasive is not required.
Kerf angle, or bevel, refers to the dimensional difference between the top and bottom of the cut cross-section. Cutting too fast will result in a wider kerf width at the top of the cut cross-section and a narrower kerf width at the bottom of the zone. In the picture above, from left to right, cuts were done at 26 inches per minute (ipm), 14 ipm and 9.7 ipm (660 millimeters per minute [mm/min], 355 mm/min and 246 mm/min). All other parameters were held constant (pressure 60 kpsi, 0.060" standoff distance, 1.3 lb/min abrasive [4134 bar, 1.5mm and 600 grams/min]). At the top of the cut, kerf width was similar, around 0.044" (1.12 mm). The difference between top and bottom going from left to right was 0.017", 0.013" and 0.011" (0.43 mm, 0.33 mm and 0.28 mm). This shows the decrease in angularity as speed decreases.

The picture to the left shows one additional cut that was done extremely slowly (1 ipm or 25.4 mm/min) to demonstrate that when speed is decreased enough, the kerf width at the bottom of the part will be larger than at the top. In this example the kerf width at the bottom was 0.014" (0.36 mm) larger than at the top.

**DRAG OF WATERJET STREAM AND CUT QUALITY**

Increasing feedrate results in increased trail back of waterjet stream. This concept is shown in Figure 5 below. Rougher edge quality is the result of more shearing action versus erosion action of abrasive at slower speeds. Modern controllers allow the user to adjust cut quality based upon part requirements. High-precision holes can be cut slower for a smoother, straighter cut. Faster cutting speeds with rougher edge quality can be used on less critical areas.

![Figure 3 - 3/4" (20 mm) Aluminum with 3 different cut speeds](image)

![Figure 4 - Increasing trail back of waterjet steam with increasing speed](image)
EFFECT OF NOZZLE HEIGHT

For best cut quality, an optimum distance between the nozzle and the work piece should be maintained. Typically, between 0.040" and 0.060" (1.0 – 1.5 mm) is the optimum height for abrasive waterjet cutting. As the distance increases above 0.060", rounding on the top edge of the cut will result. This occurs because the waterjet stream loses coherence as it travels through open air. Increased nozzle height will also result in increased kerf angle. If the distance between the nozzle and the work piece is increased by ¼", cutting speeds must be reduced by approximately 20% to achieve similar results with respect to tolerance and edge quality. Automatic height control is the most reliable and accurate way to maintain proper standoff distance. Figure 7 shows that if the nozzle height is increased too far, the jet will not have enough power to fully penetrate material that it would easily cut at much lower heights.

EFFECT OF SPEED ON INSIDE CORNERS

Since the waterjet is a non-rigid cutting tool, inside corners on parts can exhibit a certain amount of overcut on the bottom, or exit, side of the part. This can be reduced by decelerating into the corner and slowly accelerating, allowing the bottom portion of the jet to catch up with the top portion around the corner. The waterjet control must have the ability to do this automatically.
TIGHT RADII

Since the waterjet stream is a round tool, with a diameter between 0.030" and 0.040" (0.76 mm and 1.02 mm) for abrasive waterjet cutting, creating any inside corner that is perfectly square is impossible. CAM software will typically read geometries and give a user the option to automatically place a very small radius on these corners. This will avoid damaging the part and reduce processing time, as radii are faster to cut than square corners. For very acute angles, the actual part that is cut may differ significantly from the original drawing and should be considered for form, fit and function before processing.

LEAD-IN AND LEAD-OUT TYPES

Piercing in the scrap area of material and “leading-in” to the actual geometry to cut is standard operating procedure in most waterjet applications. This avoids placing a large blow-out blemish from the initial piercing on the surface of the part. At the end of a cut, a lead-out may be required to remove any “nib” from the lead-in area.

Various types of lead-ins and lead-outs can be experimented with for different materials and thicknesses. Figure 9 shows a few examples of lead-ins and leads-outs.

- Number 1 (straight line lead-in with very short straight line lead-out) is desirable for any sharp corner.
- Number 2 (arc lead-in with short arc lead-out) is good for thinner and softer materials.
- Number 3 (straight line lead in with no lead-out) gives good results on thicker, harder material.
- Number 4 is an example of a straight line lead in with short arc lead-out. CAM software should have the flexibility to combine different types of lead-ins and lead-outs should the user wish to experiment.

REDUCING LEAD-IN/LEAD-OUT WITNESS MARKS

At the end of a cut, a small nib may remain on the bottom portion of the cut in the lead-in/lead-out area. Because of the lagging effect discussed previously, when the jet reaches the end of the cut, the top portion of the jet will find the path of least resistance, and effectively “jump over” a small bit of material leaving a nib. With the more sophisticated controls and software available today, this can be reduced by decelerating at the end of the cut to allow the bottom portion of the jet to catch up with the top before reaching the end of the cut. Figure 10 below shows examples of a large nib because of too much speed at the end of a cut and an example of a minimal witness mark with appropriate slow down at the end of the cut.
WATERJET STREAM’S EFFECT ON ACCURACY

Mixing tubes are made of extremely hard material, sintered boride. However, the nozzles are subject to wear and their cost must be taken into consideration for job costing. The orifice of a mixing tube will typically increase in diameter by about 0.001” per hour of cutting because of the erosion of the abrasive flowing through the nozzle. If this wear occurs in an even fashion, up to 120 hours of cutting can be realized with a nozzle. Controls allow for compensating for this wear by allowing the operator to change the tool offset.

![Figure 10 – New and used mixing tubes. Note orifice on right is off-center.](image)

If the wear of the nozzle is not symmetrical, the waterjet stream will also not be round. This will result in wider tolerances when cutting in a certain direction.

CONSUMABLE MANAGEMENT

The tolerance requirements of a job will dictate the actual number of hours a user can expect from a nozzle. The nozzle can, of course, be set aside and used later for looser tolerance jobs. Control software should allow the ability to track hours on individual components to make consumable management easier. See Figure 12 or an example of orifice and mixing tube tracking.

![Figure 11 - Example of Software Consumable Life Tracking](image)
CHAPTER 2 – WATERJET RELATIONSHIP PARAMETERS

OVERVIEW

This section will focus on relationships between speed and edge quality, pump size, water nozzle and abrasive nozzle selection, maximum number of cutting heads and how some of these parameters can change over time.

DESIRED EDGE QUALITY

Edge quality is defined with the numbers 1 through 5. Lower numbers indicate rougher edge finish; higher numbers are smoother. For thin materials, the difference in cutting speed for Quality 1 could be as much as 3 times faster than the speed for Quality 5. For thicker materials, Quality 1 could be 6 times faster than Quality 5. For example, 4” thick Aluminum Q5 would be 0.72 ipm (18 mm/min) and Q1 would be 4.2 ipm (107 mm/min), 5.8 times faster.

PUMP SPECIFICATIONS

Every waterjet company will be able to supply a chart similar to the following showing the horsepower, maximum pressure and maximum water output for the pumps offered with their systems.

<table>
<thead>
<tr>
<th>Pump Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
</tr>
<tr>
<td>30 HP (22 kW)</td>
</tr>
<tr>
<td>50 HP (37 kW)</td>
</tr>
<tr>
<td>75 HP (56 kW)</td>
</tr>
<tr>
<td>100 HP (75 kW)</td>
</tr>
<tr>
<td>150 HP (112 kW)</td>
</tr>
<tr>
<td>Max. Continuous Output Pressure</td>
</tr>
<tr>
<td>60,000 psi (4137 bar)</td>
</tr>
<tr>
<td>Max. Output Flow Gallons/min (Liters/min)</td>
</tr>
<tr>
<td>0.65 (2.46)</td>
</tr>
<tr>
<td>1.1 (4.16)</td>
</tr>
<tr>
<td>1.6 (6.06)</td>
</tr>
<tr>
<td>2.2 (8.33)</td>
</tr>
<tr>
<td>3.2 (12.1)</td>
</tr>
</tbody>
</table>

HORSEPOWER, PRESSURE AND WATER OUTPUT

In order to achieve a required edge quality, cutting speed, tolerance and production requirement in a cost-effective manner, understanding the relationship amongst horsepower, pressure and water output is vital. These factors will determine the maximum size orifice you will be able to use, the maximum number of cutting heads you will be able to run, what speeds you will be able to cut at and the maximum thickness you will be able to cut cost effectively.

HORSEPOWER

Waterjet pumps are specified in either horsepower (HP) or kilowatts (kW) to indicate the size of the electric motor that creates the force to pressurize the water. Engineers will size the hydraulic motor depending upon the water pressure and water output they are trying to achieve.

The most common pumps seen on the market today are intensifier style pumps. A simplified diagram of the intensifier concept is shown on the next page. The pumps use hydraulics to apply a certain amount of oil pressure on one side of a piston of a certain diameter. On the water side of the pump, the diameter of the piston is much smaller. The difference in the surface area between the hydraulic side and the water side gives a multiplication factor, or intensification, to the pressure from the oil side. Most intensifier pumps have an intensification ratio of 20 times. This design will be explained in more detail in the “How it Works” chapter.
Another style pump sometimes used on waterjets is the direct drive pump. This pump uses an electric motor to turn a crankshaft that moves three or more pistons that create the water pressure, very similar to a car engine. Faster revolutions of the motor create higher pressure and more water volume. The basic concept for the direct drive is shown below.

The horsepower between an intensifier style pump and a direct drive pump cannot be directly compared. Each style pump has benefits and drawbacks that must be evaluated based upon each user’s application.

The question frequently comes up as to which is better, a direct drive or an intensifier pump. Of course depending upon which manufacturer with which you are talking, you will get different answers. The best way to answer this is to ask the following questions and do your own research:

- What percentage of pumps in use today are intensifier as opposed to direct drive?
- What percentage of new machines being sold today have intensifier pumps versus direct drive?
- How many businesses have been created to swap out a direct drive pump with a retrofit kit to change over to an intensifier – basically dispose of the direct drive?
- How many businesses have been created to swap out an intensifier pump for a direct drive – in other words dispose of an intensifier pump?
- What are the maintenance costs associated with each style pump for the first 1500 hours, including replacement of consumable and spare parts?
- How much downtime is involved to replace consumable and spare parts on each style pump? For more on pump types, please refer to the “How It Works” chapter.

For more on pump types, please refer to the “How It Works” chapter.
**PRESSURE**

The pressure of the pump, measured in PSI, will determine cutting speeds for a given orifice size and number of heads. All other things being equal, there is an almost direct correlation between pressure and cutting speed; higher pressure results in higher cutting speeds. From a practical standpoint, increasing pressure also results in higher pump consumable costs, so that must be weighed against the faster cutting speeds.

The following graph shows the cutting speeds for ½" (12 mm) stainless steel for a Quality 2 edge finish. The two lines represent two common combinations of orifices and abrasive nozzles. In each case, doubling the pressure from 30,000 psi (2068 bar) to 60,000 psi (4137 bar) results in an increase in linear cutting speed of approximately 2.9 times.

![Effect of Pressure on Cut Rates](image_url)

**WATER OUTPUT**

Water output, or flow rate, is a function of horsepower and pressure. A 50 HP intensifier pump running at 60,000 psi will generally have a maximum output of 1 gallon per minute (gpm). A 100 HP pump running at 60,000 psi will typically put out 2 gpm. This information will help you determine the maximum number of cutting heads that you can use with a pump. Different pump manufacturers will produce slightly different volumes. They may also specify a Maximum Output Pressure and an Operating Output Pressure with different associated water outputs. It is important to verify that the water output specified is what you can expect on a regular production basis (i.e. flow rate based off of Operating Output Pressure).
ORIFICE SELECTION – THE SCIENTIFIC WAY

The Maximum Continuous Output Pressure and Maximum Output Flow from the “Pump Specifications” chart are important in order to understand how many cutting heads you will be able to run with a pump.

<table>
<thead>
<tr>
<th>Pump Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
</tr>
<tr>
<td>Max. Continuous Output Pressure</td>
</tr>
<tr>
<td>Max. Output Flow</td>
</tr>
</tbody>
</table>

These numbers can be used in conjunction with the following “Flow Rate Through an Orifice” chart to determine the number of cutting heads you can use.

<table>
<thead>
<tr>
<th>Flow Rate (gpm) Through an Orifice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure (psi) x 1000</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>0.003</td>
</tr>
<tr>
<td>0.004</td>
</tr>
<tr>
<td>0.005</td>
</tr>
<tr>
<td>0.006</td>
</tr>
<tr>
<td>0.007</td>
</tr>
<tr>
<td>0.008</td>
</tr>
<tr>
<td>0.009</td>
</tr>
<tr>
<td>0.010</td>
</tr>
<tr>
<td>0.011</td>
</tr>
<tr>
<td>0.012</td>
</tr>
<tr>
<td>0.013</td>
</tr>
<tr>
<td>0.014</td>
</tr>
<tr>
<td>0.015</td>
</tr>
<tr>
<td>0.016</td>
</tr>
<tr>
<td>0.017</td>
</tr>
<tr>
<td>0.018</td>
</tr>
<tr>
<td>0.019</td>
</tr>
<tr>
<td>0.020</td>
</tr>
<tr>
<td>0.021</td>
</tr>
<tr>
<td>0.022</td>
</tr>
</tbody>
</table>
The following chart duplicates the previous chart, but for metric information.

| Orifice Diameter (mm) | 0.08 | 0.10 | 0.11 | 0.12 | 0.13 | 0.14 | 0.15 | 0.16 | 0.17 | 0.18 | 0.19 | 0.20 | 0.21 | 0.22 | 0.23 | 0.24 | 0.25 | 0.26 | 0.27 | 0.28 | 0.29 | 0.30 | 0.31 | 0.32 | 0.33 | 0.34 | 0.35 | 0.36 | 0.37 | 0.38 | 0.39 | 0.40 | 0.41 | 0.42 | 0.43 | 0.44 | 0.45 | 0.46 | 0.47 | 0.48 | 0.49 | 0.50 | 0.51 | 0.52 | 0.53 | 0.54 | 0.55 | 0.56 |
|----------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Flow Rate (Liters/min.) Through an Orifice | 137 | 174 | 206 | 241 | 275 | 310 | 345 | 380 | 414 | 449 | 483 | 518 | 553 | 588 | 623 | 657 | 692 | 727 | 762 | 797 | 832 | 867 | 902 | 937 | 972 | 1007 | 1042 | 1077 | 1112 | 1147 | 1182 | 1217 | 1252 | 1287 | 1322 | 1357 | 1392 | 1427 | 1462 | 1497 | 1532 | 1567 | 1602 | 1637 | 1672 | 1707 | 1742 | 1777 | 1812 | 1847 | 1882 | 1917 | 1952 | 1987 | 2022 | 2057 | 2092 | 2127 | 2162 | 2197 | 2232 | 2267 | 2302 | 2337 | 2372 | 2407 | 2442 | 2477 | 2512 | 2547 | 2582 | 2617 | 2652 | 2687 | 2722 | 2757 | 2792 | 2827 |
| Pressure (bar) x 1000 | 137 | 174 | 206 | 241 | 275 | 310 | 345 | 380 | 414 | 449 | 483 | 518 | 553 | 588 | 623 | 657 | 692 | 727 | 762 | 797 | 832 | 867 | 902 | 937 | 972 | 1007 | 1042 | 1077 | 1112 | 1147 | 1182 | 1217 | 1252 | 1287 | 1322 | 1357 | 1392 | 1427 | 1462 | 1497 | 1532 | 1567 | 1602 | 1637 | 1672 | 1707 | 1742 | 1777 | 1812 | 1847 | 1882 | 1917 | 1952 | 1987 | 2022 | 2057 | 2092 | 2127 | 2162 | 2197 | 2232 | 2267 | 2302 | 2337 | 2372 | 2407 | 2442 | 2477 | 2512 | 2547 | 2582 | 2617 | 2652 | 2687 | 2722 | 2757 | 2792 | 2827 |

**Example 1** – 50 HP Pump, 1 Cutting Head, 60,000 PSI, 1.1 GPM water output

1. If you were looking at the 50 HP pump, from the “Pump Specification” chart you would know that your pump puts out 1.1 gpm at 60,000 psi.
2. You would look down under the “60” column (corresponding to the 60,000 psi pump) in the “Flow Rate” chart until you found a number equal to or less than 1.1. In this case, you would end up at the cell with 1.00.

<table>
<thead>
<tr>
<th>Orifice Diameter (inch)</th>
<th>Pressure (psi) x 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td>0.003</td>
<td>0.03</td>
</tr>
<tr>
<td>0.004</td>
<td>0.05</td>
</tr>
<tr>
<td>0.005</td>
<td>0.07</td>
</tr>
<tr>
<td>0.006</td>
<td>0.11</td>
</tr>
<tr>
<td>0.007</td>
<td>0.15</td>
</tr>
<tr>
<td>0.008</td>
<td>0.19</td>
</tr>
<tr>
<td>0.009</td>
<td>0.24</td>
</tr>
<tr>
<td>0.010</td>
<td>0.30</td>
</tr>
<tr>
<td>0.011</td>
<td>0.36</td>
</tr>
<tr>
<td>0.012</td>
<td>0.43</td>
</tr>
<tr>
<td>0.013</td>
<td>0.50</td>
</tr>
<tr>
<td>v</td>
<td>0.58</td>
</tr>
</tbody>
</table>

3. You would then follow that row across to the left to see the maximum size orifice you could use for single-head cutting. In this case, the cell shows that a 0.014” would be the maximum recommended orifice for one head at 60,000 psi.

<table>
<thead>
<tr>
<th>Orifice Diameter (inch)</th>
<th>Pressure (psi) x 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td>0.003</td>
<td>0.03</td>
</tr>
<tr>
<td>0.004</td>
<td>0.05</td>
</tr>
<tr>
<td>0.005</td>
<td>0.07</td>
</tr>
<tr>
<td>0.006</td>
<td>0.11</td>
</tr>
<tr>
<td>0.007</td>
<td>0.15</td>
</tr>
<tr>
<td>0.008</td>
<td>0.19</td>
</tr>
<tr>
<td>0.009</td>
<td>0.24</td>
</tr>
<tr>
<td>0.010</td>
<td>0.30</td>
</tr>
<tr>
<td>0.011</td>
<td>0.36</td>
</tr>
<tr>
<td>0.012</td>
<td>0.43</td>
</tr>
<tr>
<td>0.013</td>
<td>0.50</td>
</tr>
<tr>
<td>0.014</td>
<td>0.58</td>
</tr>
</tbody>
</table>
If you were in a tight spot where you only had a 0.015” orifice you might be able to use it by running the pump at 55,000 psi.

<table>
<thead>
<tr>
<th>Orifice Diameter (inch)</th>
<th>Flow Rate (gpm) Through an Orifice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pressure (psi) x 1000</td>
</tr>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td>0.003</td>
<td>0.03</td>
</tr>
<tr>
<td>0.004</td>
<td>0.05</td>
</tr>
<tr>
<td>0.005</td>
<td>0.07</td>
</tr>
<tr>
<td>0.006</td>
<td>0.11</td>
</tr>
<tr>
<td>0.007</td>
<td>0.15</td>
</tr>
<tr>
<td>0.008</td>
<td>0.19</td>
</tr>
<tr>
<td>0.009</td>
<td>0.24</td>
</tr>
<tr>
<td>0.010</td>
<td>0.30</td>
</tr>
<tr>
<td>0.011</td>
<td>0.36</td>
</tr>
<tr>
<td>0.012</td>
<td>0.43</td>
</tr>
<tr>
<td>0.013</td>
<td>0.50</td>
</tr>
<tr>
<td>0.014</td>
<td>0.58</td>
</tr>
<tr>
<td>v</td>
<td>0.66</td>
</tr>
</tbody>
</table>

You would be at the 1.1 gpm limitation of the pump. If there were any water leaks in your system between the pump and the cutting head, you would likely have a pump “over stroke” situation where the pump would try to cycle too fast attempting to create the required pressure. With modern pumps, there is no harm done if this happens. The pump is simply shut down to protect itself from damage and an error message is displayed for the operator.

**Example 2** – 50 HP Pump, 2 Cutting Heads, 60,000 PSI, 1.1 GPM water output

If you wanted to run 2 cutting heads, then you would take the 1.1 gpm number, divide it by 2 for a maximum of 0.55 gpm per head. Look for the cell under 60 kpsi that has a number smaller than or equal to 0.55.

<table>
<thead>
<tr>
<th>Orifice Diameter (inch)</th>
<th>Flow Rate (gpm) Through an Orifice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pressure (psi) x 1000</td>
</tr>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td>0.003</td>
<td>0.03</td>
</tr>
<tr>
<td>0.004</td>
<td>0.05</td>
</tr>
<tr>
<td>0.005</td>
<td>0.07</td>
</tr>
<tr>
<td>0.006</td>
<td>0.11</td>
</tr>
<tr>
<td>0.007</td>
<td>0.15</td>
</tr>
<tr>
<td>0.008</td>
<td>0.19</td>
</tr>
<tr>
<td>0.009</td>
<td>0.24</td>
</tr>
<tr>
<td>0.010</td>
<td>0.30</td>
</tr>
</tbody>
</table>

In this case, under the “60” column you would end up in the 0.51 cell, meaning that one 0.010” orifice would put out 0.51 gpm. The maximum number of heads that you could run with the pump at 60 kpsi would be two (1.1 ÷ 2 = 0.55. 0.55 > 0.51 = OK).
ORIFICE SELECTION – THE EASY WAY

Since the pump design engineers have done most of the hard math already, most users need only refer to an “Orifice Selection Chart” similar to the following, which is usually supplied by the pump manufacturer.

<table>
<thead>
<tr>
<th>Max. # of orifices and dia. (inches)</th>
<th>30 HP</th>
<th>50 HP</th>
<th>75 HP</th>
<th>100 HP</th>
<th>150 HP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.011</td>
<td>0.014</td>
<td>0.018</td>
<td>0.021</td>
<td>0.025</td>
</tr>
<tr>
<td>2</td>
<td>0.007</td>
<td>0.010</td>
<td>0.013</td>
<td>0.014</td>
<td>0.018</td>
</tr>
<tr>
<td>3</td>
<td>0.006</td>
<td>0.008</td>
<td>0.010</td>
<td>0.012</td>
<td>0.014</td>
</tr>
<tr>
<td>4</td>
<td>N/A</td>
<td>0.007</td>
<td>0.009</td>
<td>0.010</td>
<td>0.013</td>
</tr>
<tr>
<td>5</td>
<td>N/A</td>
<td>0.006</td>
<td>0.008</td>
<td>0.009</td>
<td>0.011</td>
</tr>
<tr>
<td>6</td>
<td>N/A</td>
<td>N/A</td>
<td>0.007</td>
<td>0.008</td>
<td>0.010</td>
</tr>
</tbody>
</table>

Here you would quickly see that for the 50 HP pump, you could use either one 0.014” orifice or two 0.010” orifices.

GENERAL PUMP SELECTION GUIDELINES

The next step in determining which pump is appropriate for your application is to determine the types of material you will be cutting and how many cutting heads you want to be able to run at one time.

If you are cutting parts out of foam, wood, cardboard or other soft materials, then you would be dealing with a pure water application. For pure water applications, a 30 HP pump is usually sufficient. As you can see from the previous Orifice Selection chart, up to three cutting heads could be used with 0.006” orifices. If more cutting heads were needed, then a 50 HP pump could handle up to five cutting heads with 0.006” orifices.

For abrasive applications, the 50 HP is the general starting point. With this pump, you can run one head with a 0.014" orifice or two heads with 0.010" orifices. The 0.010" orifice will perform exceptionally well with respect to speed and cut quality on thinner material (1/2” and under).

The following graph shows cutting speeds for single head versus dual head cutting in ½” stainless steel. As thickness get beyond 2” (50 mm), the absolute difference in cutting speeds between the nozzle combinations starts to decrease more dramatically.

Cutting with two heads with 0.010" orifices effectively doubles the cutting speed (2 x 5.5 ipm) versus cutting with one head with a 0.010” orifice. Compared to cutting with one head with the 0.014” orifice, cutting with two heads will increase output by about 20 percent. To put this concept into real world terms, it would be like if you started cutting on a job on Monday morning with two cutting heads, then you could get it to your customer by Thursday afternoon. If you cut the job with one head, your customer wouldn’t get the part until Friday afternoon.
For someone looking to cut thicker materials on a consistent basis, then we would suggest allocating 50 HP per cutting head. If you selected a 100 HP pump, you could run two heads with 0.014”.

<table>
<thead>
<tr>
<th>Max. # of orifices and dia. inches</th>
<th>30 HP</th>
<th>50 HP</th>
<th>75 HP</th>
<th>100 HP</th>
<th>150 HP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.011</td>
<td>0.014</td>
<td>0.018</td>
<td>0.021</td>
<td>0.025</td>
</tr>
<tr>
<td>2</td>
<td>0.007</td>
<td>0.010</td>
<td>0.013</td>
<td>0.014</td>
<td>0.018</td>
</tr>
<tr>
<td>3</td>
<td>0.006</td>
<td>0.008</td>
<td>0.010</td>
<td>0.012</td>
<td>0.014</td>
</tr>
<tr>
<td>4</td>
<td>N/A</td>
<td>0.007</td>
<td>0.009</td>
<td>0.010</td>
<td>0.013</td>
</tr>
<tr>
<td>5</td>
<td>N/A</td>
<td>0.006</td>
<td>0.008</td>
<td>0.009</td>
<td>0.011</td>
</tr>
<tr>
<td>6</td>
<td>N/A</td>
<td>N/A</td>
<td>0.007</td>
<td>0.008</td>
<td>0.010</td>
</tr>
</tbody>
</table>

If you are cutting very small parts in high volumes, you might want a very large cutting table where you could run four cutting heads and quadruple your production over a single-headed system. In that case you would likely choose the 150 HP pump that can run four heads with 0.013” orifices.

**ABRASIVE NOZZLE SELECTION**

As a general rule, the diameter of the orifice for the abrasive nozzle should be approximately three times the water nozzle orifice. Some people would suggest using a smaller ratio, about 2.5 times. Using a smaller ratio does produce faster cutting speeds. The trade-off is increased nozzle wear and costs. Part tolerance will suffer because of the increased speed of nozzle wear.

Following is a quick reference guide for the most common orifices for abrasive waterjet cutting. Typical abrasive amounts and water flow are also shown for easy reference.

<table>
<thead>
<tr>
<th>Orifice (inches)</th>
<th>Abrasive Nozzle (Inches)</th>
<th>Abrasive Flow (lbs/min)</th>
<th>Water Flow @ 60 kpsi (GPM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.010</td>
<td>0.030</td>
<td>0.65 to 0.7</td>
<td>0.51</td>
</tr>
<tr>
<td>0.011</td>
<td>0.030</td>
<td>0.8</td>
<td>0.62</td>
</tr>
<tr>
<td>0.012</td>
<td>0.030</td>
<td>0.9 to 1.0</td>
<td>0.73</td>
</tr>
<tr>
<td>0.013</td>
<td>0.040</td>
<td>1.4</td>
<td>0.86</td>
</tr>
<tr>
<td>0.014</td>
<td>0.040</td>
<td>1.4</td>
<td>1.00</td>
</tr>
<tr>
<td>0.015</td>
<td>0.040</td>
<td>1.5</td>
<td>1.14</td>
</tr>
<tr>
<td>0.016</td>
<td>0.040</td>
<td>1.6</td>
<td>1.30</td>
</tr>
</tbody>
</table>
ABRASIVE AMOUNT AND CUTTING SPEEDS

In Chapter 1, “Cutting Characteristics,” under the section “Creation of the abrasive waterjet stream”, we discussed how the abrasive waterjet stream is created.

As abrasive is added to the waterjet stream, the abrasive particles are accelerated to near the speed of the waterjet, approximately 2200 miles per hour (almost three times the speed of sound. This speed imparts momentum to the abrasive particles so that they can erode the material. Adding more abrasive gives more energy to the process and erosion occurs faster. Eventually a saturation point occurs where adding more abrasive robs speed and power from the waterjet stream and cutting speeds will start to decrease. Each waterjet manufacturer goes through extensive testing with various orifice and nozzle combinations to find the optimum abrasive amount, balancing cost and cutting speed.

The following graph shows what happens to cutting speed for \(\frac{1}{2}\)" stainless steel as abrasive is added. Speeds are shown for the two most common orifice/abrasive nozzle combinations, 0.010" orifice with a 0.030" abrasive nozzle (orange line) and 0.014" orifice with a 0.040" abrasive nozzle (blue line).

Starting with an abrasive flow of zero pounds per minute, there would be absolutely no penetration of the material except for maybe a very light etching of the top surface of the material. At this point cutting speed is zero. Cutting speed increases as more and more abrasive is added. For the larger nozzle combination, speed increases until around 1.5 pounds per minute. At this point, cutting speed starts to decrease as too much kinetic energy is removed from the waterjet stream by the abrasive. A similar thing happens with the smaller orifice/nozzle combination, but at slower speeds and lower abrasive amounts.

![Graph showing cutting speed vs. abrasive amount for 0.014"/0.040" and 0.010"/0.030" nozzles.]

The optimum cost point may be slightly below what looks to be the apex of the speed curve. The “Law of Diminishing Returns” becomes evident. As the maximum speed is approached, each additional unit of abrasive that is added results in an ever smaller increase in speed. In the case of the orange line, increasing the abrasive from 0.7 pounds per minute to 1.0 pounds per minute yields an increase in speed of only 0.2 inches per minute. This 3.6% increase in speed results in a 4.7% increase in cost per inch.
SPEED AND EFFICIENCY OF NOZZLE COMBINATIONS

We can see in the following graph that larger orifice/abrasive nozzle combinations will cut faster than smaller combinations. With the larger nozzle combination, virtually all of the pump’s power is used, so it will cut faster. The smaller orifice/nozzle cuts slower because less total power from the pump is used.

Smaller orifice/nozzle combinations are more efficient though in their use of water and abrasive. The available power of the waterjet is concentrated into a smaller area, so more power is directed to the cut.

**Increasing Abrasive Amount**

1/2" Stainless Steel
60,000 psi, Quality = 2

**Comparison of Abrasive Waterjet Streams**
In the previous chart, the diameter of the larger waterjet stream on the right is 33% wider and the area of this diameter is 78% greater. This makes the energy density lower than the smaller orifice/nozzle combination. The result is that, as shown earlier and repeated in the graph below, cutting with two 0.010"/0.030" heads is more cost-effective and productive than cutting with one 0.014"/0.040" head in thinner materials (approximately ½" and thinner).

**NOZZLE WEAR**

As the abrasive nozzle wears, the diameter of the abrasive waterjet stream increases. The diameter increases by approximately 0.0001" per hour of cutting. Power per square inch is reduced. Therefore, the feed rate must be reduced in order to maintain the same edge finish, or the quality of the edge will deteriorate.

**CUTTING SPEED CALCULATORS**

Various waterjet feed rate calculators are available online. With these calculators, you can play around with the various parameters to see how cutting speed and cost per inch are affected. Below is an example of one such calculator.

With all of these calculators, it is more important to focus on cost per inch (or foot, or meter), rather than cost per hour. Focusing on cost per foot takes into account the diminishing returns discussed in the previous section. Another thing to keep in mind is that these calculators are only showing straight line cutting speeds. Depending upon part geometry, piercing times, machine design and more, actual part cutting times can vary significantly from just taking the total linear inches of cutting in a part and dividing that number by the inches per minute shown in a calculator. The calculators are useful though in at least getting an idea of speeds and costs.
MACHINABILITY INDEX

The Machinability Index shown in most waterjet feed rate calculators defines the relative cutting rates of different materials. Materials with higher numbers cut proportionately faster than lower numbers. Mild steel has a baseline value of one. Stainless steel at 0.9 would indicate that it cuts about 10% slower than mild steel to achieve similar edge quality and tolerance results.

If you know the machinability indexes of two materials, you can estimate fairly easily a good cutting speed of one material from the other. We know that the Machinability Index of stainless steel is 0.9 and below we see that Aluminum’s Machinability Index is 2.9. You know that ½” stainless cuts at 5.5 ipm for the edge quality you want. You want to know the speed for ½” Aluminum. Divide the machinability of Aluminum by the machinability of stainless. $2.9 \div 0.9 = 3.2$. Multiply the cutting speed for Stainless by 3.2 for the cutting speed in the same thickness of Aluminum. $5.5 \text{ ipm} \times 3.2 = 17.6 \text{ ipm}$. Therefore, 17.6 ipm would be a good place to start for ½” Aluminum.

SUMMARY

In this chapter we looked at the three critical specifications of a high pressure pump: horsepower, pressure and water output. We reviewed how to figure out what size orifice to use based upon these pump specifications and how many cutting heads are being used. We covered the productivity increases and cost savings of using two smaller orifices versus one large orifice. Additionally, abrasive nozzle diameter selection was discussed in terms of the ratio to the orifice being used. Finally, we looked at waterjet feed rate calculators and how Machinability Indices can be used to extrapolate the cutting speed of one material from a different material.
CHAPTER 3 – HOW HIGH PRESSURE PUMPS WORK

OVERVIEW

This chapter will discuss the pressurization of water in more detail, the two main pump designs that are used to do this, parts of the intensifier pump and troubleshooting of leaks in the intensifier pump. Transport and metering of abrasive will also be covered.

TYPES OF PUMPS

Intensifier

Intensifier pumps are called intensifiers because they use the concept of pressure intensification or amplification to generate the desired water pressure.

If you apply pressure to one side of a cylinder and the other side of the cylinder is the same surface area, the pressure on the other side will be the same. If the surface area of the smaller side is half, then the pressure on that side will be doubled. Generally with intensifier pumps there is a 20 times difference between the large surface area (where the oil pressure is applied) and the small surface area (where the water pressure is generated). The following picture shows this concept.

![Image of intensifier pump]

**Figure 12 - Difference between surface areas determines pressure intensification**

Ultimately, there must be a restriction in the flow of water in order for the pressure to be generated. This restriction is generated by the orifice in the cutting head. Pressure is maintained until the orifice diameter exceeds the limits for water output of the pump.

For very small diameter orifices, in order to maintain pressure, the pump only needs to cycle very slowly to maintain pressure. As the orifice gets larger, the pump must work faster to maintain pressure and water flow. If the orifice gets too large, the pump tries to cycle too fast for the design specification. An “over stroke” situation is sensed by the control and the pump is stopped with an error message.

If there are leaks in the water circuit between the pump and the cutting head, this can also result in a pump “over stroke” situation. The leaks effectively rob water available to go to the cutting head. The same as putting in too large of an orifice, the pump runs faster to maintain pressure until it reaches its limit.

Typically, intensifiers stroke at around 50 – 60 strokes per minute when working at full capacity.
1. Oil is forced into the right half of the hydraulic cylinder.

2. The piston-plunger assembly moves to the left. Oil is displaced out of the left half of the hydraulic cylinder and the water in the left high pressure cylinder is pressurized.

3. The plunger moves to the left.

4. Once pressure has begun to build, the high pressure water is forced out of the intensifier through the center of the check valve.

5. While the piston-plunger assembly is moving to the left, it is also allowing fresh water to flow into the right high pressure cylinder through the inlet holes of the check valve.

6. When the plunger-piston assembly has reached the end of its stroke to the left, the right high pressure cylinder is now full of water.

7. The directional control valve receives a signal via a proximity sensor near the piston to reverse the flow of hydraulic oil. Oil is now forced into the left half of the hydraulic cylinder and the piston moves to the right.

8. Oil is displaced out of the right half of the hydraulic cylinder while the water in the right high pressure cylinder is pressurized by the right plunger.
**DIRECT DRIVE**

A direct drive pump works like a car’s engine. A motor turns a crankshaft attached to 3 or more offset pistons. As the crankshaft turns, the pistons reciprocate in their respective cylinders, creating pressure in the water. Pressure and flow rate are determined by how fast the motor turns the crankshaft.

Direct drive pumps cycle much faster than intensifiers, on the order of 1500 revolutions per minute. Direct drive pumps generally are found in lower pressure applications (i.e. 55,000 pounds per square inch and under). Maintenance on the direct drive pump tends to take longer than an intensifier pump. Direct drive pumps can only run more than one cutting head only if all cutting heads are cutting the same part at the same time. With an intensifier pump, you could have cutting heads on multiple machines, cutting different parts, cycling the various cutting heads on and off in any sequence. The intensifier pump will need to only vary its stroke rate accordingly to maintain flow and pressure.

**PARTS OF THE INTENSIFIER PUMP**

1. **Electric motor and hydraulic pump**
   
The electric motor and hydraulic pump (number 1 in picture above) create the oil pressure needed for the oil side of the intensifier. This assembly is normally in the lower portion of the pump cabinet. The electric motor and pump are rated in HP (or kW for metric). Typical pump sizes are 30 HP, 50 HP, 75 HP, 100 HP and 150 HP. As discussed in the previous chapter, each pump will have an associated water output volume (gallons per minute) and pressure (psi).

   Again it is important to remember that HP is not necessarily an indication of pressure. A 150 HP pump doesn’t necessarily create more pressure than a 50 HP pump. Horsepower is more directly related to water output, since more HP will be needed to create enough power to move the piston/plunger assembly in the intensifier at the required stroke rate.
2. Directional control valves
The directional control valve (2) controls the direction of flow of the hydraulic oil to and from the intensifier.

![Figure 14 - Directional Control Valve (2)](image)

3. Intensifier
The intensifier proper consists of the hydraulic cylinder (4), high pressure cylinders (7), and check valves (8) and end caps(9). Not visible from the outside are the piston and plunger.

![Figure 15 – Intensifier](image)

4. Hydraulic cylinder
The hydraulic cylinder houses the piston and is the area where the hydraulic oil does its work. The directional control valves control the flow of oil into and out of each side of the hydraulic cylinder. At each end of the hydraulic cylinder is an end plate that is used to connect the hydraulic cylinder to the high pressure cylinder. The two end plates for the hydraulic cylinder are connected and pulled tightly in place with 4 tie rods and bolts.

![Figure 16 - Hydraulic cylinder (4)](image)

5. Piston
The piston is the larger diameter cylindrical part located within the hydraulic cylinder. The piston effectively splits the hydraulic cylinder into a left side and a right side. Oil cannot pass from one side to the other past the piston. It must exit and enter the hydraulic cylinder through the hoses attached to the directional control valve. The hydraulic oil pressure is exerted onto either side of the piston in an alternating fashion so that a back-and-forth movement of the piston and plunger assembly is generated.

![Figure 17 - Piston (5) and plunger (6) assembly](image)
6. Plunger
The plungers (6 in Figure 7) are the two smaller diameter shafts that are connected to each side of the piston. The attachment point is inside of the hydraulic cylinder. The other ends of the plungers extend into the left and right high pressure cylinders. Seals are placed around the plunger shaft to keep oil from seeping into the water side of the pump, and vice versa. The plungers are made out of either stainless steel, or, more recently, ceramic. Ceramic is used because of its ability to handle heat and high pressure with little thermal expansion.

7. High pressure cylinder
The two high pressure cylinders (7 in Figures 8 and 2) are where the water is pressurized. They are usually referred to as “left hand side” and “right hand side.” The high pressure cylinders are machined out of very thick stainless steel and treated in order to withstand the extreme pressures they are put under on a continual, cyclical basis.

8. Check Valve
There is one check valve (number 8 in Figures 15 and 21) at the end of each high pressure cylinder at the end opposite from the hydraulic cylinder. The check valve allows fresh water to enter the high pressure cylinder and high pressure water to exit the intensifier. The check valve is designed to only let water flow in one direction. Fresh water comes in though channels machined in the sides and exits through one or more holes in the face of the valve. Various seals, poppets and springs are used to maintain this water flow. Over several hundred hours these components will wear, allowing pressurized water to flow out the water inlet path, or allowing pressurized water to seep back into the high pressure cylinder. The symptoms and diagnosis of these various situations will be discussed later in the “Maintenance” chapter.
9. End Cap
The end cap (number 9 in Figures 13 and 15) is either a cylindrical or square item. The cylindrical version screws onto the output end of the high pressure cylinder. The square type is held in place with tie rods and bolts. The end cap has a hole in the center for the check valve and outlet body. It will also have a connection point for the incoming fresh water. The water flows through holes machined through the cap to line up with inlet holes in the check valve.

![Figure 22 - End Cap](image)

10. High Pressure Tubing
High pressure 304 or 316 stainless steel tubing (number 10 in Figure 13) is attached to the outlet of each check valve. Common outer diameters are 0.25", 0.313", 0.375" and 0.563". Inner diameters range from 0.062" to 0.312". There is usually a flexible protective covering around the tube.

The high pressure tubing from the left hand high pressure cylinder will join together at some point with the high pressure tubing from the right hand cylinder. The high pressure tubing carries the pressurized water to the pressure attenuator. Additional high pressure tubing will channel the high pressure water to the cutting head.

The length, number of bends and other obstructions to flow (e.g. hand valves) in the high pressure tubing path must be taken into consideration when designing a high pressure waterjet system. Pressure will drop with each bend in the tubing. Also, as the distance between the pump and the cutting head increases, internal friction of the water as it drags against the inner walls will generate heat resulting in a loss of water pressure. This topic will be discussed in more detail in the Chapter 5 “Pressure Drop in Tubing.”

![Figure 23 - High Pressure Tubing](image)

Photo Credit: Autoclave Engineer
11. Pressure Attenuator

The pressure attenuator (number 11 in Figures 13 and 14) smoothes out variations in pressure after the high pressure water has exited the intensifier. With each reversal of cycle of the intensifier, there is a slight delay in the increase of water pressure in the opposite high pressure cylinder. This delay is due to: 1) reversal of motion where instantaneous velocity at the end of the stroke equals zero, and 2) mechanical delays of reversal. All of these factors can result in a drop in water pressure. Some manufacturers do use proprietary technology to reduce this pressure drop, which we suggest you investigate when selecting a pump. Generally, if a 50 HP pump can sustain a 0.014” orifice at 60,000 psi continuous operating pressure, the implication is that this hydraulic pressure drop challenge will have been addressed.

Figure 24 - Pressure Attenuator

Figure 24 shows the pressure fluctuations in the high pressure water line prior to the pressure accumulator. This shows a pressure change from high to low of almost 22,000 psi. So, for a 60,000 psi system, the high pressure water would be going from 60,000 psi to 40,000 psi after every stroke of the intensifier.

If this pressure fluctuation were not smoothed out by the pressure attenuator, cutting results at the work piece would be undesirable. There would be a significant line in the part with every stroke of the intensifier. Recall that any change in pressure results in a change in speed of the waterjet stream at the cutting head. This change in speed changes the speed at which the abrasive particles are moving and, therefore, the amount of force they will impart on the work piece. Lower pressure leads to less speed of the water which leads to less force of the abrasive which leads to slower cutting, or rougher edge quality.

Fortunately the pressure attenuator smoothes out these pressure spikes so that the water at the cutting head maintains a steady pressure, speed and cutting power.

Source: “Pressure and Flow Rate Fluctuations at High Pressure Intensifier Pumps”, F. Trieb, et.al., 2007 American WJTA Conference and Expo
12. Inlet water

Prior to entering the pump cabinet, water may have to be treated to get the water within the waterjet manufacturer’s specifications. Within the pump cabinet, usually in the lower portion, the water will typically go through one or more final filters just prior to entering the intensifier (number 12 in Figures 13 and 26). The inlet water must be able to maintain a specified flow rate and pressure to ensure that the intensifier receives enough water. Incoming water must also meet certain requirements with respect to Total Dissolved Solids (TDS), pH, organic matter, temperature, etc. Poor water quality will result in drastically reduced high pressure component life (i.e. anything the high pressure water comes in contact with). Different pump manufacturers require different inlet water pressures, with some needing as little as 30 psi, and others mandating a water pressure booster pump to maintain 100 psi. Water quality will be discussed in more detail in the chapter 4 “Water Quality.”

13. Controls and PLC

The controls and PLC control the valves in the hydraulic circuit to determine the pressure and flow of the hydraulic oil to and from the intensifier. Various sensor and proximity switches can also be integrated into the controls to monitor the entire pump to verify things like stroke rate, oil temperature and pressure, inlet water pressure and flow rate and more. This capability makes working with and troubleshooting the modern day intensifier much easier.

ON-OFF VALVE

The pneumatic On-Off valve controls the flow of water to the cutting head. The On-Off valve at the cutting is “normally closed.” That is, when there is no compressed air supplied to the On-Off valve, a needle fits tightly against a seat to stop any high pressure water from getting to the cutting head. When compressed air is supplied to the On-Off valve (i.e. “tool on” command from the control), the needle is forced up from its seating location and the high pressure water can flow through the orifice to the cutting head.

In, or near, the high pressure pump cabinet is another On-Off valve that works in tandem with the On-Off valve at the cutting head. The On-Off valve in the pump is typically called the Safety Relief valve. This Safety Relief valve in the pump is “normally open.” This valve will stay open when there is no air supplied to it. When the On-Off valve at the cutting head closes (“tool off” command by control or no power to the system), the Safety Relief valve in the pump will open, relieving all water pressure from the high pressure tubing. When the “tool on” command is issued by the control, the Safety Relief valve closes so that all high pressure water will go to the cutting head. Note, not all manufacturers of new pumps have the Safety Relief valve as standard. We strongly suggest you ask your pump manufacturer if they supply this standard, and when it is activated. Again, some pump manufacturers will only activate the Safety Valve when an E-Stop is pressed; when the pump stops, high pressure lines are still pressurized.

Both of these On-Off valves must be in good working order to protect against accidental high pressure water discharge at the cutting head that could severely injure someone working on or near the cutting head or any of the high pressure lines. Periodic replacement of the needle, seat and associated parts is required to maintain these valves.
ABRASIVE FEEDING SYSTEM

PRESSURIZED BULK HOPPER
Abrasive is transported via tubing and pressure from a large bulk hopper located near the waterjet cutting system to a mini-hopper near the cutting head. Bulk hoppers will normally hold anywhere from several hundred pounds of abrasive to 2200 pounds. If you are cutting with one head and 1.4 pounds per minute of abrasive, then you are consuming about 84 pounds per hour. An 1100 pound hopper would last about 13 hours of operation. This would mean that the machine could run for well over a shift before it needed to be refilled. Most waterjets are provided with approximately 600 pound hoppers, which would equate to about 7 hours of operation. So, at least once during an 8 hour shift the hopper would need to be reloaded. The costs associated with the additional downtime over the course of a year should be evaluated.

MINI-HOPPER
A mini-hopper is typically mounted near and above the cutting head. Most of these mini-hoppers allow for a gravity feed of abrasive down to the cutting head. Many mini-hoppers control the amount of abrasive that can go down to the cutting head with the use of a slide with different size holes in it. The operator can change the position of the slide to change the amount of abrasive to the cutting head.

A recent advance in technology is remote CNC-control of the amount of abrasive released from the minihopper. Having this capability allows for optimum feeding of abrasive to the cutting head in relation to the water pressure at the pump for the following desirable capabilities:

- Piercing of fragile materials like glass or stone. Typically a lower water pressure will be used with a smaller amount of abrasive.
- Changing abrasive amount for different abrasive nozzle sizes to optimize part cost. This can be done automatically if the mini hopper is set up to do this.

SUMMARY
In this chapter, after a brief review of the waterjet cutting process, we looked at the two different style pumps that are used in high pressure waterjet cutting: intensifier and direct drive and covered a few of the advantages of each pump style. The water pressurization process of an intensifier pump was detailed. We went through the different parts of an intensifier pump so that you will have a good idea what a sales person or technician is talking about when they refer to a part in a pump. We also discussed the On-Off valve and how it is used at the cutting head and in the pump. The abrasive feeding system was discussed, as well as the merits of a CNC-controlled abrasive metering system.
CHAPTER 4 – WHY WATER QUALITY IS IMPORTANT

OVERVIEW
This chapter will discuss water quality requirements for high pressure waterjet cutting and why it is crucial to maintain proper water quality.

Note: See “Recommendation for water treatment” at the end of this chapter for a potential solution to everything you are about to read in this chapter about water treatment.

WATER SPECIFICATIONS
Every manufacturer has specific requirements for water quality. Check with the manufacturer to get the specifications for your particular machine.

The water supplied to the intensifier is critical to waterjet cutting due to its direct influence on the service life of the equipment components such as check valves, seals and orifices. A high concentration of Total Dissolved Solids (TDS) causes accelerated wear of any components that come in contact with the high pressure water because of the increased abrasiveness of the water from the TDS.

As part of the installation planning, a water quality analysis should be performed by a commercial company that specializes in water conditioning equipment. The minimum information that should be supplied by this analysis is TDS, silica content and pH value. Companies like Culligan can perform these tests, or you can search “water quality testing” on the internet.

Inlet water should be treated for either the removal of hardness or the reduction of TDS. Water softening is an ion exchange process that removes scale forming minerals such as calcium. TDS reduction can be accomplished with either deionizing (DI) or reverse osmosis equipment. Generally, DI or RO provides better component life than water softening.

A water purification supplier should be consulted to supply the most suitable equipment for special conditions. It might be a good idea to ask any company that you are considering using if they have supplied systems for any other high pressure waterjet cutting systems and check their references.

The best treatment process for a specific application is a function of the original water quality and the desired service life of the affected components. Sixty to 70 ppm of TDS is optimum. Any water treatment producing TDS content of less than 0.5 part per million (ppm) should be avoided since the aggressiveness of such purified water will damage pump components.


**WATER TREATMENT GUIDELINES**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Values</th>
<th>Recommended Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Dissolved Solids (TDS)</td>
<td>Low TDS (&lt;100 ppm)</td>
<td>Good water, requires only softening</td>
</tr>
<tr>
<td></td>
<td>Moderate TDS (100 – 200 ppm)</td>
<td>Can be treated by softening, DI or RO</td>
</tr>
<tr>
<td></td>
<td>High TDS (&gt;200 ppm)</td>
<td>Poor water, should be treated with RO or DI</td>
</tr>
<tr>
<td>Silica Content</td>
<td>High content (&gt;15 ppm)</td>
<td>Dual String Base DI</td>
</tr>
<tr>
<td>pH Value</td>
<td>Treated water must have a value of 6 – 8</td>
<td></td>
</tr>
</tbody>
</table>

**SUSPENDED SOLIDS**

In addition to the treatment described above, the water must be filtered for the removal of suspended solids. Different manufacturers supply differently sized final filters for this purpose, typically down to 0.45 nominal. See “Recommendation for water treatment” at the end of this chapter for an alternative to this.

**WATER SUPPLY**

The initial water supply should be at least 5 gallons per minute at 40 pounds per square inch. The water may be boosted by a small pump to the 80 psi required by most intensifiers. Some intensifiers do not require pressure boosters, requiring only 30 psi for the incoming water. This removes a potential failure point from the system.

**HYDRAULIC OIL COOLING**

Intensifier pumps have hydraulic oil that must be cooled. Typically there are three options:

1. Water-Cooled through a heat exchanger
2. Air-Over-Oil Cooler
3. Closed-Loop Chiller

**1. Heat exchanger – For water cooled pumps**

A heat exchanger is primarily used for cooling the hydraulic fluid of the intensifier pump. Typically the hydraulic oil temperature must be kept below 120° F (49° C). The heat exchanger will require a consistent water flow of 0 to 8 gpm (0 to 30 liters per minute) at an inlet temperature not exceeding 70° F in order to keep the hydraulic fluid at the proper temperature. Actual volume of water will depend on the pump selected. As many pumps are thermostatically controlled, when the pump is cool, it may be that no water is required.

This cooling water must go to drain. The cost of this water must be balanced against the costs of the other two cooling options (air-over-oil and chiller), which would not have any water going down the drain.

Public utility water is usually acceptable for cooling purposes.

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Figure 27 - View of Heat Exchanger
In situations where the water contains heavy mineral deposits, the exchanger tubes may eventually become restricted by particle buildup. If this is a chronic problem, pre-filtration and/or water softening may be necessary. Depending upon plant setup, ambient temperature can also be a factor in cooling the hydraulic fluid. Additional cooling may be required if the intensifier and/or heat exchanger is confined to a small, high-temperature space.

2. Air-Over-Oil Cooler
Some pumps can use an air-over-oil cooler to remove heat from the hydraulic oil, so no heat exchanger is required. In the summer, the unit can be vented outside the building to remove the heat from the building. In the winter it can be vented inside the building to help out with heating the building. The ambient temperature will need to be below a certain number (95 degrees for example) for the air-over-oil cooler to work efficiently.

3. Chiller
A chiller can be used to re-circulate the cooling water that is used by the intensifier’s heat exchanger. It cools the water and then sends it through the heat exchanger again, creating a closed loop. A chiller is most effective in worth considering in a few situations in particular:

- Warmer climates where the efficiency of the heat exchanger may be reduce
- Facilities that cannot send any water to a drain,
- Parts of the country where there is a water shortage, or if the cost of water is high, because a 50 HP pump can use up to 5 gpm for cooling the hydraulics.

The chiller will only reuse the cooling water; you will still be putting approximately 1 gpm with a 50 hp pump of fresh water through the cutting head, which will not be reused with the chiller.

Incoming water for the intensifier should also be maintained at 70° F (21° C) or cooler for best high pressure seal life. If this temperature cannot be maintained, then the chiller can also be used for this water.
WATER CIRCUIT OPTIONS

Following are 4 different scenarios for the water flow through a waterjet cutting system.

Option 1 – Heat exchanger in pump, all water runs to a drain.

Option 2 – Air-Over-Oil cooler
Option 3 – Chiller and heat exchanger. Water for heat exchanger re-circulates; used water from cutting runs to drain.

RECOMMENDATION FOR WATER TREATMENT

WARDJet has found that the use of a good quality water softener in conjunction with a 0.2 absolute final filter to be successful for treatment of water for the intensifier. This setup can be used as long as the water from the cutting tank is not being recycled for use through the intensifier. Worst case, if seal life does not seem to be living up to expectations, then a DI or RO system can be installed.

Option 4 – Heat exchanger, chiller and water filtration. No water to drain. Only water required is make-up water to replace evaporation and spillage.