WJTA Jet News
WaterJet Technology Association
MAY 2007
Published by the WaterJet Technology Association for the benefit of its members

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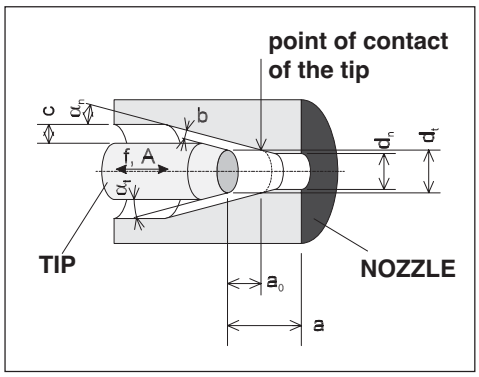
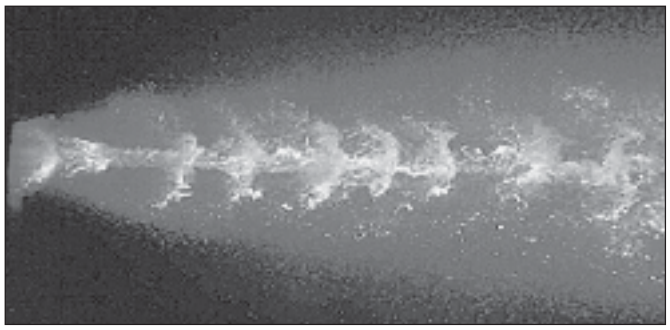
Forced Pulsed Waterjets For Cleaning

A single-orifice forced pulsed waterjet nozzle is shown in the picture below. Oscillation of the tip creates an effect shown in the picture on the right. The large mushroom shaped pulses give pulsed waterjets a superior performance compared to continuous waterjets.





However a single pulsed jet can only cover about 6.5 m^2/hr, which is not competitive for cleaning applications. This is why a rotating jet is necessary. A self-rotating forced pulsed waterjet nozzle with four orifices was shown in the picture below. Compared to the single jet nozzle, a major difference is that the single jet nozzle has no interruption in the passage of water below the tip but the four-jet nozzle does. This accounts for performance loss in the order of 40%, compared to the single jet nozzle. The advantage of this self-rotating four-jet nozzle comes from the fact that any point on the target is under repeated loading condition. For a jet diameter of 0.2 inch (depending on stand-off distance) at the target surface, a rotation speed of 3000 rpm, and a traverse speed of 50 ipm, any point on the path will receive between 24 and 150 impacts (highest at the edge). That is why the pulsed jet has a significant advantage over a continuous jet. The angle between the two forward jets can affect the performance significantly. Based on some test results, the optimum angle is between 10 and 20 degrees and a 12 degree angle was selected for this particular design. The sole purpose of the two outer jets is to provide the torque for rotation.

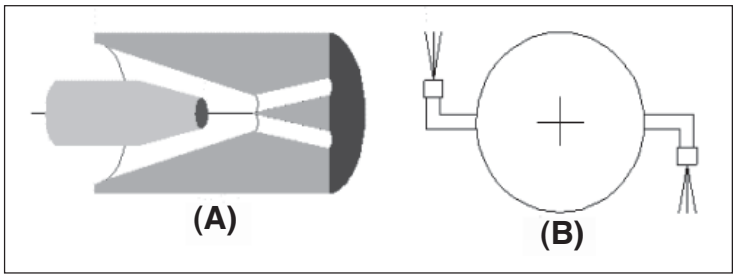


Figure 1. A schematic diagram of the four-orifice self-rotating forced pulsed waterjet nozzle. (A) Main twin-orifices (B) Outer twin-orifices for generating torque.

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2007 American Waterjet Conference and Expo
August 19-21, 2007 ● Houston, Texas
See details throughout this issue of the Jet News

Papers Considered For Presentation At The 2007 American WJTA Conference And Expo

August 21-23, 2007, Marriott Westchase Hotel, Houston, Texas

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- A Comparison of Tube Nozzle Performance, Doug Wright, John Wolgamott and Jerry Zink
- A Damage Model for Rock Under High Pressure Abrasive Water Jet, Hu Si, Xiaohong Li and Dandan Wang
- Abrasive Suspension Jet (ASJ) Cutting Bolts in Underground Coal Mine, Longlian Cui and Liqian An
- An Analysis of Rock Failure Induced by High Frequency Modulated Fluid Jets, Hugh Miller, Fun-Den Wang and Song Soo Han
- An Investigation of Methods to Entrain Abrasives in a Dental Water Jet, Robert Todd and Michael Grygla
- Automatic Control of Cutting Speed for Curvilinear Cutting, Shan Jiang and Kim Tan
- Beyond Water Jetting, Michael T. Gracey
- Considerations in the Use of Waterjet Techniques for the Removal of HVOF Coatings, Mohan Vijay, Andrew Tieu, Wenzhuo Yan, Baolin Ren and Bruce Daniels
- Cutting and Etching of Stainless Steel Trophies by AWJ, Wildor Theodoro Hennies, Carlos Tadeu Lauand, Guillermo Ruperto Martín Cortés and Maria Alice Gonzáles
- Cutting Edge Quality Improvements Through Enhanced Abrasive Waterjets, Axel Henning, Christian Haecker, Sven Anders and Engelbert Westkämper
- Cutting Glass Creatively with Abrasive Waterjet – An Overview, Vanessa Cutler
- Determination of Machinability and Abrasive Cutting Properties in AWJ Cutting, Jay Zeng
- Development of Eco Friendly Technology for Coal Cutting Under Indian Environmental Conditions, Vinay Sharma, Vikas Kumar and Somnath Chattopadhyaya
- Drilling and Slotting of Hard Rock with Abrasive Suspension Water Jet, Song Han
- Dynamic Analysis of the Spatial-Temporal Behavior of the Cutting Front in Abrasive Waterjet Cutting, Axel Henning and Engelbert Westkämper
- Energy Based Modeling of Abrasive Slurry Jet, David Summers, Pradeep Nambiath and Greg Galecki
- Enhancing the Performance of Pulsed Waterjets for Various Industrial Applications, Mohan Vijay, Andrew Tieu, Wenzhuo Yan, Baolin Ren and Bruce Daniels
- From a Single Product (AWJs) to a Multi Product Abrasive Waterjet Industry, Don Miller
- Gaining Access into a Large VBIED – An Impressive Accessory for Your ROB, Tim Ignatiuk
- High-Speed Observations of Submerged Water Jets Issuing from Abrasive Water Jet Nozzle, Seiji Shimizu, Hirokazu Adachi, Kiyoshi Izumi and Hideaki Sakai
- Impact of Residual Stresses on Accuracy of AWJ Cutting, Jay Zeng and John Olsen
- Investigation of Granite Boring Using a High Speed Liquid Impact, E.S. Geskin, V. Samardjic, K. Kluz, O. Petrenko, M. Mazurkievitz and A. Berger
- Investigation of Metal Processing Using a High Speed Liquid Impact, E.S. Geskin, V. Samardjic, G.A. Atanov, A.N. Semko and A.V. Kovaliov
- Investigation of Microforming of Metal in the Course of High Speed Liquid Impact, E.S. Geskin, V. Samardjic, G.A. Atanov, A.N. Semko and A.V. Kovaliov
- Investigation of Surface Preparation in Superplastic Formed Metals, Alex Chillman, M. Ramulu and M. Hashish
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- Laser Based Pulsing of Pure Water Jets, P. Jaschke, O. Meier, A. Ostendorf
- Numerical Modeling of Formation of a High Speed Liquid Projectile in the Course of Powder Combustion, E.S. Geskin, K. Kluz and O. Petrenko

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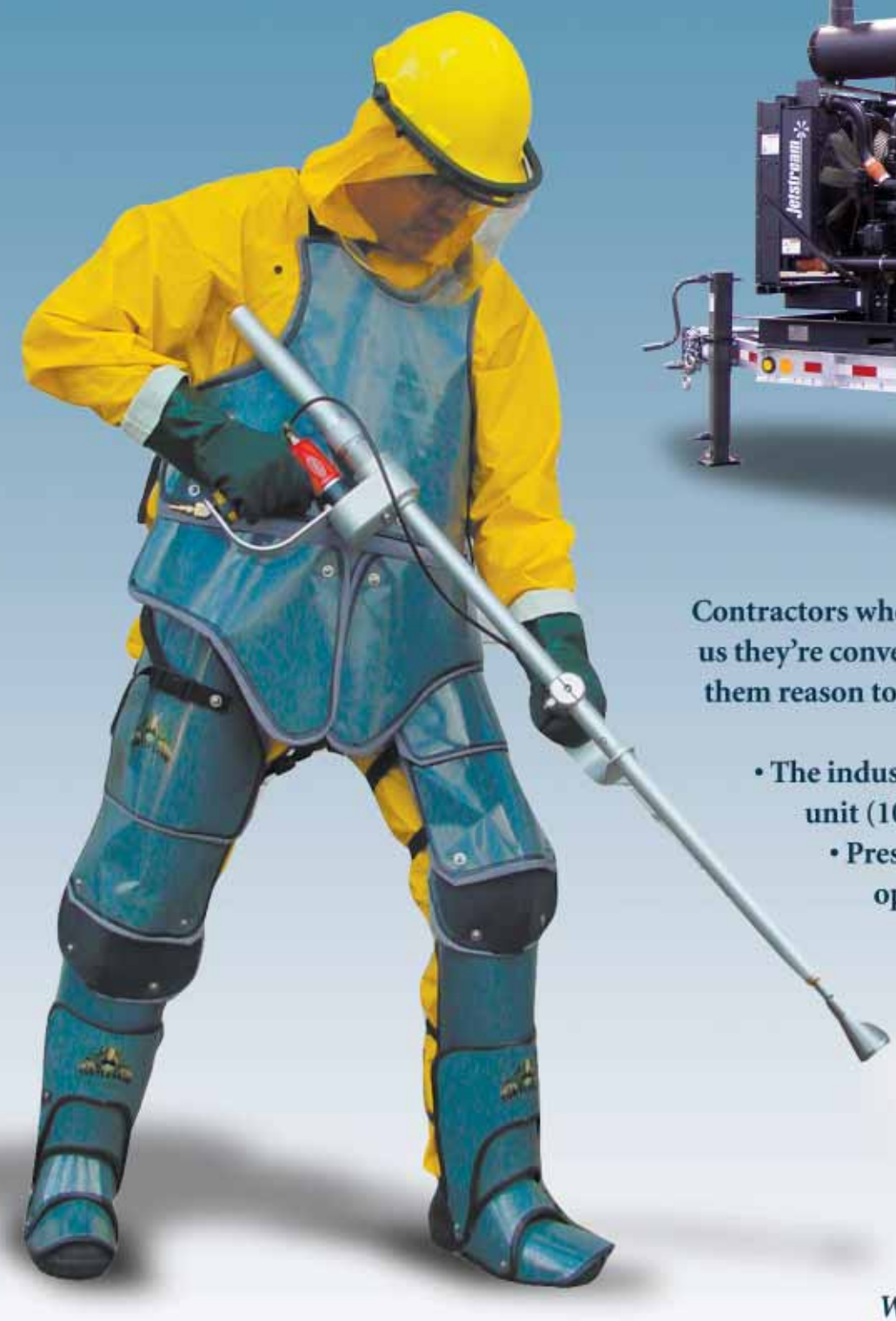
Jetstream … for a true conversion



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Forced Pulsed Waterjets For Cleaning, from page 1

Two 0.02 inch orifices at an arm length of 2.0 inch can provide 25 in-lbf (sufficient for self-rotation). A custom-made swivel is also necessary for the rotation. This self-rotating forced pulsed nozzle, operating at 10,000 psi and 2,800 rpm, successfully passed the tests of several cleaning tasks: e.g. heavily rusted samples at 9.6 m^2/hr, automobile bumper caster with 14 layers of hardened paints at 23.2 m^2/hr, etc. It was also successfully used in two field tests.

* Yan, W., Bai, C., Tieu, A., & Vijay, M.M. (2001), in Mohamed Hashish (Ed.), Proceedings of the 2001 WJTA American Waterjet Conference, Minneapolis, Minnesota, USA, August 18-21, Paper 36.

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Selected Abstracts Of Papers Considered For Presentation At The 2007 American WJTA Conference And Expo

August 19-21, 2007, Marriott Westchase Hotel, Houston, Texas

Cutting Glass Creatively With Abrasive Waterjet – An Overview

Dr. Vanessa Cutler, RCUK Fellow
University of Sunderland, Tyne & Wear, United Kingdom

This paper intends to give an overview to the research that has been carried out during the past four years relating to cutting glass for creative industries using abrasive waterjet.

Glass is used in an increasing variety of ways in art and architecture. Artists employing this material seek to work it into creative and complex forms. It needs to be cut, manipulated and molded into shape. The current cutting practices within most glass artists' studios are relatively basic, making some glass applications difficult or impossible to execute. The development of new technologies such as waterjet enables new cutting methods to be incorporated into the glass artist's practice. Within this developing context, the aims of the research were:

- To establish and demonstrate parameters of practice in cutting glass using waterjet for creative purposes.
- To produce a substantial body of practical work exploring the creative uses of waterjet cutting with written exposition.

The research was initiated with a series of cutting trials undertaken with companies both in the U.K. and Germany. The trials investigate the parameters and quality of cutting from a variety of glass types used commonly within studio practice. This laid the groundwork for the artworks and served to gain a unique 'intimacy' with the machine.

The investigation explores and enhances the practical and creative parameters through 'informed play' using the waterjet process. This was achieved by generating a series of artworks by the researcher and facilitating those of other artists.

The development of personal artworks and case studies were undertaken in parallel to extend and exemplify an understanding of the possibilities of the creative use of waterjet and glass. The resulting artworks encompassed the three main areas of glass practice: Architectural, Kiln-work, and Hot glass. The artworks have been exhibited in national and international contexts.

The important characteristics of risk, intimacy and process have been explored to enable a model of practice to be developed enabling successful creative application of waterjet.

The research consisted of innovative artwork using cutting, milling, and piercing with written exposition; which combined form a model of practice, which serves to extend the perceptions of this technology that others may build upon.

Determination Of Machinability And Abrasive Cutting Properties In AWJ Cutting

Jay Zeng
Omax Corporation, Kent, Washington

Machinability is an important material property for abrasive waterjet

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cutting. The methodology to determine the value of machinability is even more important. Improper methodology can lead to large discrepancy in its value as well as cutting results. One of the abrasive cutting properties is measured with an abrasive index. It is used to reflect the effects of different types of abrasive on the cutting results. Its value can be determined with the same methodology as the one used in determining machinability. This paper will present a methodology in determining machinability and abrasive index.

High-Speed Observations Of Submerged Waterjets Issuing From Abrasive Waterjet Nozzle

Seiji Shimizu, Department of Mechanical Engineering, Nihon University; *Hirokazu Adachi*, Hitachi, Ltd. Power Systems, Hitachi Works; *Kiyoshi Izumi*, Hitachi, Ltd. Power Systems, Hitachi Works; *Hideaki Sakai*, Sugino Machine Ltd. Japan

Submerged cutting by the abrasive water injection jet (AWIJ) is widely used in industrial machining to reduce the noise and to improve the surface quality of the cut. The submergence of the jet is usually a few centimeters in this case. Cutting by the AWIJ under submerged environment at higher ambient pressure has not been clarified sufficiently.

In order to clarify the flow structure of the AWIJ under submerged environment, high speed observations of waterjets issuing from an AWIJ nozzle were conducted by using high-speed video. The injection pressure of the jet is in the range from 100 to 380 Mpa. The submergence is approximately 1 m. The air flow rates introduced from the abrasive port of the AWIJ nozzle are 0, 20, and 50 NL/min, but abrasive was not supplied. High-speed videos were taken at a frame rate of 87600 frames per second.

Figure 1(a) shows an example of frames of a high-speed video at the injection pressure of 100 MPa and the air flow rate of 0 NL/min. The cavitating jet flow is highly unsteady. A tongue-like cavitation cloud protrudes to the downstream direction. Figure 1(b) shows an example of frames of the ventilated jet at the air flow rate of 20 NL/min. The ventilated jet flow becomes relatively steady compared with the cavitating jet. Unsteady behavior of the cavitating and ventilated waterjets issuing from the AWIJ nozzle is discussed in the paper.

Illustration a. Air flow rate is 0 NL/min

Illustration b. Air flow rate is 20 NL/min

Figure 1. Cavitating jet and ventilated jet at the injection pressure of 100 Mpa

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Impact Of Residual Stresses On Accuracy Of AWJ Cutting

Jay Zeng
OMAX Corporation
Kent, Washington

As the accuracy of abrasive waterjet (AWJ) machines is improving, a wider range of process variables are receiving attention, regarding their impact to the accuracy of AWJ cut parts. Residual stress is one of these process variables. In this experimental study, AWJ cutting tests of steel samples with and without residual stresses were conducted. The results indicate a strong link between residual stresses and part accuracy. An annealing process was used effectively to eliminate the residual stresses. A practical test was created to determine residual stress condition prior to production.

Investigation Of Methods To Entrain Abrasives In A Dental Waterjet

Michael Grygla and Robert Todd
Brigham Young University
Provo, Utah

Waterjet systems have been utilized at a wide range of different pressures. Previous research performed at Brigham Young University has shown that low pressure waterjets (200-500 psi) have the ability to cut human teeth and remove dental caries. Experiments have revealed that when abrasive particles are added to the waterjet stream, a greater amount of tooth material can be removed in a shorter period of time. BYU researchers have attempted a variety of ways to insert abrasive particles (10-30 micron size, 11% by weight) into a low pressure waterjet stream for dental applications. As with high pressure systems, challenges have included metering the desired mixture of abrasive into the stream and preventing settling and clogging of the abrasive. These challenges are more pronounced in low pressure systems.

This paper provides a broad review of existing methods to entrain abrasives in high pressure industrial waterjet systems. A list of methods and concepts to suspend abrasives in a desired low pressure dental system has also been generated. Product

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A Large Waterjet Table

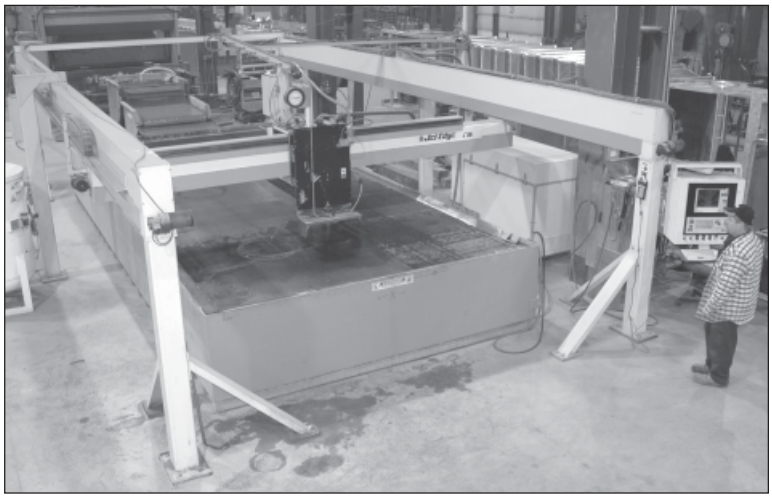
10-foot by 24-foot (3 m x 7.3 m) waterjet table is one of the largest in Canada

As a custom fabricator serving primarily the mining and water treatment industries, Stainless Steel Technology routinely transforms massive sheets of stainless steel and aluminum into Goliath-sized mechanisms that range from towering tanks to enormous quench chambers.

The Lively, Ontario, company was pushing its laser cutting system to its thickness limits when it placed an order in 2005 for what would become one of Canada's largest waterjet cutting systems, a monster 10-foot by 24-foot (3m by 7.3m) High Rail Gantry manufactured by Jet Edge of St. Michael, Minnesota. This powerful machine can cut through anything with a supersonic stream of water that is pressurized up to 60,000 psi and mixed with a garnet abrasive.

Less than a year after installing the Jet Edge system, Stainless Steel Technology broke ground on a 20,000 square-foot addition to its 35,000 square-foot (6,096m by 10,668m) manufacturing facility, an expansion President Tony Yaroshak partially credited to his new waterjet-cutting capabilities.

"It's revolutionized our business," Yaroshak said of his Jet Edge system. "It was the best way to go. It's been an excellent, excellent boon to us … I can now cut thick aluminum up to 6 inches (0.152m), same with the steel. Now there are no limits. The waterjet is able to cut any type of material. Last winter we used it to cut holes in 6-inch manganese steel. It was a very hard problem. It's an almost impossible job other than with waterjet."



Yaroshak said he did a great deal of research before he decided on buying a waterjet system from Jet Edge. He ultimately selected Jet Edge because its overhead gantry design makes it easy to place large sheets of material on the cutting table.

"We wanted an open table for top-loading approachability so you don't have to climb up and over a bunch of equipment," he said. It also did not hurt that the Jet Edge system utilized the same SigmaNest software as the company's existing laser system, drastically reducing the operators' learning curve.

After a year of operation, Yaroshak said he is quite pleased with his Jet Edge system and has recommended it to several other manufacturers.

Yaroshak said his Jet Edge system has increased his company's productivity by making it possible to produce precision-fit parts that join easily, and by eliminating heat-affected zones and time-consuming secondary finishing operations. He noted that parts cut with waterjet have a much cleaner appearance than parts cut with plasma or oxyflame – a big consideration for a company whose motto is "We don't stand behind our product. We stand in front of it."

This attention to detail has helped Yaroshak and business partner Brad Greasley transform Stainless Steel Technology from a start-up in Yaroshak's garage into a thriving business that has grown every year since its humble beginning in 1984, when Yaroshak took what would become a permanent leave of absence from his job as an electrical inspector to pursue a passion for metalworking he picked up in shop class at age 14.

Today Stainless Steel Technology employs 35 people, and Yaroshak plans to hire 10 more when his addition is done. The company's capabilities include CNC machining, waterjet, laser, and state-of-the art welding and CAD drawing processes. In addition to the mining and water treatment industries, Stainless Steel Technology also has provided fabrication services to major pulp and paper manufacturers and architectural, engineering and design firms. Stainless Steel Technology is ISO 9001:2000 certified through the Quality Management Institute (QMI), with certifications by the Canadian Welding Bureau, TSSA and ASME.

For more information about Stainless Steel Technology, call 705-692-0303 or visit http://www.stainlesssteeltech.com. For more information about Jet Edge, call 763-497-8700, visit www.jetedge.com or e-mail sales@jetedge.com.

Meet The Candidates For The WJTA Board Of Directors

An official ballot listing each of the eligible nominees will be forwarded on May 28, 2007, to all eligible voting WJTA members. The WJTA office must receive your ballot **NO LATER THAN JUNE 25, 2007.** Election results will be announced in the *Jet News* and on the WJTA website.

Meet the candidates for the 2007-2009 WJTA Board of Directors:

PAT DEBUSK of DeBusk Industrial Services Company, LaPorte, Texas, is very active in new equipment development. Mr. DeBusk has been a waterblast contractor for 43 years. A WJTA member since the association was founded in 1983, Mr. DeBusk presently serves in the office of WJTA vice president, and he is the co-chairman of the 2007 WJTA Conference Committee.

Mission/Vision: I believe the WaterJet Technology Association should continue to develop its interests and expand membership to represent the waterblasting industry worldwide. My mission/vision is to invite dialogue from all WJTA members, so the WJTA will become a forum for technical and practical information. The association should promote integrity of equipment design, manufacture and sales. Members should regulate themselves and their industry prior to any government move in the waterjet area.

Nominated by: Andrew DeBusk, DeBusk Industrial Services Company, LaPorte, Texas.

BILL GAFF is vice president of strategic sales for the environmental solutions group of Federal Signal Corporation. Mr. Gaff has worked in the environmental industry for over 25 years starting out as a service technician at then Peabody Myers (Vactor Manufacturing and a subsidiary of Federal Signal Corporation). Mr. Gaff also served as vice president of sales and marketing at Peabody Myers, president of Vactor Manufacturing and Vactor/Guzzler, president of the air and water group of Federal Signal, which included Vactor Manufacturing, Guzzler, and Jetstream, and vice president of sales and marketing of industrial products of the environmental group of Federal Signal. Mr. Gaff has a bachelor's degree in finance and business administration from Illinois State University.

Mission/Vision: I see the WJTA becoming more progressive in defining and sharing industry standards and best practices in the waterblasting and industrial vacuum industries. I also see this organization's role expanding its scope to additional adjacent industries that their membership also does business. This defining and sharing of best practices will help improve the safety of its members industry as well as reduce the operating costs such as legal, insurance, and training costs. The WJTA can also provide operational, training, and safety guidelines for smaller companies who do not have the size or staff to ensure their training and safety practices ensures their workers the safest work environment possible.

Nominated by: Bill McClister, Veolia Environmental Services, Inc., Baytown, Texas.

DR. GRZEGORZ "GREG" GALECKI is a research associate professor in the Rock Mechanics and Explosives Research Center at the University of Missouri-Rolla. He obtained his M.Sc. and Ph.D. degrees in Mechanical Engineering at Wroclaw Technical University in Poland, the latter in 1978. He has worked in the field of machine building technology, machinery, and machine tools with related research and teaching since 1974. He has over thirty years experience in experimental waterjet use, processes supported by waterjets, and designing special high pressure equipment. Pioneering work by Dr. Galecki to understand mixing and acceleration of abrasive particles was a very important part of abrasive waterjets development. More recently he has been working on development of abrasive slurry jets for precision machining of advanced materials. Dr. Galecki has over 60 publications (conference papers, reports, invention disclosures) in manufacturing. Since 1993, Dr. Galecki has been on the faculty of the High Pressure Waterjet Laboratory at UMR. His research interests are in the application of high pressure waterjet systems, with emphasis on the mechanical component design and system integration.

Mission/Vision: Over the years waterjet technology has evolved through a period of specialized applications to the present, where custom applications have become standard in many industrial uses. However the design of equipment and procedures remains very subjective. In an attempt to enhance objectivity, a discussion of standards for the waterjet industry should be initiated by WJTA through the creation of a standards committee.

Nominated by: David A. Summers, Ph.D., University of Missouri-Rolla

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Meet The Candidates For The WJTA Board Of Directors, from page 8

FABIO LA FERLA is the general manager of Idrojet S.r.l. Italy, a manufacturer of high pressure waterblasting equipment, IRS Idro Rental Services S.r.l. Italy, a high pressure water blasting equipment rental company, and KIDExtractor Limited – Malta, a manufacturer of hydraulic tube bundle extractors and other special maintenance tools. Mr. LaFerla earned his degree in chemistry in 1992 and joined Idrojet S.a.s. as technical director that same year. He subsequently served as a sales manager of Idrojet and KIDExtractor before assuming the general manager position. Mr. LaFerla has spent the last 15 years developing new technologies for special applications and the cleaning of heat exchanger tubes and heater decokings.

Mission/Vision: I believe that what makes waterjet technology unique is its potential use in a wide range of special applications from the industrial field to the medical field. I encourage finding new ideas and/or products that can increase the variety of high pressure waterjet applications. I believe that new ideas and products must be accessible for everyone worldwide, and for this reason one of the main goals of my mission is to work with the WJTA board of directors and membership to increase the worldwide recognition of waterjet technology and of the WJTA.

Nominated by: Lydia M. Frenzel, Ph.D., Advisory Council, San Marcos, Texas.

LARRY LOPER is vice president of marketing and sales at High Pressure Equipment Company, Erie, Pennsylvania. Mr. Loper is responsible for the design and implementation of the company's marketing plan. Mr. Loper has a bachelor's degree in chemistry and a master's degree in business administration. He currently serves as WJTA treasurer, and he is a member of the American Chemical Society, Society for Petroleum Engineers, AICHE, and the WJTA.

Mission/Vision: I will continue to work with the directors and membership in the further development of the organization. I will work closely with manufacturers, contractors, and component suppliers to ensure that the membership continues to benefit from this quality Association.

Nominated by: George A. Savanick, Ph.D., Consultant, Apple Valley, Minnesota.

JIM PETILLO is Vice President, Contractor & Industrial Sales for Super Products LLC. He has worked in the industry for 15 years as a Regional Manager and Vice President involving both domestic and international sales. Jim has been an active contributor to the WJTA Vacuum Truck Committee that is developing an industry operations and safety manual. Previous to his sales experience he held management and executive positions in the Human Resource profession with major corporations. He has held committee and board positions in various professional organizations at both the local and national level. Jim graduated from Purdue University with a B.S degree in Industrial Management.

Mission/Vision: There is a real opportunity for WJTA to fill a void as an organization for Industrial Contractors that utilize both water jetting and vacuum technology. I would work to grow the WJTA membership to include Industrial Contractors, Educators and Manufacturers. By evaluating the needs of this group and understanding how an association such as WJTA can best serve its members we can develop programs, conferences and shows to meet the needs of the membership. This would include exposure and development in best practices in the applications, equipment, safety and business management. One very important value of membership in WJTA that needs to be expanded is the opportunity to "network" for the purpose of continuing education and helping members solve their individual business problems.

Nominated by: Forest Shook, NLB Corporation, Wixom, Michigan.

FORREST A. SHOOK, owner and president of NLB Corporation in Wixom, Michigan, has been involved in the waterjetting industry since 1963 and has been a member of WJTA since its inception. Starting as a contractor, Forrest soon became disenchanted with the available equipment and began building his own pumps and accessories. NLB Corporation was officially created in 1971 and has been one of the leading manufacturers of waterjetting equipment ever since. During this time he has made significant contributions to the advancement, development, and application of waterjet technology. He has identified new technologies and applications that have helped grow the waterjetting industry, all the while emphasizing operator and environmental safety. He has also pioneered new waterjet processes such as hydrodemolition, automotive grate cleaning, abrasive cutting, surface preparation, tank cleaning, and many others. He holds many patents pertaining to waterjet technology.

Mission/Vision: It has been a privilege and an honor to be a part of an organization that has done so much to advance the field of waterjetting. If I am fortunate enough to return to the board, I will continue to help

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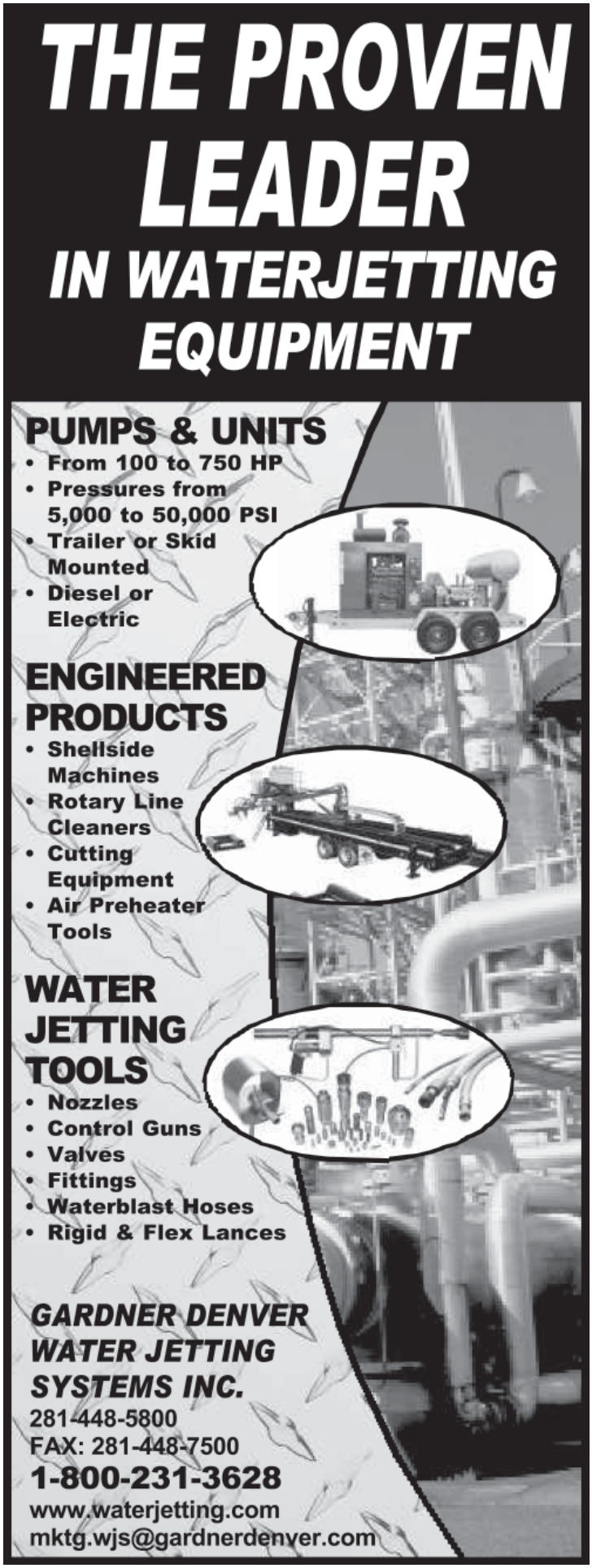

Meet The Candidates For The WJTA Board Of Directors, from page 9

identify new technologies and applications that will serve to further advance the waterjetting industry. In addition, I will represent the end users of waterjetting equipment, bringing their voice to the board meetings. And, as always, I will emphasize operator and environmental safety in all that we strive towards.

Nominated by: Jim Van Dam, NLB Corporation, Wixom, Michigan.

PAUL WEBSTER is Engineering Manager for the Polyflex Business Unit of Parker Hannifin Corporation. Mr. Webster has been involved with the design of UHP hose, end fittings, and adapters for over 20 years. Mr. Webster started his career at Rogan & Shanely/Polyflex and is a member of ASME, NACE as well as a long standing member of the WJTA.

Mission/Vision: I will work with WJTA board members to promote the highest standards of learning and service for our members and to serve as an industry liaison to foster enthusiasm and interest for WJTA. I will provide a voice for the members and act in an advisory capacity to the board. In addition, I plan to increase awareness of and further develop industrial water jetting safety through Recommended Practices.

Nominated by: Craig Anderson, Parker Polyflex, Stafford, Texas.

JOHN WOLGAMOTT is president of StoneAge Inc., a recognized leader in providing rotary nozzles and mechanized tools for waterblasting applications. In business since 1979, StoneAge now serves hundreds of customers around the world. As a charter member of the Waterjet Technology Association, John has served on its board of directors since it's founding. He has worked for the organization in many capacities including chairman of the board since 1997.

Mission/Vision: John's vision for WJTA is to serve its members by creating a forum to share information and work together to advance the profession. He believes waterjetting has great potential to further expand its usefulness in a variety of industrial applications. He will work on; marketing waterjet technology, maintaining a unified set of safety guidelines, and promoting high standards of conduct in our industry.

Nominated by: Hugh B. Miller, Ph.D., Colorado School of Mines, Golden, Colorado.

Bridge Repair In The Netherlands

The 1km long multi span steel box girder Moerdijk Bridge, over the Hollands Diep River near Dordrecht in the southern Netherlands, is a major structure on the vital E19/A16 European highway through Holland and Belgium. The current 45m wide, dual three lane bridge, opened in the late 1970s and built on the original concrete piers of the previous structure, is believed to be one of the most heavily trafficked bridges in Europe, carrying around 120,000 vehicles a day. During routine inspections of the nation's steel bridges fatigue cracking was found in Moerdijk's thin steel deck plate threatening the structure's integrity, leading the Dutch Ministry of Transport to carry out extensive repairs and strengthening involving Doornbos and Conjet hydrodemolition equipment.

The restoration, costing around ¸10.5 M and designed by the Dutch Ministry of Transport, involves repairing the cracks followed by what is believed to be one of the first major applications of a special thin very high strength concrete overlay wearing course of 105MPa. The 50mm to 70mm thick high performance, steel mesh reinforced concrete overlay is based on a secret blended recipe and additionally reinforced with steel and polyethylene fibres. It aims to spread the traffic loading and stiffen the 12mm thick steel deck plate, eliminating future fatigue problems and extend the life of the bridge.

Main bridge repair contractor Haverkort Voormolen B.V. used subcontractors to place the heavily reinforced, high performance concrete in a series of 100m long and 8m wide bays. The finished surface proved to be bumpy and slippery and was scarified by contractor and equipment hirer Doornbos Equipment using high pressure water rotors operating at 2,800bar to blast and roughen the surface. Just a few weeks after completing the first northbound three lane carriageway the concrete overlay started breaking up in two of the 20 bays, forcing the Ministry to stop the entire project and investigate the cause of the failure and urgently devise a repair.

Core samples, initially taken in the affected bays, showed extensive porosity, honeycombing and voids around the steel reinforcement and gaps up to 30mm deep between the steel deck and concrete overlay. Some gaps and voids were filled with water. Total uniform bonding between the concrete overlay and steel deck plate is vital to ensure the deck is rigid and conforms to the original restoration and strengthening design. "The ministry and Haverkort Voormolen formed a partnership to investigate the cause of the problems, including the possible influence of the traffic vibrating the deck during concreting," says Haverkort Voormolen project engineer Elwin Roelfsema. "It has been decided in the two affected bays to reduce the amount of overlap of the reinforcing bars, in the area where the truck wheels run, by changing from 2m square prefabricated reinforcing mats to hand laying larger areas. In addition we are increasing the mesh size from 50mm to 75mm square and changing to two layers of 12mm reinforcing steel instead of three layers of 8mm in the original, so providing more openings for the stiff concrete. We will also change the concrete mixing and placing method, as before we initially used an excavator with a bucket to spread the onsite batched concrete from truck mixers, prior to leveling with a pair of counter-rotating augers passing back and forth across the mat. As the concrete is quite stiff we believe there is the possibility of air being trapped as the concrete is effectively folded over on itself by the excavator during spreading. We shall just use the auger leveling system followed by a vibrating finishing beam."

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Pre-Conference Workshop on August 19 At The 2007 American WJTA Conference And Expo

August 21-23, 2007, Marriott Westchase Hotel, Houston, Texas

WATERJET TECHNOLOGY – THE BASICS

8:00 a.m. – 9:00 a.m.
Registration

9:00 a.m. – 9:30 a.m.
History

9:30 a.m. – 10:10 a.m.
Equipment

10:10 a.m. – 10:20 a.m.
Break

10:20 a.m. – 11:10 a.m.
Applications

11:10 a.m. – Noon
Safety

Noon – 1:00 p.m.
Lunch

WATERJET TECHNOLOGY – BEYOND THE BASICS

1:00 p.m. – 3:00 p.m.
Concurrent Sessions
- **Hydro Excavating**
- **Surface Prep Applications**
- **Cleaning Applications**
- **Cutting Applications**

3:00 p.m. – 3:20 p.m.
Break

3:20 p.m. – 5:00 p.m.
Concurrent Sessions: "Ask the Experts" Panels
- **Hydro Excavating**
- **Surface Prep Applications**
- **Cleaning Applications**
- **Cutting Applications**

StoneAge Deck Blaster Upgraded For 2007

StoneAge has made several improvements to the 40k psi Deck Blaster. With the turn of a handle, the dome height can be adjusted. The self-propelled drive is now operated with the pull of a knob. The air supply for both the traverse and head rotation are isolated from other giving the operator better control. The 40k psi Deck Blaster is available with a choice of either a Gardner Denver or Jetstream dump valve. Each wheel is now 3 inches wide for greater stability on uneven surfaces like automotive paint grates.

For more information, visit www.stoneagetools.com or call (970) 259-2869.

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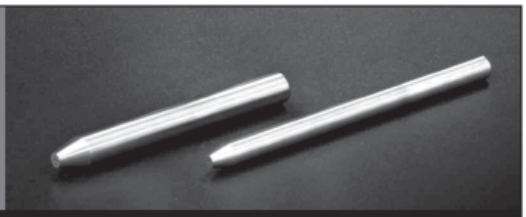

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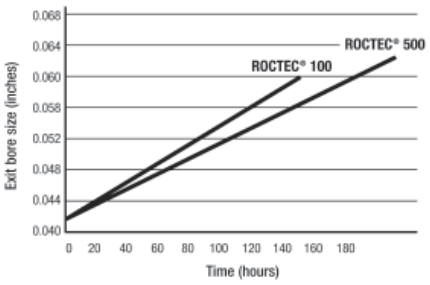

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Hydrodemolition At Pearl Harbor

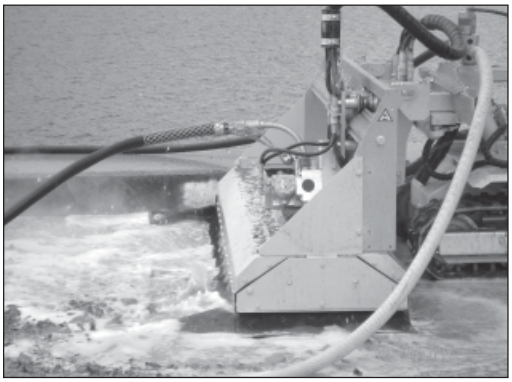
A hydrodemolition robot from Aquajet Systems is helping Triton Marine Construction to achieve remarkable production rates in the removal of spalled concrete from two piers at Pearl Harbor, in Oahu, Hawaii, USA. The Aqua Cutter HD-6000's high-pressure water jet system takes just a minute to remove a cubic foot of the weak 1940s concrete - equivalent to a cubic metre in about half an hour.

"Its performance is incredible," says Triton Marine Construction superintendent Brett Gordon. This is Triton Marine's first project using its newly-purchased HD-6000 and other schemes are already lined up. "We feel that hydrodemolition will soon be specified on every job and we decided to purchase the equipment now so that we are set up for that movement into the future."

Triton Marine, which is based in Bremerton, Washington, is working as subcontractor to Nova Group Construction to carry out renovations to Piers F12 and F13 on Ford Island at Naval Station Pearl Harbor. Areas of concrete were in poor condition and so are being replaced to provide a better surface and ensure the piers' longevity. The work involves the removal of the spalled concrete and any corroded rebar followed by their replacement with new materials.

The Aqua Cutter HD-6000 robot was supplied to Triton Marine by Putzmeister America's Water Technology Division, which also provided a two day course in its operation and servicing, followed by further training at the job site on Ford Island. "I am thrilled with Putzmeister and Aquajet," says Gordon. "They have provided me with a good, reliable product."

Triton Marine had previously always broken out concrete using labor-intensive conventional methods with hammers. The decision to buy the HD-6000 was taken with a view to forthcoming contracts, in particular a major highway project where time pressures will be intense. "We looked at the closures that will be allowed there and the manpower that would be needed for conventional methods," says Gordon. "Hydrodemolition was the best way to go. We are also looking to the future. We feel that hydrodemolition will soon be seen as the only way to remove concrete. Any other method causes more damage to the concrete."



Buying the Aqua Cutter HD-6000 for the Pearl Harbor project enabled the staff to build familiarity in its operation ahead of the more time-sensitive highway scheme. The work involves the removal of some 3,000 sq ft (280m^2) of concrete from the decks of the two piers, in individual areas of varying shapes of typically 100 sq ft (9m^2). It has been taking just one minute to remove an area of three square feet (0.27m^2) to a depth of four inches (100mm), giving a rate of a cubic foot a minute or 1 m^3 in just over half an hour. The first 110m^2 phase of the project was completed over the course of a few days in January and the remainder is due to be carried out following the delivery of a vacuum truck for quick debris removal to keep pace with the Aqua Cutter.

"The concrete was originally poured in the 1940s, when specifications and quality control were a lot less stringent than today," says Gordon. Over time, areas of the old reinforced concrete had become broken up, allowing the ingress of water.

The aggregate is a black, porous crushed stone, which is believed to be volcanic in nature. It gave a very soft concrete which the HD-6000 has been able to remove very quickly, says Eric Zimmerman, general manager of

(continued on page 23)

design principles were applied to screen, score, and rank these various concepts for entraining abrasives in a waterjet stream for dental applications. Magnetic stirring, polymer (xanthan) suspension, and ultrasonic vibrations were chosen as the three leading concepts. Experimental results are presented.

Automatic Control Of Cutting Speed For Curvilinear Cutting

Shan Jiang and Kim Tan
JAt Stream Inc., Palo Alto, California

The cutting paths of microelectronic chips are curvilinear; not straight. The cutting speed with abrasive suspension jet (ASJ) for curvilinear cutting will be changed under same ASJ cutting parameters and same cut material (e.g. pressure, nozzle size) without any control. The cutting accuracy of ASJ for curvilinear cutting is depended strongly on the cutting speed. The cutting depth is related to the cutting speed; the speed variation may cause the x-y table motor vibration that results in a degraded cutting edge quality. The paper explores the way for automatic control of cutting speed for curvilinear cutting to insure cutting with high precision. It analyzes the cutting speed variation along the cutting path and then describes the relationship between the speed and acceleration. Next, it describes the x-y table motor characteristic to clarify why a consistent desired cutting speed cannot be reached. At last, it explores a way to reach a smooth cutting speed to insure the curvilinear cutting with high precision to meet the requirement of semiconductor manufacturing.

Drilling And Slotting Of Hard Rock With Abrasive Suspension Waterjet

Song S. Han
Research Institute of Construction Technology, Samsung Corporation
Gyonggi-Do, Republic of Korea

In densely populated areas such as downtown Seoul, the removal of hard rocks for building or structural foundations requires extra effort due to complaint from the residents and owners of neighboring buildings. The conventional methods, such as hydraulic breaker, drill and blast, diamond saw cutting instantly raise the complaint level and usually result in delayed construction schedule. The abrasive suspension waterjet system has been developed for the hard-rock drilling, cutting, and notching operations in an attempt to replace or speed up the conventional methods. Various types of nozzle heads and manipulators have been designed and field-tested in construction sites. Different types of manipulators are covered in this paper with some of the basic working parameters.

Energy Based Modeling Of Abrasive Slurry Jet

Pradeep Nambiath, Greg Galecki, and David Summers
University of Missouri-Rolla

Abrasive slurry jet (ASJ) cutting systems enjoy the advantage of higher cutting efficiency over conventional abrasive waterjet (AWJ) cutting systems as a result of more efficient momentum transfer.

The use of ASJ in industrial applications is well documented but

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widespread use in manufacturing has been hampered by abrasive feed system problems.

The University of Missouri-Rolla (UMR) has developed a slurry feed system that overcomes this problem.

Based on a series of experiments and theoretical modeling, the ASJ efficiency is discussed in terms of pressure, slurry concentration, and nozzle diameter.

From A Single Product (AWJs) To A Multi-Product Abrasive Waterjet Industry

Don Miller
Miller Innovations
Bedford, United Kingdom

The market for abrasive waterjet systems based on entraining abrasive particles carried in air (AWJs) is over ten times the current user base. In this situation, abrasive waterjet manufacturing companies need to concentrate on selling their existing AWJ products. Product development is by incremental improvements.

It would be expected that the research community and small innovative companies would be developing new technologies for abrasive waterjet generation. In particular, technologies that major abrasive waterjet companies could acquire to diversify their product portfolio to meet the inevitable slackening in sales due to competition and/or a general recession in the machine tool market. In reality, there are few signs of research being carried out for a new generation of abrasive waterjet products.

The paper will discuss why a lack of understanding of fluid dynamic processes involved in the generation of abrasive waterjets has been a barrier to the development of new abrasive waterjet products. It is described how new insights into cutting head fluid dynamics allow abrasive waterjets to operate from general machining (AWJs) through fine machining to micromachining.

Key Issues Related To ASJ Singulations For Semiconductor Manufacturing

Shan Jiang and Kim Tan
JAt Stream Inc., Palo Alto, California

We have introduced commercially abrasive suspension jet (ASJ) singulations for cutting and singulating microelectronic chips. The singulations can cut the substrate with a width of 0.2mm and a speed of up to 200mm/s, provide a cost-effective cutting process for any material with both straight line and curvilinear edges and make the highest quality cut. This paper describes the key issues related to ASJ singulation features, machine performance, process parameters, and process sequences, which are all critical to meet semiconductor manufacturing requirements. First, we present background information on cutting microelectronic components, cutting requirements, cutting process sequences, and the manufacturing site. Then, we discuss the key issues of ASJ singulation to overcome the challenges to entering the fine and micromachining markets. The small nozzle (~ 0.2mm) is manufactured with new features to insure high cutting precision, long life and robust process operation without abrasive clogging. The tool design is equipped with a novel feature to insure curvilinear and linear cutting in a single path cutting with high quality and no unevenness. The clean-in-place feature and the vision-inspection feature are enhanced to insure automated cutting, cleaning, and inspection. Abrasive recycling is included to conserve abrasive and to maintain a clean environment. The de-noise design is emphasized to insure a healthy working environment.

An Analysis of Rock Failure Induced by High Frequency Modulated Fluid Jets

Hugh Miller, Fun-Den Wang, and Song Soo Han, Colorado School of Mines, Golden, Colorado

The impingement characteristics of high frequency modulated fluid jets are novel and represent a radical departure from continuous waterjets and other types of conventional hydraulic systems used in mining and rock/soil excavation. Sometimes referred to as percussive jets, these highly energetic flows impinge against rock surfaces in a quasi-controlled series of spatially discrete, high frequency fluid masses. Due to their dynamic characteristics and success in effectively fragmenting different types of crystalline rocks during laboratory testing, these jets possess the potential to develop a viable alternative to conventional excavation technologies in select hardrock applications, including the mining of tabular deposits, the driving of small diameter drifts/tunnels, and in urban excavation.

This paper presents the findings of research intended to establish empiric relationships between fluid and system parameters and the mode of rock

(continued on page 16)

failure. The study confirms long held suspicions that the failure mechanisms associated with percussive jet impingement are wholly different than those attributed to continuous waterjet for the rock types tested. In most cases, failure was dominated by the extension and coalescence of tensile fractures through hydraulic pressurization and dynamic loading, where erosional mechanisms play only an ancillary role. Often pervasive, surface spalling occurred in every rock type tested and proved to be highly dependent upon traverse velocity and orientation relative to internal rock structure. As expected, the influence of exposed fractures on rock surfaces and in the kerf was shown to benefit excavation efficiency, particularly at lower traverse speeds. As traverse velocities increased, the mode of failure appears to become increasingly less dependent upon subsurface fluid penetration and more reliant of different loading, elastic compression, and surface scouring.

Development Of Eco-Friendly Technology For Coal Cutting Under Indian Environmental Conditions

Dr. Vinay Sharma, Vikas Kumar, and Somnath Chattopadhyaya
Birla Institute of Technology,
Mesra, India

This is an era of the high pressure waterjet cutting technique in which physical and technical fundamentals have been worked out worldwide with promising application possibilities in different fields like machining, rock excavation, cleaning, tunneling, mining, etc. In traditional coal cutting, one of the most difficult operations is to develop an eco-friendly, high productivity cutting system. To overcome this problem, a most suitable system is a waterjet cutting system. Where not only the cutting process is environmental friendly, but water can be utilized for transportation of the coal from the site to the required destination in the form of a slurry. In this paper, the author has tried to summarize the utility and development of waterjet cutting equipment for Indian coal mines.

The process of material cutting and fracture by high velocity waterjets is a complex series of phenomena, which may involve compression, tension, shear, erosion, wears, cracking, wave propagation, and cavitations damage. This makes the exact analysis of the jet cutting process to be very complicated. The problem of waterjet coal cutting is a multi response problem. There are two output variables, depth of cut and cutting width whose optimization will result in the increase in the productivity of coal cutting. In this paper a Taguchi method has been used to determine the effective process parameters for improving the productivity of coal mines.

Parameters Affecting Surface Preparation

Doug Wright, John Wolgamott, and Gerry Zink
StoneAge, Inc., Durango, Colorado

Waterjet surface preparation is typically performed using pressures from 20,000 to 40,000 psi, with rotating nozzle heads varying in diameter from 2-inch to 14 inches. Materials being removed include coatings, oxidation or scales. The purpose of this research was to determine the effects of variables such as standoff distance, traverse speed, surface speed, rotation speed, and the size, number and angle of jets.

A Comparison Of Tube Nozzle Performance

Doug Wright, John Wolgamott, and Gerry Zink
StoneAge, Inc., Durango, Colorado

Tubes in the size range of 5/8-inch to 2 inches in diameter, ranging in length from 5 to 65 feet, such as are found in heat exchangers, evaporators and coolers, are frequently waterblast-

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cleaned using a technique called flex lancing. Flex lancing uses a nozzle on the end of a flexible hose, fed into and out of the tubes by an operator. There exist several basic designs of these nozzles that are used in tube cleaning. The goal of these tests was to measure the relative performance of the most common designs of tube nozzles. These tubes may be completely plugged or may only have a thin scale built up on their inner walls; an attempt was made to simulate these types of conditions for the performance comparisons.

Beyond Waterjetting

Michael T. Gracey, P.E.
Reliable Pumps Consultants
Houston, Texas

The proposed paper is to touch on several subjects that have to do with waterjetting and high pressure positive displacement pumps used in various fields. It is to include discussions of:

- Up to 40,000 psi waterjetting
- Water blasting applications
- Other fields of application
- Oil and gas industry uses for pumps
- Chemical and petrochemical uses for pumps

The field of applications includes recent pump packages to perform surface preparation on offshore structures, unique uses for water blaster type pump packages in diverse businesses and specialty equipment used for purposes other than water blasting. Ultra-high waterjetting at low flow is being used for cleaning and surface preparation aboard ship and offshore with a discussion of pumps will be the first topic of the paper. A high-pressure pump package was recently delivered to a nuclear power plant for cleaning fuel rod tubes is an example of water blasting diversity.

The oil and gas industry uses a variety of positive displacement pumps that include large plunger and piston pumps for well servicing and salt-water disposal. An example is a 350 horsepower piston pump for salt-water disposal on an offshore platform near China that was recently supplied. Another example is eight pump packages for glycol service supplied to a Houston based engineering group to replace damaged equipment in Iraq.

Specialty products such as pump units for sub-sea flushing operations; wellhead device testing and chemical pumping will be reviewed. Examples of personal experiences, practical applications and pumping systems will be presented along with case studies and special projects that are germane to the topics being discussed. Photos and illustrations will be used to support the subject of the paper with slides to be used during the presentation of the paper. The author has been working high pressure pumps since 1976 and worked for pump manufacturers and packagers to handle a variety of fluids and pressures.

Investigation Of Metal Processing Using A High Speed Liquid Impact

V. Samardjic, E.S. Geskin, G.A. Atanov, A.N. Semko, and A.V. Kovaliov
New Jersey Institute of Technology
Newark, New Jersey

Metal deformation and welding in the course of an impact of high speed liquid projectiles (impulsive jets) was investigated experimentally. The projectiles were generated by a launcher where the chemical energy of a powder was converted into the kinetic energy of a projectile and were

(continued on page 18)

Safety Committee Solicits Comments On Improvements To *Recommended Practices*

The WJTA Safety Committee hereby solicits comments regarding improvements to the publication, *Recommended Practices for the Use of Manually Operated High Pressure Waterjetting Equipment*. While *Recommended Practices* is reviewed periodically at the biennial conferences of the WaterJet Technology Association, your comments and suggestions for improving the publication are invited and welcome anytime.

Please address your comments and suggestions to: Safety Committee, c/o WJTA, 906 Olive Street, Suite 1200, St. Louis, MO 63101-1434, phone: (314)241-1445, fax: (314)241-1449, e-mail: wjta@wjta.org, web site: www.wjta.org.

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Selected Abstracts Of Papers Considered For Presentation At The 2007 American WJTA Conference And Expo, August 19-21, 2007, Marriott Westchase Hotel, Houston, Texas, from page 17

used as a punch, while the die geometry determined the final shape of a workpiece. The deformation and welding of steel, copper, and bronze samples was investigated experimentally. Selected samples underwent forging, stamping, and extrusion operations. It was shown that the deformation was carried out at the extreme high speed and the shape of the die determined at a desired accuracy the geometry of a generated part. Welding of same and dissimilar materials using the liquid impact was also studied. Ultrasound examination showed the continuity if the joint generated in the course of the impact. Potential application of the liquid impact for metals processing is discussed.

Optimization Of UHP Waterjet Cutting Heads; The Orifice

Mark Powell
Flow International Corporation
Kent, Washington

Selecting the correct jewels, geometry, and orifice mount design are critical factors in optimizing the performance of a waterjet cutting head in various UHP shapecutting applications. Synthetic sapphire, synthetic ruby, and diamond are three common materials that orifice jewels are composed of.

This paper focuses on a critical component of all waterjet cutting heads, the orifice. A review of the jewel types, geometry considerations and a discussion of practical orifice mount design are presented. A review of a typical state of the art, high-performance cutting head illustrates these considerations and how this affects the optimization of the cutting head in practical applications.

Laser Based Pulsing Of Pure Waterjets

P. Jäschke, O. Meier and A. Ostendorf
Laser Zentrum Hannover
Hannover, Germany

Surface treatment as well as cutting of metals, polymers and ceramics using waterjet technology, has been established for some time. Compared to conventional techniques such as milling or grinding, the efficiency of the waterjet technique is quite low due to low process velocities.

The ablation performance of a waterjet can be enhanced by introducing a dynamic component to the jet. This can be achieved by increasing the distance between the nozzle and the work piece, making use of the natural droplet disintegration. However, this results in decreasing energy densities. Furthermore, the accuracy of the treatment becomes worse due to a widening of the waterjet.

To address this problem, i.e. achieving a high energy droplet water stream at small standoff distances with a defined impact rate, laser radiation has been used to introduce steam bubbles in close proximity to the nozzle in order to generate a pulsed disruption of the jet.

Investigations on waterjet pulsing using CO_2-laser radiation reveal an enhancement of the ablation rate of stainless steel. In order to generate short pulses within the range of 10^{-6} to 10^{-8} seconds, a diode-pumped Q-switched Nd:YAG-laser comes into operation. Due to the lower absorptivity of this laser wavelength within the waterjet, dissolvable substrates are added to the water. Using this configuration, pulse frequencies up to 60 kHz are realized.

New Facility For StoneAge

StoneAge has moved into a new facility four miles south of Durango, Colorado. This new home is 33,000 square feet on four acres, which is more than twice the size of their previous facility.

The PO Box, telephone, and fax numbers remain the same. Visit www.stoneagetools.com or contact StoneAge Inc., PO Box 2907, Durango, CO 81302, phone: (970) 259-2869, fax: (970) 259-2868.

Surface Preparation Workshop, June 4, 2007

Dr. Lydia Frenzel will present **"Surface Preparation- The Latest Developments" Workshop (Information Updated for 2007)** [subtitled Dr. Lydia's Finishing School for Inspectors] from 1:00-5:00 p.m. on June 4, 2007, at the Town and Country Resort and Convention Center, 500 Hotel Circle North, San Diego, California. The course is being held in conjunction with Mega Rust 2007 Coatings & Corrosion Conference, June 4-7, 2007.

The course will include a series of workshop topics covering Surface Preparation Standards with Water Jetting, Water Blasting, Wet Abrasive Blasting, Flash Rust, and Salts. There will be time for questions and answers. Integrated into the topics are: economics, profile of the substrate, flash rust, salts, water additives, appearance, Why do some specifications work and some just get us into trouble?, Worker training and safety, and environmental solutions.

A certificate of attendance will be issued.

The Course Price: $185 – Choose this "Optional" registration item during Mega Rust 2007 registration. Register at: http://www.nstcenter.com, under training "Surface Preparation." Level of Competence- All levels- engineers, specifiers, jetters. This course is sponsored by: Advisory Council and MegaRust

KMT Acquires French Service Company

KMT regards service and the aftermarket as a priority area for expansion and, accordingly, has acquired the French service company AquaForce. AquaForce offers service contracts, remodeling, spare parts and maintenance of waterjet cutting machines, primarily in the French market. The company, which has five employees, had a turnover of about EUR 1.5 M in 2006 excluding sales to KMT.

"We have had productive cooperation with AquaForce since 2004 and a large portion of their sales is attributable to KMT's installed base. We are acquiring AquaForce with the aim of strengthening our position in the southern European market in general and the French market in particular," says Sten Camitz, president of KMT Cutting Systems.

The business will be operated as a profit center within KMT Cutting Systems and is consolidated from January 1, 2007.

Papers Considered For Presentation At The 2007 American WJTA Conference And Expo, from page 2

- Numerical Simulation of Rock Breaking Process Under High Pressure Abrasive Water Jet, Hu Si, Xiaohong Li and Dandan Wang
- Optimization of UHP Waterjet Cutting Heads; the Orifice, Mark Powell
- Parameter Optimization in Munitions Cutting Using Abrasive Waterjet, David Summers, Pradeep Nambiath, Greg Galecki, L. John Tyler and Robert Fossey
- Parameters Affecting Surface Preparation, Doug Wright, John Wolgamott and Jerry Zink
- Pressure and Flow Rate Fluctuations at High Pressure Intensifier Pumps, Franz Trieb, Reinhard Karl and Rene Moderer
- Reproduction of A Work of Art by AWJ: Floor of the Saint Mark Basilica, Wildor Theodoro Hennies, Valena Hennies Lauand, Eliana Raposo and Heloisa Raposo
- Research On Ultrafine Comminutin of Minerals by Thermally Assisted High Pressure Water Jet, Fu Sheng, Li Hong and Shi Zhaoyao
- The Basis of Explosives Washing-Out Technology from Heavy-Artillery Ammunition, Przemyslaw Borkowski, Józef Borkowski, Andrzej Maranda, Ryszard Kostiw, Wojciech Goryca and Dariusz Wozniak
- The Effect of Waterjet Cleaning on Surface Properties, Lydia M. Frenzel
- The Optimization of High Pressure, Suspension Waterjet Cutting Process with Use of the Artificial Neural Network, Andrzej Perec
- The Technology and the Machine for Cutting Wall Stone of Correct Form by Ultra-High Pressure Water Jet, John Alexan Asatryan
- Ultra High Pressure Waterjet Rust Removal Line Design, Shengxiong Xue, Donghui Zhang, Lidong Yi, Yongqiang Wang, Zhengwen Chen, and Huaqing Zhu
- Use of Pre-Profiling a Milled Pocket as a Means of Improving Machining and Lowering Energy Costs, David Summers, Shajin Zhang, Christopher Swallow and Greg Galecki
- Water Peening Effect on Fatigue Performance, Alex Chillman, M. Ramulu and M. Hashish

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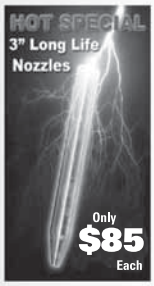

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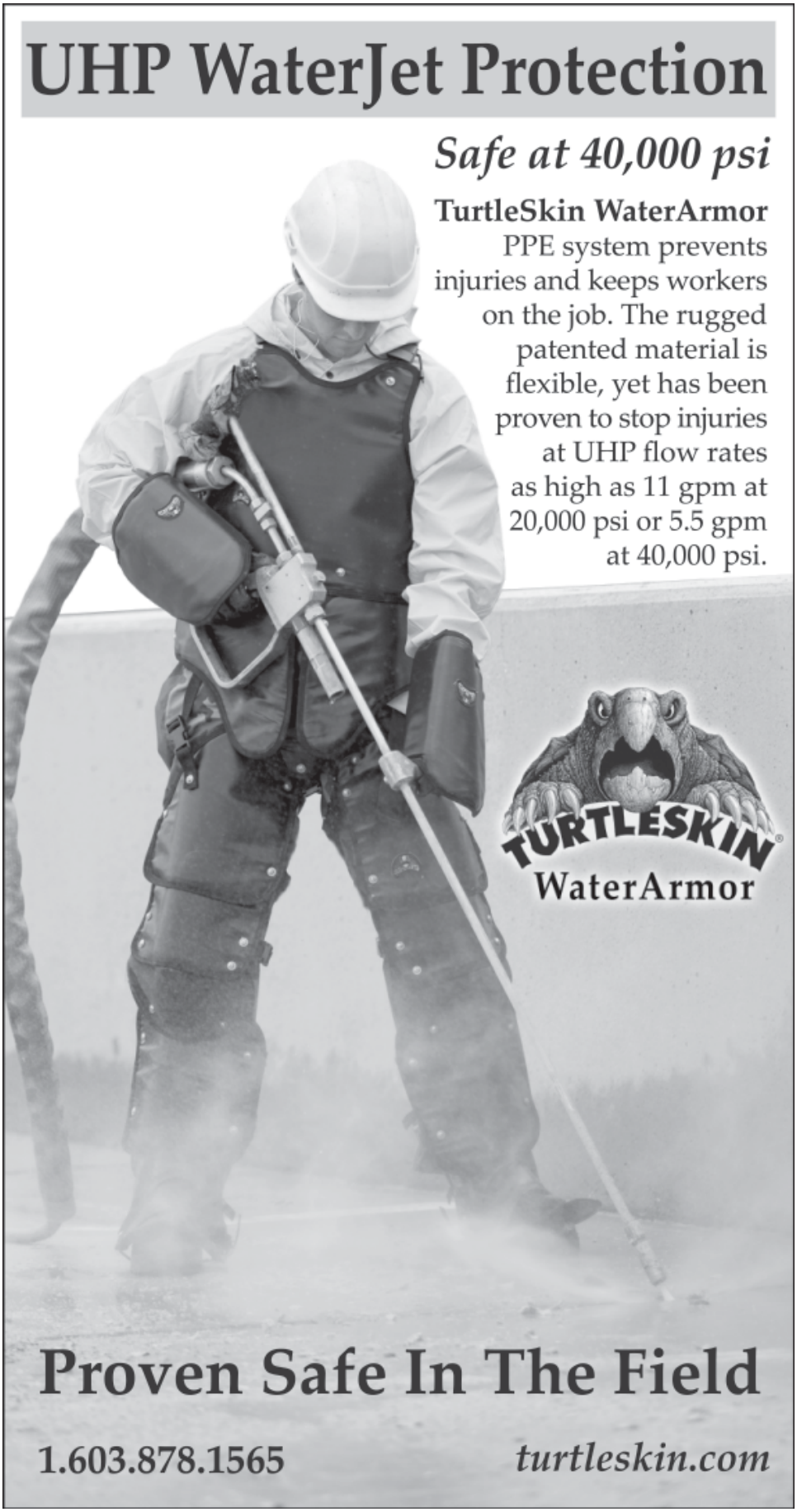

David Sullivan Joins Barton Mines Company LLC

Barton Mines Company, LLC has announced the appointment of David Sullivan as regional sales manager for the newly created Western Great Lakes region. This region includes Indiana, Illinois, Wisconsin, Kentucky and Tennessee.

David Sullivan

Mr. Sullivan joins the company with more than 18 years of experience in industrial sales and marketing with industry leading companies.

"I am very excited about this opportunity," said Mr. Sullivan. "I look forward to representing Barton Mines, and to serving the many fine companies that operate in this new territory."

For more information, visit www.barton.com.

Authorized Distributor And Assembly Center For Ontario, Canada

SPIR STAR, the manufacturer of high pressure hose with working pressures up to 50,000 psi, is pleased to announce that Deetag Ltd. in London, Ontario, is now an authorized distributor and assembly center for the province of Ontario. Deetag Ltd. will now be able to better serve local customers by having a complete stock of hose and end fittings in addition to having the capacity to repair high pressure hose assemblies.

For further information, please contact Dean Gordon at 519-659-4673.

David Dumas Joins AccuStream

AccuStream Inc., St. Paul, Minnesota has recently hired David Dumas to its sales staff. He is responsible for development, sales and support for OEM customers. Mr. Dumas brings 20 years of experience in the sales, engineering and manufacturing of waterjet cutting equipment.

David Dumas

For more information on AccuStream, visit www.accustream.com, call 1-866-566-7099 or email info@accustream.com

Yellow Lube

A waterjet thread anti seize and thread lubricant that stays on the threads longer and will not stain your clothing or hands. Proven in some of the harshest Precision Cutting and Portable Waterjet environments. Available in the larger 6 oz. tubes.

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Bridge Repair In The Netherlands, from page 11

Prior to replacing the revised concrete overlay the damaged sections had to be removed. "We looked at two methods and initially tried pulling it off with a bucket on an excavator, but this was damaging the steel deck," says Elwin Roelfsema. "So we had no other alternative but to try hydrodemolition and contracted Doornbos to remove the concrete and all the reinforcing in the two bays covering about 1,700m^2." In addition to high pressure water scarifying of the concrete wearing course, Doornbos also used one of its three Conjet 322 hydrodemolition robots to break away and roughen the longitudinal edges of the overlay to form a connecting bond with the adjacent lane.

"Although we had earlier used the Conjet 322 to successfully roughen the edges of the thin overlay for bonding to the next lane, TBI was initially sceptical and didn't think hydrodemolition would be able to remove all the very high strength concrete from around and below the densely placed steel reinforcement," says Doornbos project manager Jurjen Volmer. "We tested our Conjet 322 on the overlay, which worked well, but was not powerful enough so we bought Conjet's largest 432 Robot specifically for this project and coupled it to two of our existing 500 hp Hammelmann high pressure pumps. These provide a combined flow of 360 litres/min and pressure of 1100 bar at the 432's single jetting nozzle. We have to remove about 130m^3 of this heavily reinforced, extremely high 105MPa strength concrete, which, due to the uneven deck plate, varies in thickness from 50mm to 70mm. This is the toughest hydrodemolition job I have been involved with and we are managing to remove between 3.5m^3 to 4m^3/10 high pressure hours on the thickest areas, rising to 4.5m^3 to 5m^3/10 high pressure hours on the thinnest sections."

Water for the hydrodemolition process is pumped from the estuary into a purifier and holding tanks prior to pumping up onto the bridge and along to the main high pressure Hammelmann pumps. After passing through the Conjet 432 and removing the high strength concrete the dirty water is collected in a sump and pumped through a series of settling tanks and sand filters prior to discharging the clean water back into the estuary. After the successful hydrodem-olition Doornbos follows on cutting out the steel mesh reinforcing and removing the broken concrete to fully expose the steel deck plate. The company expects to finish its approximate ¸350,000 contract during the first week of May 2007.

"Hydrodemolition with the Conjet 432 Robot has proved to be a very safe and effective way of removing the damaged sections of high strength concrete overlay," says Elwin Roelfsema. "There is no other method we could have used without damaging the deck plate. We expect to finish the repair to these two sections and all the investigations on all the other sections of the east side northbound carriageway of the bridge by June. What we find during these investigations and the extent of any damage will depend on whether it can all be repaired. The results from our investigations and repairs to the east side of the bridge will also depend on whether we can overlay the west side southbound carriageway with high strength concrete and that will be no sooner than 2008."

The *Jet News* is published by the WaterJet Technology Association (WJTA) and is a benefit of membership in the Association.

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Hydrodemolition At Pearl Harbor, from page 13

Putzmeister's Water Technology division. "This is an exceptionally high production rate - about 3-4 times higher than normal," he adds.

The HD-6000's forward movement and the oscillation of its head can be easily adjusted to suit the area to be removed. In the weakest areas of the Pearl Harbor piers, only one or two passes of the high pressure jet head are needed to remove the concrete to the required depth.

Triton Marine staff quickly built up familiarity with the operation, gaining expertise in adjusting parameters such as the cutting width, speed and angle of the jet. "Setting up the machine very fast and very easy," says Gordon. It took just two minutes from finishing one area to setting up for a neighboring area that could be reached from the same set-up position of the high- pressure water pump.

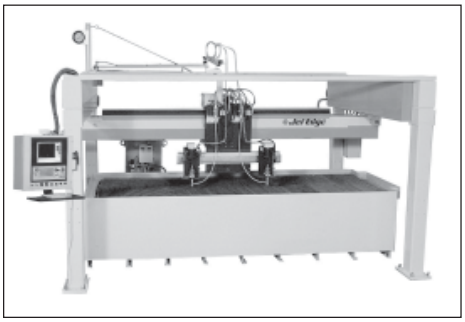
The versatility of the HD-6000 avoids the unnecessary removal of sound concrete, adds Gordon. The passage of the jet is determined by adjusting the travelling range of the lance roller and the distance moved by the robot's tractor unit. This ensures that the hydrodemolition is carried out only on the damaged concrete, without harm to the surrounding areas.

The Aquajet robot can be adjusted in moments to take account of the differing shapes and sizes of individual areas to be removed. Repairs were often much narrower than the width of the machine head but this was catered for using the HD-6000's proximity switch adjustment which facilitates easy adaptation to suit varying widths. Magnetic stops determine how far the head goes before turning. The distance of tractor travel is also easily controlled, through visual markers set outside the removal area.

"Without these parameter adjustments, the movement time between patches would have increased and the overall production rate would have been greatly reduced," says Zimmerman. "Also facilitating the high production rate was the flawless performance of the HD-6000."

Jet Edge Introduces New iP60-50 Intensifier Pump

Jet Edge, Inc. is pleased to introduce the new Jet Edge iP60-50 intensifier pump. This revolutionary new pump is the very latest addition to Jet Edge's legendary line of intensifier pumps.



Rated for 60,000 psi, the 50-horsepower iP60-50 features numerous design evolutions from its predecessor, the 55-50C intensifier pump. Design improvements include a new non-contact wet electronic stroke sensor that replaces the contact actuator/proximity sensor combination, allowing for improved performance and reliability; a simplified piston/plunger design that requires only one tool for replacement; a redesigned intensifier assembly that can be assembled with standard tools; and an improved check tube featuring fewer parts than the previous model. Featuring an extended-life hydraulic system, the iP60-50 intensifier pump provides easy access for all service and maintenance. It requires very few tools to maintain, and can easily be serviced in-house, reducing down-time and increasing productivity.

For more information about the Jet Edge iP60-50 intensifier pump or other Jet Edge waterjet machinery, visit www.jetedge.com or call 1-800-JET-EDGE.

2007 American WJTA Conference And Expo August 19-21, 2007

Marriott Houston Westchase, Houston, Texas

- **Live, Onsite Demonstrations** of a variety of waterjet applications, including cleaning, paint/coating removal, concrete preparation, and testing the durability of safety equipment. Industrial vacuum/air moving operations will also be demonstrated.
- **Waterjet Expo** featuring displays of waterjetting equipment, systems and supplies and industrial vacuum/air moving vehicles.
- **Waterjet Boot Camp**—Industry experts offer information and suggestions on ways to help contractors buy smart, improve efficiency and generate profitable new business. Sessions are presented in the exhibit hall so participants can alternate between viewing exhibits and catching sessions of interest.
- **Waterjet Technology: Basics and Beyond Pre-Conference Workshop**—Start with the basics and follow up with an in depth look at waterjet applications: Surface Preparation, Cleaning Applications, and Cutting Applications.
- **Emerging Technology, New Applications**—Hear some of the world's foremost engineers and researchers share new developments in applications, mechanics, equipment, and procedures.

Hotel Reservations at the Marriott Houston Westchase. The Marriott Houston Westchase, 2900 Briarpark Drive, Houston, Texas 77042, is the central location for the WJTA Conference and Expo activities. The Marriott is a **smoke-free** facility. For reservations, call toll-free **1-800-452-5110** or contact the Marriott directly at **1-713-978-7400.** Be sure to identify yourself as attending the WaterJet Technology Association Conference to receive the special group rates of **$109 single/$119 double occupancy. August 10, 2007,** is the deadline for guaranteed room availability. Reservations received after **August 10, 2007,** will be confirmed on a space available basis. Rooms may still be available after August 10, but not necessarily at the rates listed above.

The Hilton Houston Westchase, an alternate hotel, is located two blocks from the Marriott at 9999 Westheimer, Houston, Texas 77042. **Smoking and non-smoking rooms are available.** For reservations, call **1-713-974-1000.** Be sure to identify yourself as attending the WJTA Conference to receive the special group rate of **$114 single or double occupancy. August 6, 2007,** is the deadline for guaranteed room availability. Reservations received after **August 6, 2007,** will be confirmed on a space available basis. Rooms may still be available after August 6, but not necessarily at the rates listed above.

Visit WJTA's website, www.wjta.org, for updated Conference information or contact: WJTA, 906 Olive Street, Suite 1200, St. Louis, MO 63101-1434, phone: 314-241-1445, fax: 314-241-1449, email: wjta@wjta.org

Jetstream Introduces New Mobile Waterblast Unit

New unit features water tank system that protects pump and blaster components from unnecessary wear

Jetstream of Houston, manufacturer of high-quality waterblasters, parts and accessories, has introduced the X-Series mobile waterblast unit featuring Jetstream's patented UNx™ fluid system designed for fast conversion between 10,000, 20,000 and 40,000 psi operating pressures. The new unit also features the Guardian Filter System™ – an innovative water tank system with integrated filters designed to help extend system life – as well as a new trailer design with a lower center of gravity and an optimized wheelbase for improved towing and steering.

Consisting of a rugged, rotomolded 100-gallon tank with dual replaceable filters inside, the Guardian Filter System automatically frees all fill water of abrasive dirt and contaminants that can shorten the life of pumps and gun components. Positioned at the front of the trailer frame to improve tank and pump access while optimizing weight distribution on the dual axle trailer frame, the large capacity water tank reduces chances of cavitation by increasing dwell time. The water tank and filter system are available for retrofit on other makes and models of mobile water blast units.

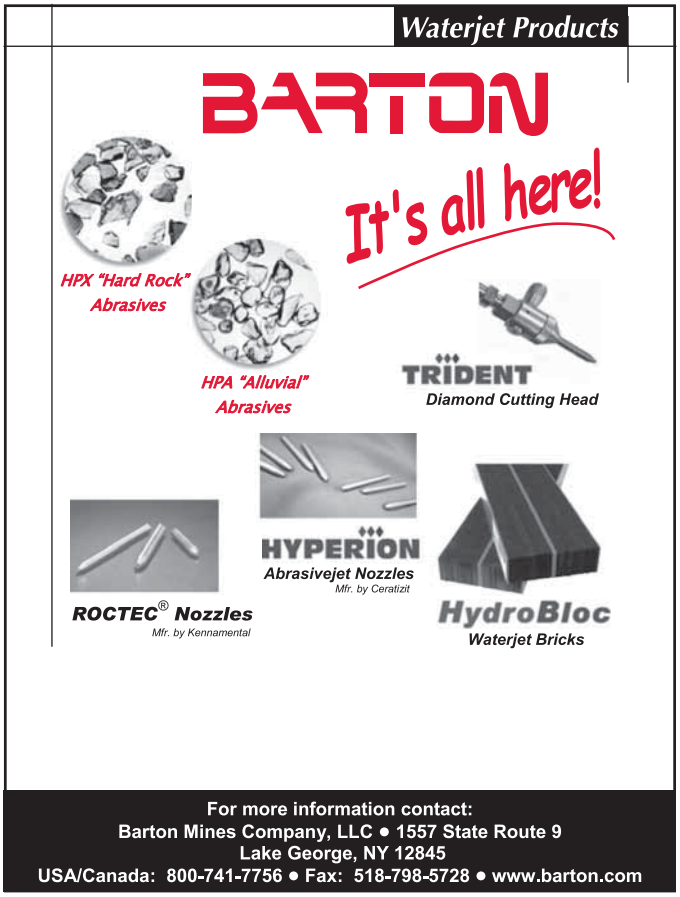
Jetstream X-Series mobile waterblast units are available in 110 to 500 hp models, with operating pressures from 6,000 to 40,000 psi.

Jetstream manufactures industrial high-pressure waterblasting equipment operated at pressures up to 40,000 psi for a wide range of applications, including industrial cleaning and

surface preparation. Product offerings include a complete line of skid- and trailer-mounted pump units, control guns, valves, hoses, replacement parts and nozzles.

Jetstream of Houston, LLP is a division of Federal Signal Corporation's (NYSE:FSS) Environmental Solutions Group, which includes Elgin Sweeper, Guzzler Manufacturing, RAVO International and Vactor Manufacturing. For more information, visit www.waterblast.com.

One of the best,
Diamond Cutting Head 'S5000'



New Conjet Robot 364

The Conjet Robot 364 MPA can remove concrete from numerous surfaces, including above and underneath the robot with a minimal set up time. Due to its rigid designed and improved multipurpose arm, which reaches up to 6m above the robot and 5m to the side, the new Robot 364 MPA can operate with a reaction force up to 2000N, which is equivalent to the force of a water jet generated by a 550kW (700 HP) high-pressure water pump.

The new features on the Robot 364 MPA include hydraulically height adjustable steering wheels that add an additional degree of freedom for positioning the feedbeam with its integral jetting lance and individually hydraulically extendable drive wheels to optimize robot stability. In addition the design of the new multipurpose arm offer higher accuracy in positioning and holding the feedbeam.

The closed loop control system features the latest state of the art PLC (micro computer) and a new control box controlling the hydrodemolition process. There are nine pre-loaded programs for the most common hydrodemolition tasks and in addition the operators can store up to eleven programs with their own set up parameters. Two level cut and accelerated lance turning are other features included in the system.

For safety reasons, when the robot is supplied with high-pressure water from a Conjet Powerpack the robot and powerpack control systems are normally integrated. This enables the powerpack to speed up when the robot is switched into automatic mode and returns to idle when it is stopped. Should the emergency stop be activated on either the robot or the powerpack both systems shut down immediately.

The Robot 364 is electrically powered so that it can be operated in tunnels and parking garages without producing any exhaust gases that are hazardous for the operators.

For more information, visit www.conjet.com, call: +46(0)8-5565-2240, or fax: +46(0)8-5565-2260.

Waterjet Boot Camp At The 2007 American WJTA Conference And Expo

Preliminary Schedule

August 21-23, 2007, Marriott Westchase Hotel, Houston, Texas

How to buy smart, improve efficiency, and generate profitable new business

30-minute presentations by industry experts packed with helpful information. Attend presentations of interest to you while visiting the WJTA 2007 Conference Expo. Located in the exhibition hall.

TIME	MONDAY, AUGUST 20	TUESDAY, AUGUST 21
10:30 a.m.	**Proper Inlet Pump Suction Conditions** By: Jamie Forrest, NLB Corp	**Introduction to Industrial Vacuum Trucks/Air Movers** By: Tony Fuller, Jetstream of Houston, LLP Gary Toothe, Thompson Industrial Services
11:30 a.m.	**DOT Regulations for Trucks and Trailers** By: Speaker to be announced	**Hose Fittings, Pressure Testing** By: Speaker to be announced
1:30 p.m.	**Cutting Edge Quality in Abrasive Waterjet Cutting** By: Axel H. Henning, OMAX Corporation	
2:30 p.m.	**Safety First In Waterjetting: A Review of Best Practices** By: Jenny Houston, TurtleSkin WaterArmor by Warwick Mills	
3:30 p.m.	**Introduction to High Pressure Waterblasting** By: Gary Toothe, Thompson Industrial Services	

Candidates Sought For 2007 WJTA Awards

You are invited to submit candidates for the special awards that are presented biennially by the WaterJet Technology Association to honor a company, organization or individual who has made a significant contribution to the industry through accomplishments that directly enhance waterjet technology and the industry as a whole. A list of previous WJTA award recipients appears below.

Candidate nominations must be received no later than July 2, 2007. The award recipient(s), to be selected by the Awards Committee of the WaterJet Technology Association, will be honored at a presentation ceremony on Monday, August 20, 2007, in conjunction with the 2007 American WJTA Conference and Expo in Houston, Texas.

An official form for candidate nominations appears on page 28. Complete one form for each nomination submitted. Please make additional copies of the form as needed. Completed nomination forms may be faxed to (314)241-1449 or mailed to the WaterJet Technology Association, 906 Olive Street, Suite 1200, St. Louis, MO 63101-1434, USA.

Previous Award Recipients

1981	Pioneer Award	Jacob Frank (deceased)
1983	Pioneer Award	H.D Stephens, Bedford, England
1985	Pioneer Award	William Cooley (deceased)
1987	Pioneer Award	Norman Franz, Ph.D., Vancouver, BC, Canada
1989	Pioneer Award	Richard Paseman, Houston, TX
1991	Pioneer Award	John H. Olsen, Ph.D., Kent, WA
1993	Pioneer Award	Fun-Den Wang, Ph.D., Golden, CO
	Safety Award	David Summers, Ph.D., Rolla, MO
		NLB Corporation, Wixom, MI
	Service Award	George A. Savanick, Ph.D., Apple Valley, MN
		Mohan Vijay, Ph.D., Gloucester, ON, Canada
	Technology Award	Mohamed Hashish, Ph.D., Kent, WA
		Autoclave Engineers, Erie, PA
		Hammelmann Corporation, Dayton, OH
1995	Pioneer Award	George Rankin, Houston, TX
	Safety Award	Autoclave Engineers, Erie, PA
	Service Award	Thomas J. Labus, Lake Geneva, WI
	Technology Award	Thomas J. Kim, Ph.D., Kingston, RI
1997	Pioneer Award	David A. Summers, Ph.D., Rolla, MO
	Service Award	Andrew F. Conn, Ph.D., Baltimore, MD
	Technology Award	Prof. Dr-Ing. Hartmut Louis, Hannover, Germany
1999	Pioneer Award	Mohamed Hashish, Ph.D., Kent, WA
	Safety Award	Bruce Wood (deceased)
	Service Award	John Wolgamott, Durango, CO
	Technology Award	Ryoji Kobayashi, Ph.D., Ishinomake, Japan
2001	Pioneer Award	George A. Savanick, Ph.D., Apple Valley, MN
	Technology Award	Richard Ward, Kent, OH
2003	Pioneer Award	Pat DeBusk, LaPorte, TX
	Service Award	Mohamed Hashish, Ph.D., Kent, WA
	Technology Award	Ernest S. Geskin, Ph.D., Newark, NJ
2005	Pioneer Award	Hartmut Louis, Dr.-Ing., Germany
	Safety Award	TurtleSkin WaterArmor, New Ispwich, NH
	Service Award	NLB Corporation, Wixom, MI
	Technology Award	Jay Zeng, Ph.D., Kent, WA

2007 WJTA Awards Nomination Form

Instructions: Complete sections below and submit a narrative (300-word maximum) to support your nomination on a separate sheet of paper. Please print or type all information.

I nominate the following company, organization, or person as a candidate to receive a 2007 WJTA Award (please print or type full individual, company or organization name):

_____

company, organization, or person

❒ Distinguished Pioneer Award

The nominee must:

- Have made contributions to the waterjet industry;
- Have made contributions to the achievement of the goals of WJTA;
- Have high moral character;
- Have strong personal and business ethics;
- Be dedicated to the future of the waterjet industry and to the growth of WJTA.

❒ Service Award

How has the nominated company, organization or individual contributed in time and talent toward improvement in the WaterJet Technology Association?

❒ Technology Award

What has the nominated company, organization or individual done to introduce new and innovative ideas in engineering or manufacturing? This could include, but is not limited to, new products, new manufacturing techniques, patents . . . any unique activity that advanced the technology of the waterjet industry.

❒ Safety Award

What has the nominated company, organization or individual done to introduce new and innovative ideas in safety? This could include, but is not limited to new products, new concepts, new safety techniques . . . any unique activity which increases the overall safety of waterjet equipment.

CANDIDATE: _____ Company: _____

Address: _____

City: _____ State: _____ Country: _____ Postal Code: _____

Phone In US/Canada (_____) _____ Fax (_____) _____
area code area code

Phone Outside US/Canada [____] (____)_____ Fax [____] (____) _____
country code city code country code city code

CANDIDATE SUBMITTED BY: _____ Company: _____

Address: _____

City: _____ State: _____ Country: _____ Postal Code: _____

Phone In US/Canada (_____) _____ Fax (_____) _____
area code area code

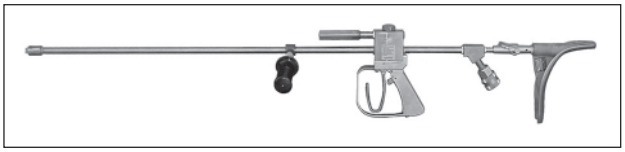
Phone Outside US/Canada [____] (____)_____ Fax [____] (____) _____
country code city code country code city code

Nominations must be received no later than July 2, 2007.

For a prompt response, fax completed form to (314)241-1449, or mail to the WJTA, 906 Olive Street, Suite 1200, St. Louis, MO 63101-1434, USA.

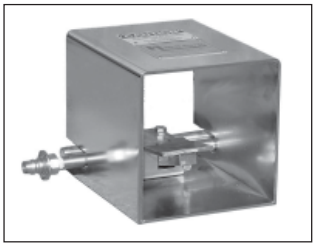
NLB Introduces 15,000 PSI Lance, Foot Control

A high-productivity water jet lance and foot control from NLB Corp. features a quick-change cartridge valve that an operator can replace in less than 60 seconds. They operate at pressures up to 15,000 psi (1,035 bar).



The NLB NCG15-286 lance is designed to maximize operator comfort and protection. It weighs just 12 lbs. (5.5 kg), and has a one-finger latch to prevent accidental actuation. A light pull on the patented trigger (U.S. patent no. 5,636,789) initiates the water jet action, and a push forward immediately dumps the pressure. The shoulder stock and the hand grip are adjustable to suit the operator.

NLB's latest foot control valve, the FC15-286, complements the new lance. It features a patented pedal design to force the valve into dump mode, if necessary, and handles flows up to 25 gpm (95 lpm). All wetted parts are made of stainless steel for durability, and the enclosure doubles as a handy carrying case.



Like all NLB accessories, NCG15-286 lance and FC15-286 foot control are made of top-quality materials and are thoroughly tested before shipment.

NLB Corp., a leader in high-pressure and ultra-high pressure water jet technology, manufactures a full line of quality water jetting systems and accessories for contractor and industrial uses. These include surface preparation, paint removal, tank and tube cleaning, concrete hydrodemolition, concrete and pipe cutting, and more.

For more information, visit www.nlbcorp.com or call (248) 624-5555.

Conference Exhibitors At The 2007 American WJTA Conference And Expo

August 21-23, 2007, Marriott Westchase Hotel, Houston, Texas

AccuStream
Advanced Precision Services
Barton Mines Company, LLC
Bingham Manufacturers
Boatman Industries, Inc.
Burny/AMC
Business & Industry Connection (BIC) Magazine
Cleaner Times Magazine
Enz USA Inc.
Flow International Corporation
G.T. Waterblast
Gardner Denver Water Jetting Systems, Inc.
General Pump
Giant Industries, Inc.
Great Lakes - Eglinton
Hammelmann Corp.
Haskel International, Inc.
Heintzmann Corporation
High Pressure Equipment Co.
HoldTight Solutions, Inc.
IVS Hydro
Jetstream of Houston, LLP
KMT Waterjet Systems, Inc.
Kennametal Boride Abrasive Flow Products
LaPlace Equipment Co., Inc.
NLB Corp.
OMAX Corporation
Parker Polyflex
Peinemann
Powertrack International Inc.
QualJet
Reliable Pumps Consultants
S.M.T.
SPIR STAR
Sprague Products
StoneAge, Inc.
Super Products LLC
Terydon Inc.
TurtleSkin WaterArmor by Warwick Mills
Under Pressure Systems, Inc.
Universal Minerals, Inc.
VLN Advanced Technologies Inc.
Vacuum Truck Rentals, LLC
Water Line Co. Ltd.
Wilco Supply L.P.
WOMA Corporation

(exhibitor list as of May 1, 2007)

WaterJet Technology Association's Order Form for Publications/Products

Name _____ Member # _____

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(to receive shipping confirmation)

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❑ Check or Money Order payable to **WJTA** (U.S. DOLLARS ONLY)

❑ PO # _____ (Enclose PO)

❑ Please charge my ❑ MC ❑ VISA ❑ American Express ❑ Discover

Credit Card # _____

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Print name as it appears on card

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Cardholder's signature

THREE EASY WAYS TO ORDER

By Phone: Just call **(314)241-1445** and have your credit card information ready. (MC/VISA/Am. Exp./ Discover ONLY).

By Fax: Fill out the order form with your credit card information and call our 24-hour fax number at: **(314)241-1449**.

By Mail: Fill out the order form and mail with applicable payment to: **WJTA, 906 Olive Street, Ste. 1200, St. Louis, MO 63101-1434.**

	WJTA Member Price	Non Member Price	Shipping & Handling	
____ **Proceedings CD-ROM of The 2005 WJTA American Waterjet Conference** (2005)	@ $ 109.00	$ 129.00	$ 8.00	= $_____
____ **Proceedings CD-ROM of The 2003 WJTA American Waterjet Conference** (2003)	@ $ 35.00	$ 55.00	$ 8.00	= $_____
____ **Proceedings CD-ROM of The 2001 WJTA American Waterjet Conference** (2001)	@ $ 10.00	$ 30.00	$ 8.00	= $_____
____ **Proceedings Book & CD-ROM of The 10th American Waterjet Conference** (1999)	@ $ 10.00	$ 30.00	$ 8.00	= $_____
____ **Proceedings Of The 9th American Waterjet Conference** (1997)	@ $ 10.00	$ 25.00	$ 8.00	= $_____
____ **Proceedings Of The 8th American Waterjet Conference** (1995)	@ $ 0.00	$ 0.00	$ 8.00	= $_____
____ **Proceedings Of The 7th American Waterjet Conference** (1993)	@ $ 0.00	$ 0.00	$ 8.00	= $_____
____ **Waterjet Technology: Basics and Beyond** 8/21/05 PowerPoint presentations in printed format	@ $ 20.00	$ 25.00	$ 8.00	= $_____
____ **An Overview of Waterjet Fundamentals And Applications,** Fifth Edition (2001)	@ $ 55.00	$ 70.00	$ 8.00	= $_____
____ **An Overview of Waterjet Fundamentals And Applications** 8/17/03 PowerPoint presentations in printed format	@ $ 30.00	$ 35.00	$ 8.00	= $_____

Minimum charge of $8 per order. $8 for 1-3 items purchased; $16 for 4-7 items purchased; for 8 or more items purchased, contact the WJTA office.

Recommended Safety Practices, English Edition

1 - 10 copies	_____ # of copies	x $ 5.00 ea.	$ 10.00 ea.	= $_____
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Specify: ❑ **VHS Video or** ❑ **CDROM**

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***Contact the WJTA office for the shipping and handling charge of more than one Safety Video.**

Baseball Cap	_____ # of caps	x $ 7.95 each	$ 7.95 each	$ 6.00 ea.	= $_____
WJTA Navy Blue Polo Shirt Size_____ (S, M, L, XL, 2X)	_____ # of shirts	x $ 30.00 each	$ 35.00 each	$ 7.00 ea.	= $_____

Safety Cards	1-10 safety cards	_____ # of cards	x .30 each	.50 each	= $_____
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Safety Cards: 1-50 cards ..... FREE (**For the purchase of more than 50 safety cards, call the WJTA office for the shipping and handling charge.**) = $_____

For shipping and handling charges outside the USA, contact the WJTA Office.

TOTAL ENCLOSED **$**

KMT + Aqua-Dyne = Water Intensified

KMT, known worldwide for their reliable, high precision and quality high pressure pumps, brings their standard of excellence to the Aqua-Dyne family of high pressure water jetting products.

The KMT Aqua-Dyne team is committed to delivering professional customer service and experienced technical support to keep our customer loyalty *second-to-none*.

KMT Aqua-Dyne products offer the reliability and power for most cleaning, surface preparation and hydro-demolition applications.

KMT. Creating value through precision.

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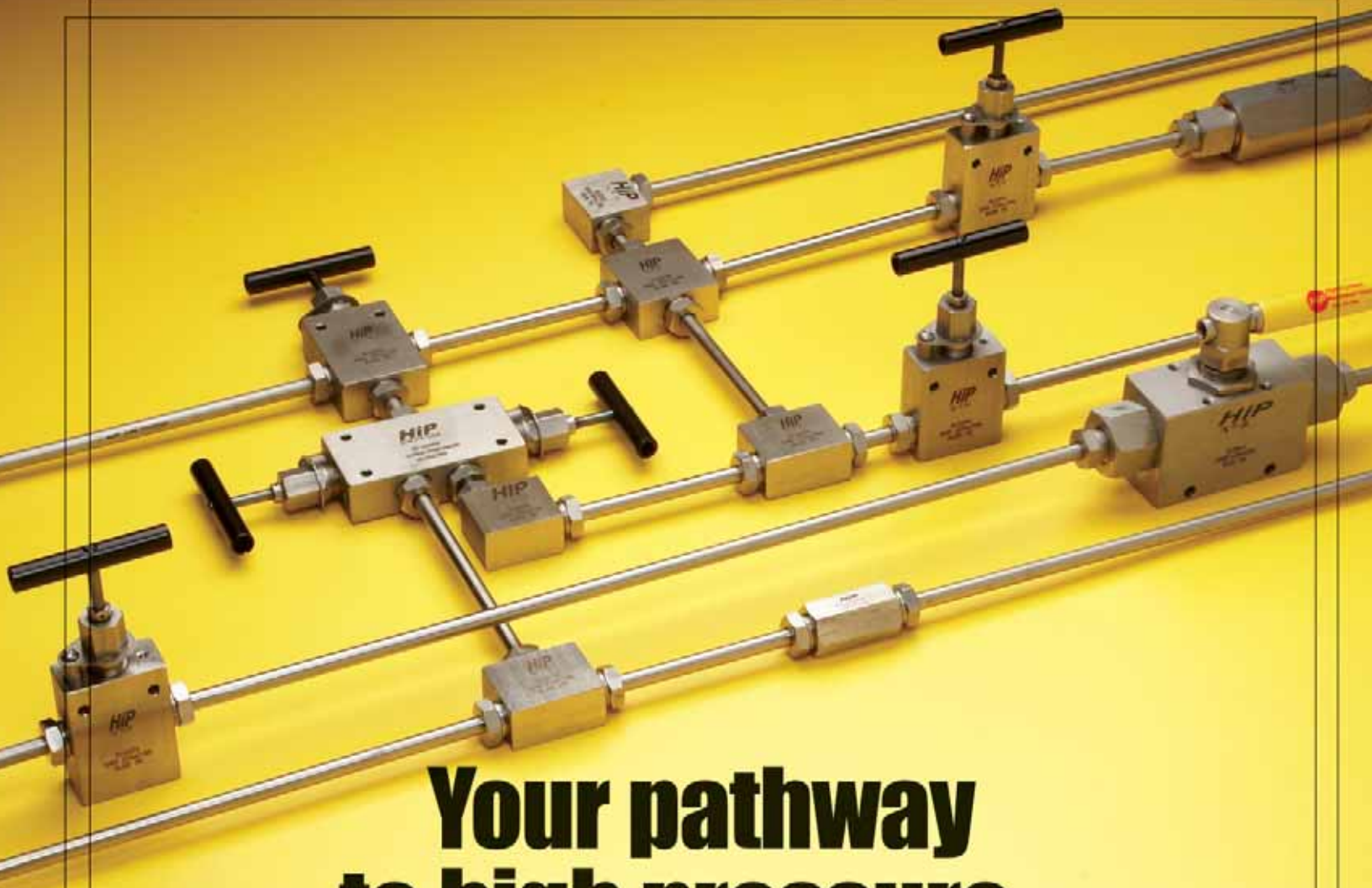

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What's in a name? In our case it clearly states the total focus and dedication of our organization ... unwavering for more than 50 years.
HiP... High Pressure Equipment Company. For you HiP offers:

- Complete line of valves, fittings and tubing
- Six pressure classes from 10,000 to 150,000 psi
- Quality you can count on, proven by our ISO9001 certification
- Responsive engineering support
- Extensive inventory for same day shipment of many products
- Short lead times for special materials and custom manifolds

Whether you're working in waterjet, oil and gas, chemical/petrochem or general industry – your pathway to high pressure leads to HiP.

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