WJTA Water Jet Technology Association

Jet News

APRIL 1995

Published by the Water Jet Technology Association for the benefit of its members

818 Olive Street, Suite 918 • St. Louis, MO 63101-1598, USA • Telephone: (314)241-1445, Fax: (314)241-1449

Water Jet Cutting System Quarries Granite Blocks

In 1989, Peter Wyatt, president of N-E-D Corporation, began developing a water jet cutting system for quarrying granite blocks. The system that evolved was the Ned-Jet™ 2000 Slot Cutting System, which has consistently proven to achieve more than 20 square feet per hour in high-quartz granite quarries.

The cutting system needs only six to seven gallons of clean water per minute at 80 to 100 psi.

The machine can produce a vertical slot just over 15' deep with a 1¾"- to 3"-wide slot to whatever length needed. When everything is running, the machine can operate for 15 hours without having to be moved. The cutting mechanism also has built-in safety mechanisms to shut the machine down.

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Slot cutting in a granite quarry. Note the depth of the slot.

Slot cutting in a granite quarry. Note the length of the slot.

On the inside

Water Jet Cutting System Quarries Granite Blocks, from page 1

The company is using the machine at an average consumable operating cost of about $2.70 per square foot.

In addition, the Ned-Jet 2000 has cut over 13,000 square feet at Cold Spring Granite's Milbank, SD, quarries. Jerry Wittrock, foreman at one of the quarries, said, "With a burner we get a lot of heat cracks, as much as one foot on either side of the channel. With the Ned-Jet, we get none of that."

The water jet system consists of a high pressure intensifier that increases pressure to about 37,000 psi at the nozzle. The intensifier uses a 250 HP diesel power unit.

A water jet lance automatically moves up/down and indexes forward with an onboard computer that can be programmed on-site to adjust for site conditions.

The diesel-powered intensifier sends pressurized water through a flexible hose to the lance.

Oscillating water jet which cuts deep slots in hard rock.

Slot cutter operating on a bench in a granite quarry.

Although the operation of the unit is fully automated once the parameters are set, the vertical speed of the lance and the horizontal index distance can be set by the operator.

The most noticeable feature of the water jet is the noise reduction at the bottom of the cut compared to the top. The nozzle cuts through standing water at the bottom that significantly reduces the noise level.

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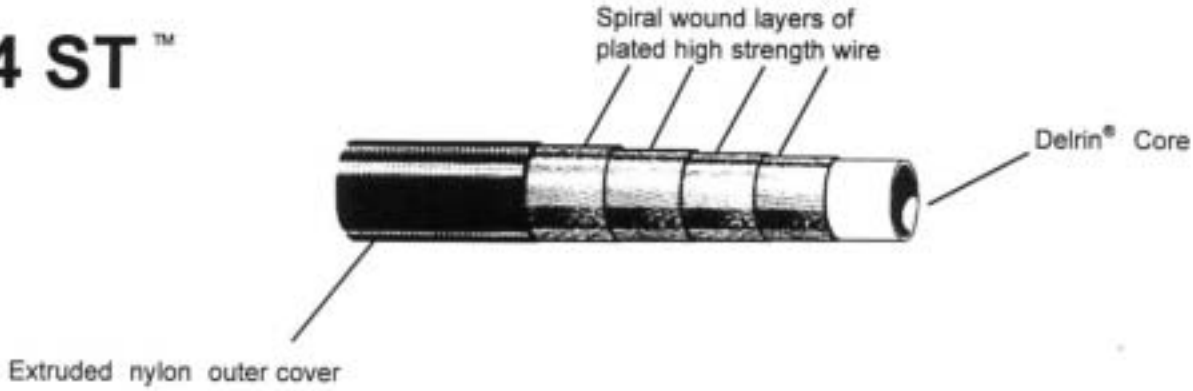
WJTA Administration

Polyflex Hose

4004 ST ™



Delrin is a registered trade mark of DuPont. Other Polyoxymethylene plastics may be used.

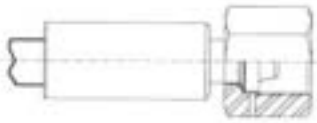
HOSE SPECIFICATIONS

Hose Size (in)		Pressure Ratings (psi)		Min. Bend Radius (in)	Weight Lb/ft
ID	OD	BURST	WORKING		
.15	.37	75,000	30,000	3.9	.13

Ratings are based on hose working temperature between -40 °F and +140° F. Contact Parker/Polyflex for temperatures outside this range.

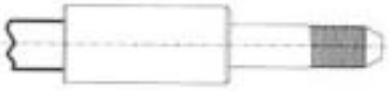
STANDARD END FITTINGS

Thread	ID	Max OD	Length	Pressure Rating (psi)	Part #
Type "M" Swivel (9/16" - 18 thd) s/s	.100	.875	2.50	30,000	E404CXA1
1/4" - 28 Left Hand Nozzle Nipple s/s	.100	.460	2.40	30,000	E404UAA1
1/4" High Pressure Tube Nipple s/s	.100	.575	3.00	30,000	E404HAA1
3/8" High Pressure Tube Nipple s/s	.100	.575	3.50	30,000	E404HBA1



Type "M" Swivel
9/16" - 18 thd

Tube Nipple
1/4" - 28 Left Hand thread Nozzle Nipple



Tube Nipple
1/4" High Pressure
3/8" High Pressure

Parflex Division
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4263 Dacoma, Houston, TX 77092
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Conjet Repairs Pipelines On The Sea Floor

Technology developed by the Swedish company Conjet has been successfully tested by the Norwegian oil company Statoil for use in pipeline repairs in very deep waters.

The Conjet equipment was used to cut through the protective concrete coating around a pipeline in a water depth of 600 meters and then to cut the steel pipeline itself, the oil company reports.

As operator of a fast-growing network of pipelines in the North Sea, Statoil will next year be installing a pipeline to carry oil from the Troll Field to the Mongstad refinery. In addition to crossing some very rough seabed terrain, it will pass through areas where water depths reach 540 meters.

Both installing and maintaining the pipeline will have to be carried out without the aid of divers. And if repairs prove necessary — for example, the replacement of a damaged section — that will also have to be done using equipment operated from the surface.

Conjet is a specialist in the use of high-pressure systems for both cleaning and cutting purposes on land. It uses water jets of up to 1,200 bar to cut through concrete, and a mixture of water and grit pressurized up to 400 bar to cut through steel.

To investigate whether its technology would also work several hundred meters under water, Statoil prepared a test frame carrying a 1.4 meter section of 40 inch pipeline as used for the Zeepipe 2A line - 24.7 mm steel thickness, 5 mm bitumen coating and 100 mm concrete coating.

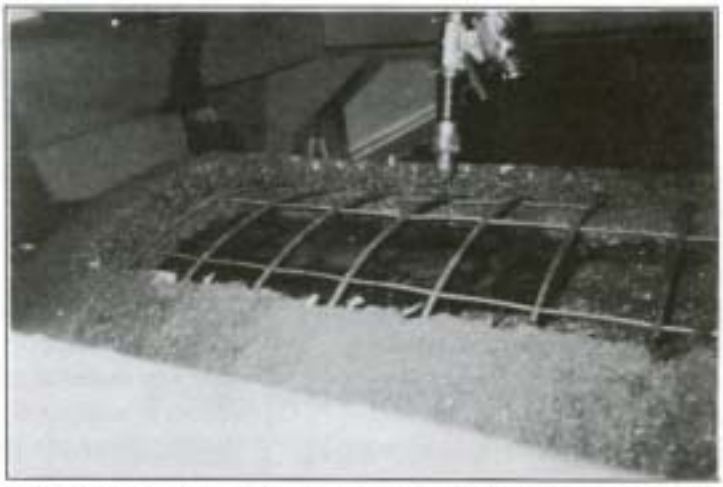
Also installed on the frame was a hydraulically operated turntable carrying the cutting tools. The frame was carried by an ROV which provided hydraulic power and control signals to operate the turntable and a video camera to transmit the action.

Deepwater tests

After initial tests in shallow waters in Haugesund, the project team moved to a test site in the Kross and Vinda fjords not far from Stavanger. Concrete removal was tackled first; at depths of 150 and 300 meters, the Conjet equipment cut through the concrete layer with one sweep of the nozzle in 44 and 51 seconds respectively.

The effect of the water jet decreases with increasing water depth due to pressure loss in

(continued on page 9)



Hydrodemolished concrete on pipe cutting accomplished under water.

Abrasive Waterjet Mixing Tube Wear — New Vistas

The University of Rhode Island (URI) and Dow Chemical Company are collaborating in the investigation of abrasive waterjet nozzle wear in an effort to produce longer lasting mixing tubes. It is well known that in abrasive waterjet (AWJ) machining systems, the shortest lived component is the mixing tube or nozzle. Recent advances in ceramic technology have led to significant improvements in mixing tube life. For instance, the composite carbide nozzle ROCTEC* 100 manufactured by Boride Products, Inc. has an average life of approximately 80 hours with garnet abrasive. Wear of regular mixing tubes is typically characterized by measuring the exit and entrance diameters at periodic intervals. In general, such wear studies illustrate that the entrance diameter increases at a faster rate than the exit diameter, but do not explain the pattern of wear along the length of the nozzle. The exit diameter increase is often approximated as a linear function of time. Nozzle life is determined by setting an allowable limit on the deviation of exit diameter from the initial value, generally 10-25%. Experiments conducted at URI demonstrate that the exit diameter increase is highly non-uniform. Over the life of the nozzle, however, the exit diameter may be approximated as a linear function. The nozzle weight loss, on the other hand, is very uniform throughout the life of the nozzle. In the study conducted, the wear profiles (which appear as two or three waves) within the nozzles are measured by pinning with successively large diameter gage pins. At periodic intervals these measurements are compared with silicone castings of the entire wear profile. The gage pin profiles are shown to match the castings very well. Therefore, pinning provides a simple

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Water Jets Clean Out Tank Cars

The speed and efficiency of sludge removal from rail tank-cars can be dramatically improved by an automated cleaning system from Bristol Equipment Company. The Bristol Model M-7C Tank Cleaner directs a high pressure stream of water, slurry, or other wash solvent against bottom sludge or caked material in rail-cars, trucks or similar tanks. Consisting of a nozzle assembly and a remote control center, the system provides for adjustable two-axis program control of the direction, position and speed of the wash solvent stream. The combination of dynamic cutting force and flushing action strips caked materials and removes it by flow through a bottom drain in the tank.

Model M-7C, a typical trackside cleaning system. The control system for the Model M-7C tank cleaner is shown on the platform. The monitor is on the end of the loading arm lowered into the manway of the rail car.

The new Model M-7 Series C system was specifically designed for heavy clean-out duty in high corrosion areas, such as phosphoric acid transport cars. The nozzle assembly features type 316 stainless steel construction throughout with stainless armored TFE solvent and hydraulic control hoses. Up to 250 gpm of wash media can be accommodated by the 2" ips piping system, while alloy 20 bearings in the twin rotary joints effectively resist corrosion. Heavy solids concentrations and corrosive acids can be handled because the wash media piping is totally separate from the nozzle positioning actuators.

The program control mounts in a remote, protected area. It uses safe, compressed air as a power source, translating it to controlled hydraulic force. The pressure oil circuit drives the nozzle in a controlled pattern across the length and width of a tank. Both axes of movement are adjustable for both speed and direction control. The control center automatically changes nozzle speed at various points in a sweep to direct the washing stream exactly where required and to reduce total cleaning time.

The M-7C Cleaner Systems now in operation have achieved remarkable results. Valuable acid, kaolin clay, calcium carbonate and other raw material can be recovered from the slurry discharge. The system is customarily handled by a single operator, and traditional cleaning times can be reduced over 75%. Other benefits of this field-

continued on page 6

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Water Jet Cutting System Quarries Granite Blocks, from page 2

The Ned-Jet 2000 system is capable of a noise reduction from 107 dBA (when the nozzle is at the top of the cut) to 95 dBA (when the tip is at the bottom). The noise level drops quickly as you move away from the mast and power unit. And the unit is so automatic that minimal monitoring by the operator is necessary.

The water jet meets U.S. Department of Labor's Mine & Safety Health Administration (MSHA) policy requirements as a replacement for hand-held channel burners; however, hearing protection is still recommended, said MSHA officials following an evaluation of the high-pressure water jet cutting system at Fletcher Granite Company's Milford, NH, quarry. Fletcher Granite Corporation, the first company in the United States to purchase a Ned-Jet 2000, has operated the unit since the summer of 1993.

Article reprinted by permission from the February 1995 issue of **Dimensional Stone** magazine. Photographs provided courtesy of Ned-Jet Cutting Systems, Inc., Worcester, MA.

Water Jets Clean Out Tank Cars, from page 4

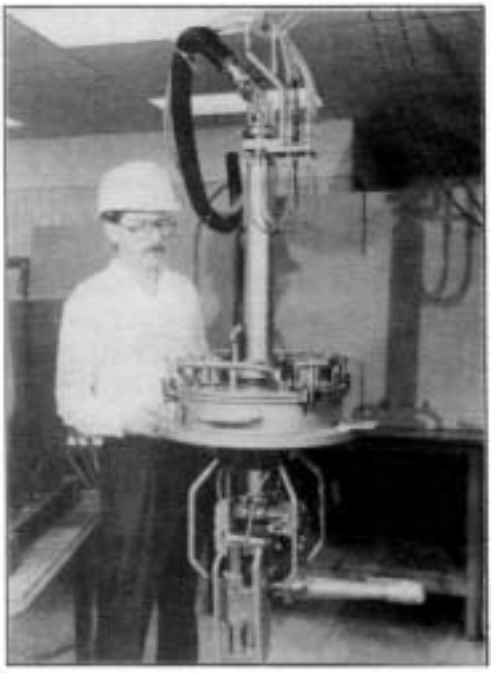
proven system include much cleaner tanks and considerable weight removal without damage to the tank or lining. Reduced water consumption and pollution control requirements, reduced maintenance, and imported working conditions also are cited by users.

Bristol Equipment also has a system designed to remove hazardous deposits from highway trailers or rail tank cars.

Inspecting the results of "jet sluicing" of the interior of a car.

The TC-N1 Cleaning System features a sealed mounting system that contains fumes or spray as the jet removes hazardous deposits from inside trailers or railcars. The system directs a high-pressure stream of liquid or slurry against sludge or debris on the bottom of the tanks, loosening deposits and flushing them out of the tank bottom drain. Consisting of a Nozzle Assembly and a separate Control, the TC-N1 System provides automated control of the direction, speed and area covered by the jet-cleaning stream.

The new TC-N1 Cleaning System was specifically designed for heavy-duty cleaning work, especially where fugitive emissions must be prevented. The all-stainless Nozzle Assembly handles up to 250 gpm of wash solvent at pressures to 250 psi. If necessary, the wash solvent can be heated to enhance the cutting and flushing action. Heavy solids concentrations and corrosive solvents can be used as the wash medium because the 1-1/2" solvent piping is completely separate from the nozzle positioning actuators.



A TC-N1 Cleaning System, complete with a manway adapter ring.

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New Developments, Products, Services

Contact **Aqua-Dyne, Inc.**, for a free 9"x4" slide rule used for the selection of water jet nozzles and the matching of pump size to gpm flow at a selected psi rating. Offer valid through September 1995, or while supplies last. Aqua-Dyne specializes in state-of-the-art, high-pressure industrial pumps and nozzles and has been providing design, consulting and the manufacturing of positive displacement pumps and water jetting systems since 1968. For more information and your free slide rule, contact Aqua-Dyne, Inc., 3620 West 11th Street, Houston, TX 77008, phone: (713)864-6929, fax: (713)864-0313.

Autoclave Engineers has introduced a line of specialty pressure manifolds designed to incorporate several needle valve, fitting or adapter type connection components into a single component. Specialty pressure manifolds minimize space requirements and reduce installation time necessary to plumb a pressure system. In addition, by reducing the number of components used in a system, manifolds reduce the number of potential leads. Autoclave Engineers will design and build pressure manifolds to meet

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People In The News

Congratulations to WJTA Board Member, **Dr. Thomas J. Kim**, dean of the Rhode Island University College of Engineering, and **Jay Zeng**, a 1994 doctoral graduate in mechanical engineering, on receiving the "Best Paper Award" presented at the 12th International Conference on Water Jet Technology held in Rouen, France, October 25-27, 1994. The paper, *"Development of a Parameter Prediction Model for Abrasive Waterjet Turning,"* was part of the doctoral research of Zeng, who is now a senior research engineer at **Ingersoll-Rand Company** in Detroit.

Darrell Saha has joined **Butterworth Jetting Systems Inc.** as a regional sales manager. Saha is responsible for Butterworth pump and Liqua Blaster sales for South, Southeast and East Asia; the former Soviet Republic (Russia); Venezuela and India. A graduate of Texas A & M University, Saha brings his mechanical engineering knowledge and water jetting experience to help fulfill Butterworth's customer needs. **Ned Williams** has also joined the Butterworth team and will serve as the company's process and specialty pump manager with responsibilities for domestic and international sales. Williams has 43 years of centrifugal and reciprocating pump sales to the oilfield, refining markets, gas plants, chemical plants and offshore. For more information and a new pump catalog, call Butterworth Jetting Systems toll-free at (800)231-3628.

Richard Demmings has been appointed general manager of **Ingersoll-Rand Waterjet Systems'** headquarters in Farmington Hills, Michigan. Demmings began his career with Ingersoll-Rand in 1960, and has held a number of key manufacturing positions for the company. Prior to heading I-R Waterjet, he was general manager of ARO Life Support Products Division in Buffalo, New York, which specializes in the manufacture of aerospace products.

New Developments, Products, Services, from page 7

specific installation, layout and pressure requirements. For more information, contact Autoclave Engineers Group, 2930 West 22nd Street, Box 5051, Erie, PA 16512, phone: (814)838-5700, fax: (814)838-5811.

CCI Training Services is offering comprehensive water jet training seminars in Houston, Texas (June 1, August 26 and 31, 1995); Virginia Beach, Virginia (June 6, 1995); and in Corpus Christi, Texas (October 22, 1995). Course instructor is WJTA member **Dr. Lydia M. Frenzel**. For more information, contact CCI Training Services, 2203 Timberloch Place, Suite 231, The Woodlands, TX 77380, or call 1-800-521-8879.

Flow International Corporation (FLOW) has introduced the AD-4800 Flying Bridge, a precision waterjet shape cutting system. The AD-4800 features a flexible work envelope adaptable to high- or low-volume applications. The standard AD-4800 package includes a CNC-controlled, two-axis robot, a 55,000 psi pump and a waterjet or PASER™ abrasive waterjet system. To handle high-volume applications and increase productivity, FLOW offers the AD-4800 in optional dual-cutting head, shuttle table and swivel column configurations. Also new from FLOW is the CougarPro 3000, a portable, ultrahigh-pressure waterjet cleaning system for plant maintenance applications. The CougarPro 3000 offers the productivity and environmental benefits of a 40,000 psi waterjet system at an affordable cost. Compact in size, the CougarPro fits through a standard size door, giving users convenient access to virtually all areas of a facility. The unit comes mounted on a cart for easy mobility. For more information, contact FLOW, 23500 64th Avenue South, Kent, WA 98032, phone: (206)850-3500, fax: (206)813-3285.

continued next column

Ingersoll-Rand Waterjet Systems has signed a marketing agreement with Romeo Engineering, Inc., a full service, engineering-based company in Fort Worth, Texas. The two companies will together market and produce custom engineered, automated waterjet systems for highly specialized applications in the general industry market place. For more information, contact Scott Mabie, Ingersoll-Rand Waterjet Systems, 23629 Industrial Park Drive, Farmington Hills, MI 48335, phone: (810)471-0888.

Jetech has published *"Jetech Accessories-Tools for High Pressure Jetting, Cutting and Cleaning,"* which describes and illustrates the latest water jetting accessories available from Jetech. The new TAPT rotating high pressure gun; Jetech standard hand lances; VS-890 series grate, floor and deck cleaner; Eddy-Jet rotating seals; high pressure valves and the new MGV-90 series of multi-tool valves are described in detail. Jetech has also announced the release of a new ultra high pressure pump booster, a type of water-to-water intensifier that differs from typical oil-to-water intensifiers. Light and portable, the Model DA-4D is capable of employing an ordinary 5,000 psi or 10,000 psi jetting pump and increasing pressure by four times to 20,000 to 40,000 psi respectively. For more information, contact Jetech, P.O. Box 86, Bedford, MI 49020, phone: (616)692-3211, fax: (616)692-2150.

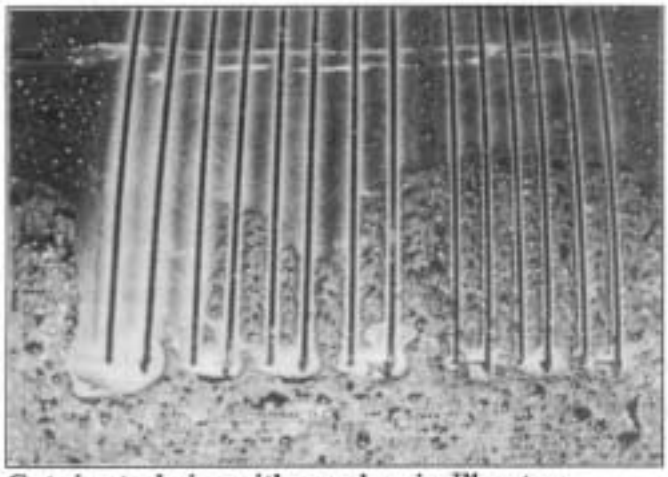
Jetting Systems & Accessories, Inc. has introduced the newest version of its flexible lancing unit. Blending field proven technology with some innovative new ideas led to a reduction of both physical size and weight by almost 50%. The redesigned lance drive has increased the available thrust and friction applied to the lance. The unit is available in both single and dual lance versions with operating pressures to 20,000 psi. A more flexible guide hose is now available in unlimited lengths. For more information, contact Jetting Systems & Accessories, Inc., 10110 Hardison Lane, Houston, Texas 77041, phone: (713)939-0015, fax: (713)939-7326.

NLB Corporation's new Model SCC-7100 shellside waterblasting system automatically cleans heat exchangers from eight feet to 25 feet long. The unit directs high-pressure water of up to 10,000 psi to remove product build-up, crude oil, scale, catalyst, and minerals over the entire length and circumference of a tube bundle, making heat transfer more efficient. The SCC-7100 features NLB's patented SPIN JET® rotating nozzles to assure thorough coverage of all of a tube bundle's outside surfaces. Also new from NLB is a 400 hp waterblasting system that features a flexible triplex pump and fluid end design that allows the user to easily change pressure and flow characteristics from 20,000 psi and 33 gpm to 7,000 psi and 95 gpm with other variations in between. The system is powered by a 525 hp diesel engine and is mounted on a steel skid for placement on a truck bed, semi-trailer or low boy. It is as suitable for automated cleaning, such as heat exchanger shellside blasting and boiler cleaning in power plants, as it is for operations involving hand-held lances. For more information, contact NLB Corporation, 29830 Beck Road, Wixom, MI 48393-2824, phone: (810)624-5555, fax: (810)624-0908.

Conjet Repairs Pipelines On The Sea Floor, from page 3

the hose and greater ambient water pressure. Nevertheless, Statoil reported that: "Impressive results were achieved, and at 600 meters water depth it takes less than one and a half hours to remove the concrete coating along a 1 meter length of 40 inch pipe."

The results of the steel cutting trails proved even more impressive, according to Statoil. It took less than half an hour to cut through the pipe. Moreover, the cut was entirely smooth, so that in a repair situation, the bevelling tools could be installed without further preparations.



Cuts in steel pipe with aquabrasive™ system cutting performed under water.

Another advantage of the water-jet method is that, since the tool has no direct contact with the pipeline, it cannot be damaged or its operation interrupted because of residual tensions from the installation operation causing pipeline movements.

This is a problem for methods such as saws which physically engage with the metal.

Having proven its worth, the Conjet tools will now be built into a concrete removal machine which will form part of the suite of equipment developed by Statoil for carrying out deepwater pipeline repairs.

For more information contact Lars-Goran Nilsson, Conjet, telephone +46 8642 2590 or fax: +46 8642 0766.

Article reprinted by permission from the October 1994 *Offshore Oil Man* magazine. Photographs provided courtesy of Bill Hall, Minnetonka, MN.

Ship used in test at sea.

A Video To Promote Water Jetting Technology

The WJTA is working on the production of a videotape of 15 to 20 minutes duration that shows the different uses of water jetting. This video will be shown at various trade shows during the year to promote water jetting technology by demonstrating its many applications.

In an attempt to produce this video at a reasonable cost, we are asking members of the WJTA to submit footage that can become part of this video. WJTA will need you to sign a release form giving the WJTA the right to edit and use your videotape. All members who contribute to the video will be acknowledged.

If you have footage that you think might be useful in this video, please send a written description of the material that you could donate to the WJTA for this purpose.

If you have any questions, please contact the WJTA office at (314)241-1445.

Test frame on dock.

Water Jets Clean Out Tank Cars, from page 6

A replaceable carbide bushing resists wear on the jet nozzle tip, and a valve on the discharge can be closed to prevent dripping of hazardous materials between car washings.

A unique feature of the TC-N1 design is the ability to tilt the trunk column 15 degrees to either side of vertical. This allows the jet stream to clean behind vertical obstructions such as loading pipes or valve rods. Also, the entire trunk section can be raised and lowered to effectively clean different size tanks.

The Control is a separate assembly, designed to be mounted in a protected area away from the dangers of moving cars. Safe, compressed air is the only power source. Air pressure is translated into controlled hydraulic force which powers the two-axis nozzle drives. The dual actuators move the jet stream in an efficient cleaning pattern across deposits on the bottom half of the tank. Indicators on the control identify the nozzle position, as well as speed and direction of movement. This makes it unnecessary for the operator to look into the hazardous tank interior.

The TC-N1 is designed to help processors meet stringent air quality, environmental protection, and operator safety requirements in the inherently hazardous tank-cleaning field. Bristol cleaning systems now in operation have achieved remarkable results in cleaning highway trailers carrying mixed flammable wastes within 20 minutes. Other models handle everything from phosphoric acid to kaolin clay.

Additional information on these tank cleaning systems or related cleaning systems is available by contacting Bristol Equipment Company at 210 Beaver Street, Box 696, Yorkville, IL 60560, calling (708)553-7161, or fax messages to (708)553-5981.

Photographs provided courtesy of Bristol Equipment Company.

Nominations Open For WJTA Board Of Directors

Nominations for the Water Jet Technology Association (WJTA) Board of Directors are now open.

The two-year terms of office of Thomas J. Kim, Josiah Phillips, George Rankin, Forrest Shook, Mohan Vijay, Ph.D., and John Wolgamott, will expire on August 27, 1995. Therefore, nominations are sought for six (6) board members, each to serve a four-year term of office beginning August 27, 1995.

According to the WJTA bylaws, each of the above-named individuals are eligible for re-nomination and re-election to the WJTA Board of Directors.

With regard to all first-time nominees, the WJTA bylaws provide that no more than one of the elected board members may be from the same company or organization. Therefore, board members may not be nominated from facilities that are already represented on the board by individuals whose terms expire in 1997. These facilities include: Conn Consulting (Andrew F. Conn, Ph.D.); Quest Integrated (Mohamed Hashish, Ph.D.); Scire Corporation (Thomas J. Labus); U.S. Bureau of Mines (George A. Savanick, Ph.D.); University of Missouri-Rolla (David A. Summers, Ph.D.); or MPW Industrial Services (Bruce Wood).

Nominations/Elections Procedures

In accordance with the bylaws of the Water Jet Technology Association, revised in 1993, nominations and elections to the Board of Directors include the following procedures:

- Two calls for nominations to the board of directors will be published in the *Jet News*. The first call for nominations appeared in the February issue and the second call appears in this issue. **Nominations will be accepted through June 30, 1995.**
- A list of the eligible nominees and a brief biographical sketch for each individual will be published in the June 1995 issue of *Jet News*.
- An official ballot listing the eligible nominees will then be forwarded by mail to all eligible voting members of the Association on July 14. **Signed and executed ballots must be mailed to the Association's office for tallying by August 15, 1995.**
- The names of newly elected board members will be announced on Sunday, August 27, 1995, at the WJTA general membership meeting held in conjunction with the 8th American Water Jet Conference in Houston, Texas.

Only eligible members of the Water Jet Technology Association may submit a nomination and nominees must be eligible members of the Water Jet Technology Association.

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Nominations Open For WJTA Board Of Directors, from page 10

According to the WJTA bylaws, any WJTA member in good standing (1995 membership dues paid) may submit a nomination(s). Nominees must also be WJTA members in good standing. The deadline for making nominations is eight (8) weeks prior to the biennial business meeting scheduled for Sunday, August 27. Therefore, your nomination(s) should reach the WJTA office no later than **June 30, 1995**.

To submit a nomination(s), complete the form below and return to: Mohan Vijay, Ph.D., Chairman, Committee On Nomination, Water Jet Technology Association, 818 Olive Street, Suite 918, St. Louis, MO 63101-1598, Phone: (314)241-1445, Fax: (314)241-1449.

Remember, nominations must be received no later than June 30, 1995.

WJTA Nomination Form

Name Of Nominee _____

Title _____

Address _____

City _____ State _____

Country _____ Postal Code _____

Telephone ( ) _____ Fax ( ) _____

Attach biographical information with a brief statement of your nominee's mission and vision for WJTA.

Name Of Nominator _____

Title _____

Address _____

City _____ State _____

Country _____ Postal Code _____

Telephone ( ) _____ Fax ( ) _____

Abrasive Waterjet Mixing Tube Wear — New Vistas, from page 4

way to study the wear patterns within the nozzle. These wear patterns are used to explain observed non-uniform exit diameter wear and uniform nozzle weight loss.

The process of boring these nozzles from either end can result in a step in the bore that may be visible to the naked eye. Although quality control procedures in manufacturing maintain this step in the bore to less than 0.001," the effect of this small step on nozzle performance has not previously been systematically studied. In the URI/Dow study, the effect of offset bores on the AWJ machining process is being investigated in conjunction with nozzle wear and cutting performance. Preliminary experimental results demonstrate that the off-center bore adversely affects the nozzle wear and cutting performance only when the measured bore offset is greater than 0.008" (0.2 mm). A nozzle with an offset less than 0.008" is as good as a nozzle with zero offset.

Additional studies in nozzle wear, cutting performance and nozzle design are ongoing. It is anticipated that these studies will provide better insight into the mechanisms of wear of the mixing tubes that might lead to the production of longer lasting mixing tubes.

*Trademark of the Dow Chemical Company.

1995 Calendar Of Events

May 25-28: Stonetech '95 Nürnberg, 9th International Trade Fair Natural Stone and Stoneprocessing Technology, Nuremberg, Germany, phone: 09 11/86 06-0, fax: 09 11/86 06-2 28.

June 7-9: ISSA Interclean-Mexico Exhibition, Monterrey, Mexico, (708)982-0800

August 26-29: WJTA 8th American Water Jet Conference, Houston, Texas, (314)241-1445.

October 11-14: CETA PowerClean '95, Georgia World Conference Center, Atlanta, Georgia, (800)441-0111.

Seven Easy Ways To Attend The 1995 WJTA Conference

1. **FULL CONFERENCE:** Includes admission to all technical and scientific sessions (except Short Course), exhibit hall, coffee breaks, luncheons, receptions, Texas Theme Party, and technical tour and demonstration. **Each full registrant also receives one hardbound copy of the Conference Proceedings.**

2. **COMBO:** Includes everything listed under Full Conference **PLUS** admission to the Water Jet Short Course.

3. **SAVE $ ON MULTIPLE EMPLOYEE FULL/COMBO REGISTRATIONS:** Companies that purchase three or more full or combo registrations receive a special discount for each additional employee registered after the first two. To take advantage of the special discount, register the first two (2) employees from your company at the regular FULL/COMBO rates and receive the discounted rate for the third and subsequent employee registrations.

4. **DAILY ATTENDANCE:** Includes admission to all technical and scientific sessions, exhibit hall, coffee breaks, and luncheon for one day. Daily registration on Tuesday also includes the technical tour and demonstration.

   NOTE: The official Conference Proceedings and admission to receptions and/or Texas Theme Party are **NOT** included in the daily registration fee. The Proceedings and tickets to the receptions/banquet must be purchased separately.

5. **WATER JETTING SHORT COURSE:** Includes the manual *Fluid Jet Technology — Fundamentals And Applications*, coffee breaks, and luncheon.

6. **EXHIBIT HALL ONLY:** Includes admission to the WJTA Exhibit Hall where you'll see water jetting equipment, supplies, and services on display.

Discounts for WJTA members and early-bird registrants!

WJTA members receive a special discount off the regular registration fees. You will also receive a special additional discount if your registration is postmarked or received in the WJTA office by **August 1, 1995.**

7. **TECHNICAL TOUR ONLY:** Includes round-trip bus transportation, luncheon, and admission to company sites where you'll see live water jetting demonstrations.

CANCELLATION POLICY: Fees will be refunded in full for cancellations received at least six weeks prior to the Conference. Cancellations received more than 21 days and less than six weeks prior to the Conference will be subject to a $50 charge. No refund will be made for cancellations received less than 21 days prior to the Conference. However, substitutions may be made at any time.

8th American Water Jet Conference

August 26-29, 1995 Houston, Texas

HOTEL RESERVATIONS FORM

Please print or type

Name _____ Company _____

Address _____

City _____ State _____ Address: ☐ Home ☐ Company

Country _____ Postal Code _____

For arrival on _____ Depart on _____

Day Date Time Day Date Time

Room type preference: ☐ King ☐ Double/Double Smoking Preference: ☐ Non-Smoking ☐ Smoking

Which preference is more important: ☐ Bed type ☐ Smoking Preference

Please list names of guests sharing your room _____

_____

Special requests _____

Reservations received after **8/5/95** will be confirmed on an availability basis.

Rates: **$90**, single or double occupancy.

The JW Marriott regrets that it cannot hold your reservation after 6:00 p.m. on the day of arrival without a credit card, or first night's room deposit by check or money order (do **NOT** send cash). Deposits will be refunded only if cancellation notification is given up to 24 hours prior to arrival. If more than one room is requested, please enclose list of names with addresses, indicating which guests share rooms.

☐ Check or money order enclosed - Amount $ _____ ☐ American Express ☐ Carte Blanche

☐ Master Card (Please include interbank # directly below card #) ☐ VISA ☐ Diners Club ☐ Discover

Credit Card Number _____ Expiration Date ____/____

Signature _____ Telephone ( ) _____

JW MARRIOTT HOTEL

5150 Westheimer • Houston, Texas 77056 • (713)961-1500

Check-out time is noon. Rooms may not be available for check-in until after 3:00 PM. **RESERVATIONS REQUESTED BEYOND THE CUT OFF DATE, AUGUST 5, 1995, ARE SUBJECT TO AVAILABILITY. ROOMS MAY STILL BE AVAILABLE AFTER THE CUT OFF DATE, BUT NOT NECESSARILY AT THE ABOVE RATE. PLEASE APPLY 15% SALES AND LODGING TAX TO THE ABOVE RATES. (Tax rates subject to change.)**

1995 WJTA Conference Registration Form

❑ **YES,** **I want to learn the latest water jet technology developments and applications. Please register me for the 8th American Water Jet Conference!**

❑ **I can't attend but please keep me on your mailing list for other information about the WJTA.**

Name _____ Title _____

Company _____

Address _____

Mailing Address: ❑ Home ❑ Work

City _____ State _____ Country _____ Zip Code _____

Telephone # ( )_____ Fax # ( )_____

Information for name tag_____

Print name as you wish it to appear on you name tag

Payment Method

❑ Enclosed is my check, payable to **Water Jet Technology Association** (U.S. DOLLARS ONLY).

❑ Please charge my ❑ MasterCard ❑ VISA ❑ American Express

Credit Card # _____ Expiration Date ____/____

_____ _____

Print name as it appears on card Cardholder's signature

Join the Water Jet Technology Association now and receive a substantial discount off Conference registration fees.

	WJTA MEMBER		NONMEMBER*		
	By 8/1/95	*After 8/1/95*	*By 8/1/95*	*After 8/1/95*	
❑ **Full Conference** ONLY	$ 440	$ 470	$ 490	$ 520	= $_____
❑ **Combo** Full Conference And Water Jet Short Course	$ 610	$ 640	$ 660	$ 690	= $_____
❑ **Daily.** Please check day(s)	$175/day	$190/day	$195/day	$210/day	
❑ Sunday ❑ Monday	_____ days x $_____				= $_____

MULTIPLE CORPORATE REGISTRATIONS

(Applies to third and subsequent registrants from same company)

❑ **Full Conference** ONLY	$ 365	$ 395	$ 415	$ 445	= $_____
❑ **Combo** Full Conference And Water Jet Short Course	$ 535	$ 565	$ 585	$ 615	= $_____

☞ **OPTIONAL**

WJTA MEMBERSHIP ❑ $50 Individual membership ❑ $350 Corporate membership = $_____

❑ **Water Jet Short Course**	$ 225	$ 240	$ 250	$ 265	= $_____
❑ **Extra Texas Theme Party Tickets**	$ 55	$ 60	$ 55	$ 60	= $_____
❑ **Exhibit Hall Admission**	$ 20	$ 20	$ 20	$ 20	= $_____
❑ **Technical Tour & Demonstration**	$ 85	$ 95	$ 85	$ 95	= $_____
❑ **Extra Conference Proceedings** (1 copy included in Combo and Full registration packages)	$ 125	$ 125	$ 150	$ 150	= $_____

❑ **Special Offer:** Register for the 1995 Conference and pay only $95 for extra copies of the Conference Proceedings! **Offer valid through 8/31/95** **SAVE $30** ____ Copies x $95.00 = $_____

*Non-WJTA members who are members of the International Society of Water Jet Technology are permitted a 5% discount off nonmember registration fees.

*Full-time students may register at a 50% discount off nonmember registration fees.

TOTAL ENCLOSED $_____

The Water Jet Technology Association's

8th American Water Jet Conference

August 26-29, 1995

JW Marriott Hotel Houston, Texas

Preliminary Schedule Of Events

Saturday, August 26

8:30 a.m. - Noon	Short Course on the Fundamentals and Applications of Water Jet Technology
Noon - 1:30 p.m.	Luncheon for "Short Course" Participants
1:30 p.m. - 4:30 p.m.	Short Course, cont'd.
6:30 p.m. - 9:30 p.m.	Welcoming Reception In The Exhibit Hall
	Exhibit Opens

Sunday, August 27

8:00 a.m. - 11:00 a.m.	Applications Workshops
8:30 a.m. - 11:30 a.m.	Research & Development Sessions
9:30 a.m. - 5:00 p.m.	Exhibits
Noon - 2:00 p.m.	Awards Luncheon
2:30 p.m. - 4:30 p.m.	Applications Workshops, cont'd.
2:00 p.m. - 5:00 p.m.	Research & Development Sessions, cont'd.
5:00 p.m. - 6:00 p.m.	WJTA Biennial Business Meeting

Monday, August 28

9:30 a.m. - 2:30 p.m.	Exhibits
8:00 a.m. - 11:00 a.m.	Applications Workshops
8:30 a.m. - 11:30 a.m.	Research & Development Sessions
Noon - 2:00 p.m.	Luncheon In Exhibit Hall
2:00 p.m. - 4:30 p.m.	Applications Workshops, cont'd.
2:00 p.m. - 5:00 p.m.	Research & Development Sessions, cont'd.
6:30 p.m. - 11:00 p.m.	Texas Theme Party

Tuesday, August 29

9:30 a.m. - 3:00 p.m.	Technical Tour And Field Demonstrations