

# WJTA Jet News

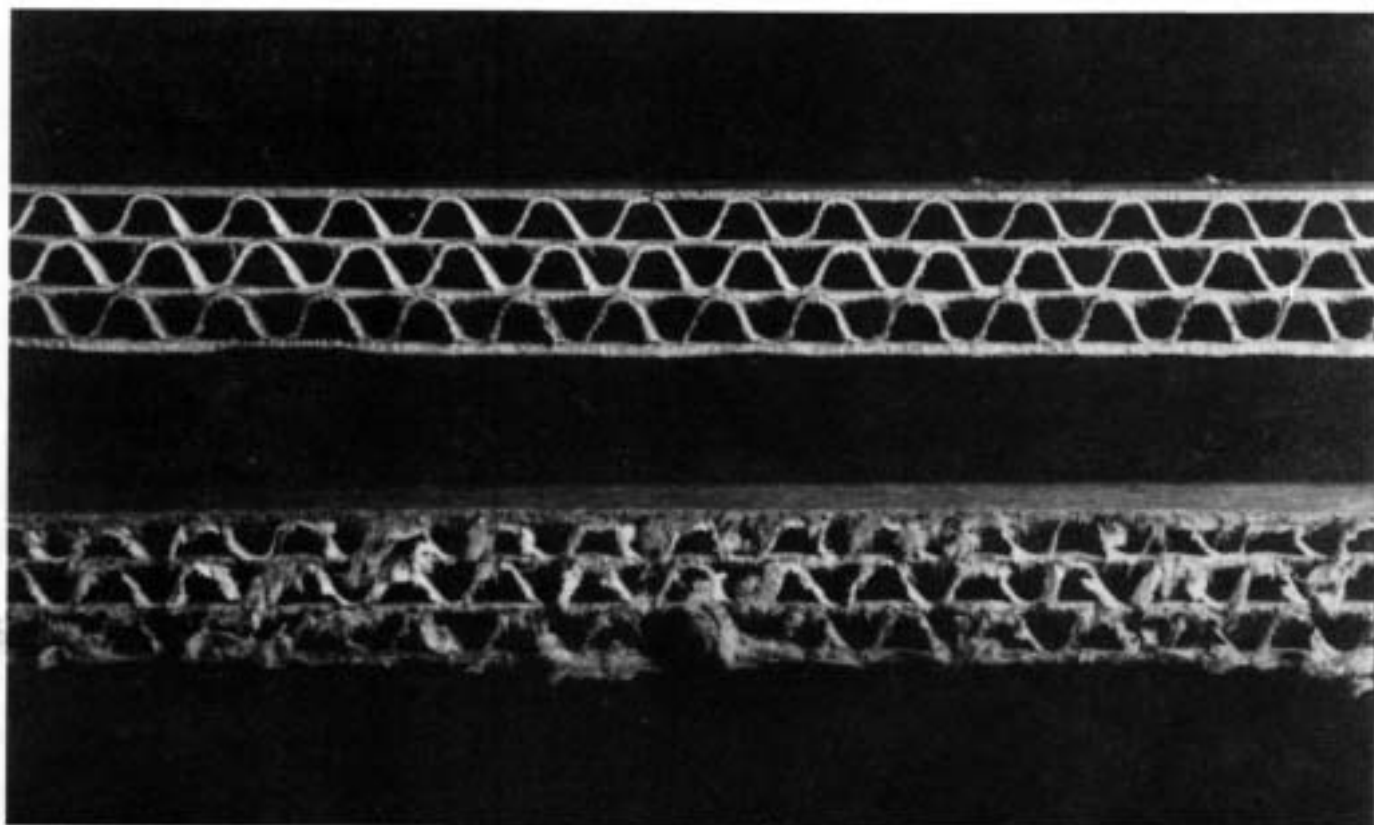
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Two lengths of 5/8-inch-thick triple wall corrugated boxboard. The photo illustrates the difference between a water jet cut edge (top) and conventional knife slitting (bottom). Photo courtesy of Ingersoll-Rand Waterjet Cutting Systems.

## From The President's Desk...

Planning continues for the Sixth American Water Jet Technology Conference to be held from Saturday, August 24 to Tuesday, August 27, 1991, in Houston, Texas. The headquarters hotel will be the Westin Galleria in the Houston Galleria, one of the World's largest and most impressive indoor shopping malls. The Houston Galleria contains over 300 retail, restaurant, and entertainment establishments, five office towers, four movie theaters, 10,000 parking spaces and an indoor ice skating rink. An exhibition will be held in a hall immediately adjacent to the meeting rooms in the Westin Galleria. A demonstration of equipment will be held in an industrial site about 15 minutes by car from the Westin. An attempt is being made to organize a field trip to water jetting sites in the Houston area.

This issue of *Jet News* focuses on safety. Dr. Summers' article on water jets and safety points out that water jet penetration injuries require immediate attention. A bibliography relating to fluid jet injuries is included. These papers illustrate the treatment that has been recommended for patients who have been injured by grease, fuel oil, or water jets. I recommend that emergency rooms in the vicinity of your water jet facility be made aware of this literature.

- George A. Savanick, Ph.D.

## Conference Proceedings Available

The official Proceedings of the 5th American Water Jet Conference, held August 27-31, 1989, in Toronto, Ontario, Canada, are now available in a single, hard cover volume. A variety of presentations relating to the following general topics are included: Rock Cutting, Basic Studies, Concrete, Construction and Industrial Uses, Coal and Soil Cutting, Medical Applications and Safety Considerations.

The Proceedings are available for \$75.00 each, plus \$5.00 for shipping and handling (in continental U.S.). Additional shipping charges apply for destinations outside the U.S. To order, contact:

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ATTN: Dr. George Savanick  
818 Olive Street - Suite 918  
St. Louis, MO 63101, USA  
(314)241-1445

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*Truth emerges more easily from error than from confusion.*

- Francis Bacon

## Waterjet Cutting And Safety

by Dr. David Summers, University of Missouri-Rolla

At the BHRA waterjet meeting held in the United Kingdom in 1983, a medical doctor was discussing the safety of waterjet cutting operations. He commented that this had to be one of the safest of new technologies since, during his preparation for the paper, he had found only three recorded incidents in the literature. Unfortunately when the chairman of the meeting then polled the audience, he found that over half the audience had sent one of their employees to a hospital with a waterjet related injury. There have been reports of deaths from waterjet related accidents. It is, therefore, appropriate that the safety aspects of this new technology be discussed in *Jet News*.

In a number of factories, the advantages of waterjets in cutting applications have led to their incorporation into the product line. At one recent demonstration, the operator showed the "safety" of the tool by backing the nozzle out of the workpiece and holding his hand in the jet, at a distance of some 6 inches from the nozzle. He was not wearing any discernible safety equipment (including no safety glasses) during this demonstration. This is an extremely hazardous and foolish practice and should be strongly discouraged. A variety of different injuries may result for a number of reasons.

To make an initial point in seeking to discourage the practice, the operator was accustomed to working with a 50,000-psi jet issuing through an orifice of roughly 0.007 inches diameter. Had a larger nozzle been placed in the jet and the pump operated at a lower pressure, the jet would have remained coherent for more than 1 foot. The operator, in such an instance, might have sustained a severe injury.

### Types Of Injury

The amount of damage that an individual will sustain depends very much on the length of time of exposure and the amount of fluid which hits the surface. As will be discussed later, where the exposure is of any length, then considerable damage may occur. But even when the individual is exposed to a very short "burst" of high pressure, the damage may be considerably greater than that which can be seen. Because of the small scale of the injury at the injection point of the jet stream, there is a natural tendency on the part of the physician to assume that the waterjet has dissipated relatively close to the injection site.

Unfortunately, the relative innocuousness of the wound tends to suggest that there has been little damage to the person and that little further treatment is required. The common form of treatment, for example, is to make a small puncture at the site in order to facilitate drainage and assume that such treatment is all that is necessary.

However, should the wound be X-rayed and the fluid is opaque, it can be seen that fluid entering through a very small pin hole can penetrate all the way down the finger.

Obviously the normal treatment for this type of wound will not provide any path for the fluid deeper in the finger. This poses three levels of problem for the patient. The first is that a finger is surrounded by skin with very little elasticity. Thus, any additional fluid injection will pressurize the flesh and blood vessels in the digit and lead to the possible death of tissue. This is in addition to the damage done by the mechanical impact of fluid with the tissue itself. Additional pressure may arise if the fluid carries bacteria or toxic materials into the wound, since these may themselves cause additional swelling of the flesh and put additional pressure on the tissue. They will also lead to tissue death.

The development of tissue death and severe infections within the damaged flesh can occur quite quickly and demands rapid, and obviously, relatively radical surgery on the wound. This must often be quite extensive if the wound is to be properly cleaned and drained to prevent subsequent reinfection and tissue death.

Although there have been very few documented cases with the injection of high-pressure waterjets into people, there have been a significant number of cases where other fluids have been injected into people, at the same sort of pressures and flow rates as are now found in industry. The medical records from these injuries are more extensive and stress the need for rapid and comprehensive treatment.

If a person enters the hospital within a day with an injury of this type, there is, depending upon the injury, a 20-percent chance that the doctor will have to amputate the limb that was affected. If the patient delays only two days, the chance goes up to 60 percent, and if the patient waits a week, it is certain that they will lose the limb that the jet was injected into.

(continued on page 4)

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## Waterjet Cutting And Safety, from page 2

### The Pressure That Injures

The widespread use of waterjets over a large range in pressure raises the question "What waterjet pressure is safe?" In order to give an answer to the question, consider the following pieces of information.

To begin with, one must recognize that there are certain conditions in which we want to inject fluid into a body. One is for the sake of giving a medical immunization shot. Where large numbers of people are involved, a device has been developed for the "needle-less" injection. This provides a relatively painless way of injecting fluid under the skin. It requires, however, that the patient not move during the injection since, otherwise, a cut may be made. Data from the injection of dye into cadavers show that the tool can quite effectively inject fluid to a depth of up to 1 inch into the flesh.

The injection guns normally operate at a pressure of about 3,000 psi. With the small size of the jet, this pressure is what it takes to drive the jet into the skin and distribute the medication enough to do some good. This, however, depends on the coarseness of the skin of the individual. With young children and on the softer parts of the body, the jet will penetrate over 1 inch at a pressure of 2,000 psi. The fragility of the flesh can be illustrated with another different sample.

Recent developments in Japan and Sweden have looked at another beneficial use of waterjets in medicine. The application arises as a result of the need for operations on the liver. The problem with liver operations is that there are a lot of blood vessels in the liver and most liver complaints occur in elderly people. Normally a surgeon will remove diseased tissue with a scalpel cutting out the diseased tissue and removing it. In the process, however, a knife will cut through the blood vessels in the tissue. That can lead to a relatively high level of blood loss and can produce a shock in the patient from which death may result.

Japanese surgeons have used a waterjet at a pressure of only 150 psi to erode liver tissue from around the ligaments and blood vessels in the area around the infection. They then tie off blood vessels before cutting them and this will minimize blood loss. By September of 1988, the Japanese team had operated on over 60 people, 41 of whom did not require blood transfusion. This is a significant medical benefit.

But there is a negative side. The negative aspect is the demonstration that at only 150 psi it is possible to cut through human flesh. While this depends on the location of the tissue, it is easy to demonstrate in a relatively harmless fashion. If a conventional WaterPick used to clean teeth is set to operate at the maximum pulsation rate, then at a pressure of only 90 psi one can cause fairly extensive bleeding in the mouth, if it is directed in the wrong place.

This illustrates that there is no pressure at which operating waterjets can be considered to be totally safe. Every jet must be considered as giving the potential for a human injury. Basic protective clothing is a mandatory requirement for any operator. It is particularly important to protect the face and neck.

### Abrasive Waterjets

In the case where abrasive is used in the water, even protective clothing offers relatively little protection. Tests were carried out on a cow's leg. The cut was made at about 1,500 psi and the jet not only went through the leg, it removed all the marrow, chewed up the skin and made a devastating wound.

Protection is a vital part of waterjet installations. It must provide a protective barrier between the equipment and the operator. This becomes of even greater importance when the jet is attached to a robot. Here the cutting jet is at the end of a cutting arm. This arm can move, without warning, over a large path. An abrasive jet can cut 20 feet beyond the end of the nozzle.

(continued on page 6)

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## The Cutting Edge by George A. Savanick

Granite quarrying companies are scrambling to comply with the U.S. Mining Safety and Health Administration policy letter No. 89-IV-1 which states that hand-held channel burners should be replaced with a less noisy means of cutting slots in granite. Water jet slot cutters are candidates to replace hand-held channel burners along with automated channel burners and wire saws.

Major remedial work is planned on the freeway system in the earthquake-prone San Francisco Bay area. Freeway overpasses will be reinforced with steel plates. These plates will be affixed by steel pins. Water-jet drills are being considered to drill the holes in the concrete for the pins.

Water jets are also being considered for drilling during construction of underground radio-active waste depositories. Water-jet drills have the desirable quality of not inducing damage in the rock adjacent to the drill hole or slot.

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## Accident Case Study - UK Municipal Authority by Paddy Swan, S.P.D. Swan Consultants, Derbyshire, U.K.

An operator with one-year's experience but with no formal training, was employed by a contractor to clean some drains at a Council Transport Depot. The drains were 3 inches in diameter and the manhole was some 6 feet deep. On arrival at the site, the operator, operating alone started up his 30-hp unit operating at 1000-2000 psi and 10-15 gal/min with the water going to dump. He placed a multiple jet nozzle attached to the hose into the full manhole.

The operator returned to his unit, put the pressure to load and proceeded to let the hose run out from his hose reel. The hose appeared to stop after a short distance so the operator went to the manhole. The jet suddenly appeared from the manhole and hit the operator directly in the face. The nozzle took the operator's eye out.

On investigation the nozzle was found to be worn, but adequate and the hose was in good condition.

### CONSIDER THE FOLLOWING:

What were the major causes of this accident? How could it have been avoided?

(see answer on page 7)

## Automated Waterjet Cutting Processes

May 1-2, 1990  
Embassy Suites Hotel  
Southfield (Detroit), Michigan

The Society of Manufacturing Engineers is planning the third annual "Automated Waterjet Cutting" clinic. This two-day clinic will cover the process and how-to details of automated water and abrasive jet cutting.

This clinic was designed to provide you with the information you need to evaluate various waterjet and hydro-abrasive jet cutting systems. Experts from industry will discuss advances in waterjet systems and application issues such as the cutting of metallic and non-metallic material, robotic capabilities, job cutting alternatives, and more.

### Topics To Be Covered

The following is a partial list of the topics that will be discussed in this clinic:

- Waterjet systems
- Non-traditional machining with water and abrasive jets
- Selection and justification of equipment
- Water conditioners
- Abrasives
- Robotic software
- Automatic, aerospace and appliance industry applications
- Job shop cutting
- Fixturing
- Safety and environmental considerations
- User case histories

### What You Will Learn

Waterjet cutting is a cost-effective cutting-and-trimming tool that can save you time and money. By attending this clinic, you will learn how waterjet cutting can help you increase production time, achieve net shape accuracies, eliminate material waste caused by heat-affected zones, and eliminate sharpening requirements.

### Clinic Location

All sessions of the "Automated Waterjet Cutting Processes" clinic will be held at the Embassy Suites Hotel in Southfield (Detroit), Michigan. Attendees staying at the Embassy Suites Hotel will receive a SME discount on their room rates. Make your reservations by calling (313) 350-2000.

### Registration

To register for the "Automated Waterjet Cutting Process" clinic by phone, call the SME Customer Service Center at 1-800-733-4SME (between 8:00 a.m. - 4:40 p.m. Eastern Time).

## Waterjet Cutting And Safety, from page 4

Yet in a number of installations, the working area will be marked by a barricade of little more than a simple rope at the limit of the arm movement.

Barricades must be placed much further back away from the cutting area clearly marking what they are and should provide more protection than the open mesh barricade. An abrasive or plain waterjet will pass right through a roped-off plane.

The simplest device is to hang a Plexiglas shield around the working area. This provides something one can see through and at the same time has enough weight to adsorb the energy of the jet which might otherwise cause a hazard and injury.

At the same time, when cutting through a surface, the operator should be familiar with what likely might happen if the jet goes through the other side. Both sides of the work need to be protected.

One should also be familiar with any toxic materials that might be given off during waterjet cutting. An interesting example arose when putting out a burning coal seam in Montana. While the waterjet totally extinguished the fire at the point of contact, the fire generated some fumes which were of considerable hazard to the operator of the jetting equipment. This required that protective monitoring instruments be used around the site during the experiments.

### Safe Use Of Waterjets

These findings should not lead to the idea that waterjets are inherently dangerous. Rather, if sufficient precautions are taken, both robots and waterjets can be very useful. For example, at the University of Missouri-Rolla, we have built and operate on a regular basis, a WOMBAT. This device is a remotely-operated waterjet robot which washes the explosive from a variety of missiles and other containers. However, safe use of this equipment requires that the potentially hazardous features of both robotic and waterjet equipment be recognized. When that is the case, then work which might otherwise be too hazardous to be performed becomes possible.

Waterjets are a cutting tool of the future. As we see this dawn of the new age, our responsibility as engineers demands that we learn how best to safely and effectively use this new tool. In this way, we can bring it to its full potential to the better progress of us all.

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## Accident Case Study - UK Municipal Authority, from page 5

**WHAT WERE THE MAJOR CAUSES OF THIS ACCIDENT?  
HOW COULD IT HAVE BEEN AVOIDED?**

Single operator (inexperienced and untrained) did not insert the hose and assembly nozzle correctly into a drain.

**MORAL:** This was a two-man job! A drain guide should be used to ensure the nozzle is in the drain.

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- FOR DRILL TUBES DRILL BITS AND DECKING
- CLEANS BLACKJACK WHEN HOT
- ENVIROMENTALLY FRIENDLY AND SAFE

## INSTRUCTIONS

Use with Quill or other pressure washers - soap on rinse off. For manual use dilute with hot or cold water 50 : 50 or greater agitate with brush rinse away

**QUILL MUDBLASTER CONTAINS INHIBITED SODIUM HYDROXIDE SOLUTION**  
**HEALTH AND SAFETY INFORMATION**

- Keep out of the reach of children
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- Will be irritating to eyes and skin if in prolonged contact
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1824



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August 24-27, 1991  
Westin Galleria  
Houston, Texas**

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Mail completed form and abstract, **NO LATER THAN DECEMBER 1, 1990**, to:

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## Upcoming Events

**May 1-2, 1990** - Automated Water Jet Cutting Process - Detroit, Michigan. Please contact Kristin Dudash (313) 271-1500, ext. 399.

**October 1990** - Waterjet Short Course - Milwaukee, Wisconsin. Please contact Roger Hirons, University of Wisconsin Extension (414) 227-3105.

**October 31 - November 2, 1990** - Tenth International Symposium on Jet Cutting Technology, Amsterdam, Holland. Please contact BHRA, Cranfield, Bedford, England.

**May 9-10, 1991** - First Asian Conference on Recent Advances in Jetting Technology, Singapore.

**August 24-27, 1991** - Sixth Water Jet Technology Conference, Houston, Texas. Please contact the Water Jet Technology Association (314) 241-1445.

**September 24-26, 1991** - Geomechanics '91, Hrodex, Czechoslovakia. Please contact Z. Rakowski, Mining Institute of Czechoslovak Academy of Science, A. Rimana 176B, 70800 Ostrava Poruba, Czechoslovakia.