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Safety Hazards in Waterjet Cutting

By Brian Tenace, P.E.

Waterjet cutting machines (often simply called 'waterjets' in the industry) are essentially platforms that use ultra-high pressure water to manufacture cut parts with accuracy as high as .001 inch. They can cut materials ranging from glass and stone to steel and even plastics. Such machines can cost under $1.00 per minute to run, even including labor. Waterjets are some of the most versatile cutting tools available today. They produce virtually no heat-affected zone. They also use CNC (computer numerically controlled) programs, which allow continuously variable speeds for different edge conditions and cut quality. The waterjet dissipates heat, and the jet stream minimizes harmful chemical vaporization from cut materials. Small and mid-sized companies throughout the U.S. depend on these powerful tools to manage all sorts of custom two-dimensional cuts.

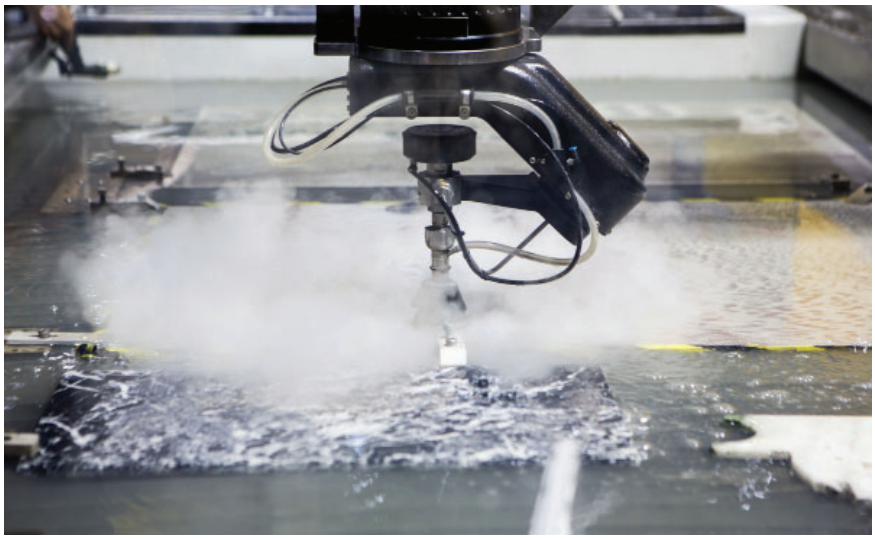
But waterjets present unique hazards to the manufacturing environment. The following challenges require special attention:

- The cutting "torch" utilizes high pressure water and abrasive (usually crushed garnet) that require regular maintenance.
- The waterjet gantry traverses the entire work surface, which increases the cutting danger zone size versus stationary cutting tools.
- Product removal can require walking directly on consumable support grates.
- Overspray can coat the vicinity.

Typical waterjet machine. Note the deposition of abrasive on the machine and surroundings indicative of a heavily used piece of equipment.

High Pressure and Inlet Hoses

High pressure hoses should be inspected during each shift. Inlet hose bending can be minimized during operation of the waterjet by creating large radii in the tubing and following manufacturer installation guidance. Flexible, wide hose supports allow the hammer effects of cycling pumps to be absorbed by the inlet hose. Frequently, this means suspending the hose above the traveling gantry.



Waterjet machine in operation. While underwater cutting and proper settings can minimize spray, cutting with water creates spray that can sometimes wet objects far away from a cutting "torch."

Additionally, supply hoses should be frequently inspected for leakage. At 60,000 psi or greater, water damage can become widespread fast.

Gantry/Intrusion Guarding

Objects or people in the path of traveling gantries are another issue unique to waterjet machines. While many other CNC machines (such as lasers) move the material to the cutting torch, waterjet machines are designed to move the cutting torch to the cut surface.

A moving gantry provides more flexibility in clamping and cutting of heavier or non-uniform parts. However, gantry infrastructure typically extends beyond the table's footprint. Light safety curtains can provide emergency shut-off protection when objects or people get too close to the machine. More traditional barriers, such as a combination of physical curtains and/or chains around the immediate surroundings of the machine, can also lower the chance of incidents.

Product Removal

Operators should never reach over the table during operation of the waterjet. While a stream of hot plasma or laser light screams "danger," it is easy to become complacent around a high-pressure stream of water. We play in water, and it is easy to lose perspective. The "torch's" high velocity stream can amputate limbs instantly, and abrasives can enter the bloodstream from smaller wounds, resulting in massive damage to arteries or the heart.

Product removal from a waterjet table. Note the sharp edges of the support media.

This is why part removal during operation is an issue on waterjet tables. Smaller parts can fall between the grates or be propelled by pressure from below during cutting. Mechanical grabbing devices can mitigate risk somewhat. Smaller grating or even stopping the waterjet are safer alternatives.

This author has witnessed operators climbing onto the grates during operation. This is extremely dangerous and should never be allowed. While the CNC path may be known, the support material is necessarily perforated. Oftentimes, grate gaps are wide enough to allow feet to slip inside. The waterjet "torch" cuts the tops of grates too, often creating a bed of rusted points. Any contact on or near the grates (such as removing parts by hand or kicking pieces into place) requires PPE, such as thick, closed-toe boots or work gloves. Since the environment is wet and the water in a waterjet can remain in the tank for weeks or even months, even small injuries must be treated with care.

Overspray

Any operator who stands within 5-10 feet of a waterjet for long has gotten wet. Overspray occurs frequently during operation of the waterjet. The pressure below the cut can cause parts to move into the stream, reflecting water out of the tank. Piercing produces blow-back. Cutting too fast or with too little pressure (or even cutting directly over support grates) redirects at least some of the water.

Overspray concerns include operator injury and housekeeping problems that extend far beyond the machine footprint. Operators and bystanders must wear eye protection. Wrap-around eye protection is preferred where the operator may look away from the stream. Meanwhile, the mixture of abrasive and water vapor can coat warning signs, painted/taped traffic lanes on the floor, and other surfaces. Electrical outlets should be shielded. Physical curtains around the device direct deposition on other machinery and working areas, and the operator should always watch the machine.

Mismatched wooden pallets with a foot stool used to access waterjet. Note the distance of the ladder to the machine and the age of the pallets. This type of platform should never be used for climbing in a production environment as the risk of falling/tipping is simply too high.

Versatile Tools

While waterjets pose unique challenges, their ability to cut such a diverse range of materials and thicknesses makes them indispensable for industry. Safe management through guarding, smart product handling, good water management, and proper PPE can encourage low risk productivity.

Brian Tenace, PE, holds a Bachelor of Science in Mechanical Engineering and Master of Science in Mechanical Engineering from the University of Florida, and is a Licensed Professional Engineer. He has over 15 years of manufacturing and machine design experience in production and quality-driven environments. Over his engineering career, Brian worked in fenestration design in addition to designing hardware, above/below ground spill containment vessels, extrusions, dies and molds. He conducted root cause analyses for fatigue, weld, and corrosion failures in steel, springs, pressure vents and sheet metals. He developed tests according to standards and custom specifications as needed, along with modifying manufacturing processes. His failure analysis experience includes impact testing, design for ballistic protection, water infiltration resistance and corrosion. Brian has an in-depth knowledge of many standards with emphasis on fenestration standards and impact standards. Brian regularly investigates property damage claims involving machinery and equipment in a variety of environments, as well as personal injury, wrongful death, and product liability claims for both insurance adjusters and attorneys.