WJTA WaterJet Technology Association

Jet News

MARCH 2000

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Coating Restoration On Steel Structures

Coating Restoration On The Quebec Bridge

Innovations in Structural Steel Preservation

By: Bridgecote/Feroguard Technologies
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Corrpro Canada Inc.
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(Article on page 8)

Thames Barrier Repairs

The problem:

The Thames Barrier was erected in 1989 to provide flood control to the upper reaches of the Thames River including the heavily populated areas of London. The gates could be raised from the riverbed into a vertical defense position in the event high surge tides threatened the London metropolitan area.

In October of 1997 a sand dredger, the Sand Kite, wrecked into one of the main gates of the Thames Barrier. The ship was damaged. It

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In Memoriam

Bruce Wood, a longtime member of the WaterJet Technology Association and serving as the WJTA treasurer, passed away unexpectedly on February 9, 2000. Mr. Wood was 58.

Bruce Wood

A graduate of the University of Cincinnati with a Bachelor of Science degree in Engineering, Bruce was involved in the waterjet industry for over 20 years. He was employed at MPW Industrial Services where he held the position of Director of Engineering and Technology. He was responsible for two patents in the field of high pressure solvent washing of paint totes.

Bruce joined the WJTA in 1990 and has been actively involved in the association since that time. He has presented papers at several conferences, both in this country and in Europe. He was currently serving on the WJTA Board of Directors, a position he has held since 1993. He also served as the WJTA treasurer since his election to that office in 1995.

Bruce was very active in the area of industry safety, and he was a major proponent for the development of safety training and practices for the WaterJet Technology Association. He coordinated and presented several safety seminars and contributed to the WJTA safety manual, *Recommended Practices for the Use of Manually Operated High Pressure Water-jetting Equipment*. He was presented with the WJTA Safety Award in recognition of his devotion and contributions to the improvement of safety relating to waterjet developments and applications in 1999 during the 10th American Waterjet Conference.

An active member of his community, Bruce held the office of President of the Welsh Hills Symphony, President of the Licking County Apartment Association, and Choir Director for the St. John's Lutheran Church. His interests also included sailing and antiques. He is survived by his wife of 20 years, Marie, as well as children Shelby, Jeanine and Mark.

The family suggests memorials to the American Heart Association; Unverferth House (a recuperation facility for heart transplant patients) 190 King Avenue, Columbus, Ohio, 43201; or St. John's Lutheran Church - Teen Center Hall, 6004 Linville Road, Newark, Ohio 43055.

Calendar Of Events

SEPTEMBER 6-8, 2000

15th International Conference on Jetting Technology, Ronneby, Sweden. This Conference provides the forum to present and discuss the many industrial applications of jetting technology, the very latest in research and development, and the new issues and challenges for suppliers and users.

For further information, please contact: Lorna Brooker, Conference Organizer, BHR Group Limited, The Fluid Engineering Centre, Cranfield, Bedfordshire MK43 0AJ, UK, telephone: [44](0)1234 750422, fax: [44](0)1234 750074, email: lbrooker@bhrgroup.co.uk

OCTOBER 9-11, 2000

The CMTE with its co-hosts the Australian High Pressure Water Jetting Association (AUSJET) and The Water Jet Technology Society of Japan (WJTSJ) are hosting the 6th Pacific Rim International Conference on Water Jetting Technology in Sydney, Australia.

The Conference will focus on the development and implementation of new technologies that contribute to improved productivity, health and safety in the waterjetting industry.

For more information contact: Water Jetting Technology Conference, c/o CMTE, PO Box 883, Kenmore Q 4069, telephone: +61 7 3212 4420, fax: +61 7 3212 4683, email: cmte@cat.csiro.au, web site: www.cmte.org.au/news/waterjet.html

Advances In Hydrodemolition In Sweden

By: Carl Strömdahl

High pressure waterjetting equipment is extremely efficient at removing damaged concrete. Carl Strömdahl, President of Conjet AB, herein outlines the development of this increasingly popular concrete repair technique.

Removing damaged or poor quality concrete from sensitive structures such as bridges, dam walls, tunnels, docks, harbors, multi-story car parking decks and runways, using pneumatic and hydraulic breakers or road milling machines is universally accepted as being very inefficient and even damaging to the structure being repaired. These once-favored techniques are now outdated and indiscriminate as they remove and leave both good and bad concrete and cause damage to the remaining healthy and sound concrete and steel reinforcement, as well as injuring jackhammer operators.

Road milling machines are severely restricted when working on reinforced concrete. They cut out damaged and good material only down to any reinforcement. Contractors' laborers using hand held breakers have extreme difficulty chipping away concrete around and below reinforcement without causing additional damage to the sound concrete and rebar. The rust on the exposed rebar has to be removed by sandblasting before pouring in fresh concrete. Independent laboratory pull off tests of the old and new concrete have also shown that concrete breaks at the bond.

Breaker chisels and milling machine cutters also hit and vibrate the steel reinforcing causing a "zip fastener effect" leading to micro cracking in the surrounding, and previously undamaged concrete, and a break down of the rigid bonding to the rebar. This can contribute to the speeding up of any corrosion and cause delamination in the concrete. Exceptionally noisy and

Carl Strömdahl

vibrating hand held breakers are also very stressful on operators and hearing difficulties and vibration injuries to fingers and arms are extremely commonplace.

In the early 1980s the Swedish National Road Administration, Vägverket, was becoming increasingly concerned with the disadvantages of using the then conventional methods of cutting out concrete on bridge decks damaged by salt and frost and started to research safer and more efficient alternatives. The organization was aware that waterjetting had been used for removing paint and hard cement deposits and they considered that the concept could possibly be adapted and adopted to cut away or demolish weak concrete. Vägverket, together with Swedish construction and mining equipment manufacturer Atlas Copco and one of Sweden's major civil engineering contractors formed a group to jointly evaluate and develop the idea.

The joint venture focused its research at the time into extremely high pressure waterjetting technology and producing equipment capable of selectively removing only the damaged or poor quality concrete from bridge decks while leaving healthy and sound concrete in place. Suitable high pressure waterjetting equipment was successfully developed by a special "Conjet" project group formed within Atlas Copco and a prototype machine was made in 1983. The purpose-built Conjet Robot equipment, together with the integral and the vitally important bonding of new concrete to the old and sound material left in place, was thoroughly tested and proven by the joint venture.

Extensive trials were conducted on specially constructed test slabs, made up of stepped layers of different strengths of concrete, and on a variety of damaged structures in Sweden prior to the Conjet Robot's introduction to the world market in 1985. The tests clearly demonstrated that the high pressure waterjet equipment could selectively remove the different layers of concrete. Also the Conjet Robot equipment did not cause any new damage to the roughened surface, or create micro cracks in the remaining healthy concrete.

The joint venture's research and development was supported by equally extensive and successful independent trails carried out by Professor Johan Silfwerbrand at Stockholm's Royal Institute of Technology during the 1980s. The Royal Institute of Technology performed pull off tests to compare the bonding of new concrete to old. Base slabs were cast and left to cure for several months prior to their surfaces being broken away by hand held pneumatic breakers and robotic high pressure waterjetting equipment.

The prepared surfaces were cleaned by compressed air jets and vacuum cleaners and the slabs kept moist before casting the new overlay. The composite slabs were carefully cured to minimize risk of shrinkage and left for a year before carrying out pull off tests. Laboratory tests conclusively proved the bonding of the waterjetted interfaces to be twice as strong as those prepared by mechanical chipping. The selective removal of concrete using high pressure waterjets was christened "hydrodemolition" and several Conjet Robots were soon in use around the world.

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Advances In Hydrodemolition In Sweden, from page 3

In 1990 the senior staff running Atlas Copco's Conjet project purchased the organization and formed the independent company Conjet AB. The new company totally focused on the design, development and manufacture of robotic high pressure waterjetting equipment and now exports 95% of its production. The firm has expanded rapidly and in 1994 moved into new premises at Haninge, 20km south of Stockholm. Conjet AB, jointly owned and operated by Lars-Göran Nilsson, Kent Fahlström and Carl Strömdahl, specializes in the design, development and manufacture of remotely operated, computer-controlled high pressure waterjetting hydrodemolition machines.

The firm makes an extensive range of Robots, including the very latest Conjet Robot 322 which has just been added to its extensive product range. The new Robot 322, together with all the other Conjet machines, has been designed to comply with the stringent European safety regulations and carry the appropriate CE (Commune Eurpéen) marking. Conjet Robots are now available in cutting widths up to 7m, can remove concrete to depths of up to 500mm and can blast away between 0.5m³/h to 1.5m³/h of concrete, depending on the machine and strength of concrete.

Conjet hydrodemolition equipment relies on a jet of high pressure water exiting from a special nozzle at supersonic speed and forcing its way into the porous and cracked surface of the damaged concrete. The cracks, caused by hardening, ageing, bending, frost, alkali silica reaction, carbonization and ingress of de-icing salt, propagate from the surface and dramatically reduce the concrete's tensile strength, which in normal undamaged concrete is about 7% of the compressive strength.

Water, at pressures of 800bar to 1500bar and flows ranging from 150litres/min to 300litres/min, is fed to the nozzle from 350kW to 550kW diesel driven high pressure pumps housed in a sound insulated standard 20ft ISO container. The waterjet penetrates the damaged surface creating a hydraulic pressure in the concrete, which breaks and lifts away when the internal pressure rises above the tensile strength of the concrete.

The special nozzle is coupled to a remotely operated, computer controlled, fully adjustable Robot waterjetting machine. The nozzle is set at a predetermined angle of attack

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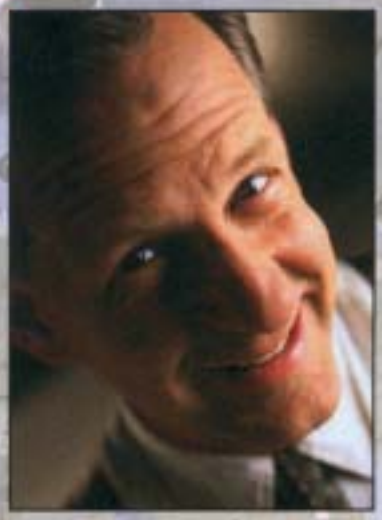

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Advances In Hydrodemolition In Sweden, from page 4

to the concrete and mounted on an oscillating cassette, which is attached to a traversing cradle running back and forth along a feed beam. When the cradle reaches the end of its travel the nozzle swivels over to maintain the same angle, which enables the jet to operate with a sweeping action to cut away concrete behind reinforcement. At the same time the machine moves back a predetermined distance ready to make the next adjacent cut.

Safety is paramount and the entire feed beam and nozzle assembly is attached to the end of the robot's standard or multi-positioning arm and covered by a protective shroud. This articulating boom gives the operator considerable flexibility to use the machine for a wide variety of hydrodemolition tasks on horizontal, vertical, angled and curved surfaces, ceilings and soffits. The boom can also reach under a bridge deck soffit while the machine stays on the deck above.

Hydrodemolition with robots has increasingly proved to be a considerably more cost effective concrete removal method on sensitive structures than traditional pneumatic breaker and milling techniques. Conjet waterjetting machines, which normally only require a single operator, remove concrete between 25 and 50 times faster and far more efficiently than normal breaking and milling equipment. The remotely operated, computer controlled waterjetting machines also have built in automatic quality control. Once a Conjet Robot has been pre-set by the operator the machine only removes weak and damaged areas of concrete to a pre-determined "quality depth" above or below any steel reinforcement, which, if exposed, is also cleaned of rust.

The remaining healthy and sound concrete's rough and uneven textured surface provides a very efficient and much stronger bonding interface for the new replacement concrete than the surface left by milling machines and breakers. The preferred hydrodemolition method does not cause any new damage to the concrete surface or leave micro cracks.

Details of all the machine's computer controlled operations and functions, such as nozzle angle, cradle and oscillating speed, cutting width and production rate in m^2/hour, are displayed on a screen on the robot's control panel. A constant monitoring system provides the operator with a visual alarm display on the screen if the equipment deviates from its pre-set sequence. The computer controls also incorporate a self diagnostic system and again provide the operator with a visual alarm and display of any machine faults, which, if serious, will trigger the computer to automatically shut the equipment down.

The operator selects one of several pre-loaded software programs that have adjustable parameters to ensure that only concrete to a predetermined quality depth is selectively removed in a continuous, uniform and safe operation. Additional programs are available to suit customers' individual requirements. The robot operator can also easily adapt and program the computer on site to match a specific operation or set the computer to memorize and save specific working settings for future use.

All machine functions are controlled from a hand portable, remote control console ensuring safe operation for the operator. An additional safety feature requires the operator to respond to a flashing indicator light on the control box every two minutes and reactivate the robot's control system, otherwise the machine will automatically shut down.

Concrete on a damaged structure must first be analysed to determine the extent of the repair and the depth to be removed. Core samples need to be taken and concrete strengths checked. Chloride content and penetration, together with frost resistance also has to be verified to develop a profile of the overall damage and assess the depth of poor and weak concrete to be cut out. This quality depth is first tried on a small area of the structure, but may need to be deepened if there is

(continued on page 21)

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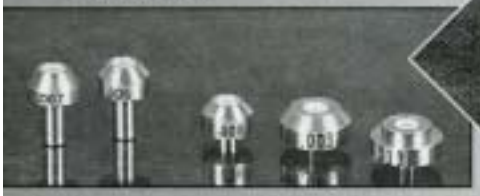

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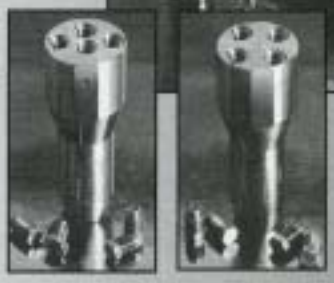

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Coating Restoration On The Quebec Bridge, from page 1

Introduction

The Quebec Bridge, located at mile 2.70, Bridge Sub-division Quebec City, Quebec, Canada, was considered the eighth "Wonder of The World," when construction was completed in 1919. It is the longest cantilever, steel railway bridge in the world. Its "sister" bridge is the Firth of Forth Bridge in Scotland. The Quebec Bridge is a riveted steel structure with 8,000,000 square feet of coatable structural steel. The overall length is 3239 feet and the width is 94 feet. The bridge is 340 feet high, from the top of the cantilever to the water below. Each cantilever span is 580 feet long. The Quebec Bridge accommodates one rail line, three lanes of automotive traffic and two pedestrian walkways. The Quebec Bridge was declared a historic monument in 1987, by the Canadian & American Society of Civil Engineers and a National Historic Site on January 24, 1996 by the Department of Canadian Heritage.

The Quebec Bridge Reclamation project is scheduled to run from 1998 to 2007 and is broken up into one- and two-year contracts involving steel repairs and a new coating system. The team participants include CN North America – the owner; Corrpro Canada – consultants and quality assurance; Bridgecote/Feroguard –coating supplier; Nor-Lag Coatings Ltd. – contractor/applicator.

Environment and containment are the two main concerns of owners when considering a lead removal project. Both environment and containment imply increased costs. The original proposal called for a total removal of all the existing coating by abrasive blasting. When cost estimates were put forward for the 8,000,000 square foot bridge, they ranged from $120 million (C$15.00 per sq. ft) to $180 million (C$22.50 per sq. ft.) Canadian Funds. Wide variations in pricing were the result of structural design constraints which limited the amount of area to be enclosed with negative pressure containment. Waterjetting and selective water washing, innovative containment systems, followed by an overcoat system, were used to reduce these costs to (C$6.00 to C$7.00 per sq. ft.) without impacting the owners requirement for a minimum 25+ year coating system service life and a five year performance warranty. Pack rust between plates and weeping joints, are an anathema to a completed coatings application. A Modified Overbased Crystalline Calcium Sulfonate (MOCCS) coating system was specified. The MOCCS coating system contains and controls these structural problems. The coating manufacturer supplied a five-year structure-specific warranty, which includes both material and labor.

Scope of Current Work

The first phase of the coating project consists of completion of the Portal and half of the South Arm. Work on the first phase began in April 1999 and will be completed by the end of 2000. The whole project is scheduled for completion in the fall of 2007. Steel repairs are planned throughout the restoration of the bridge. To avoid work-sequencing conflicts, the steel erector has begun work at the opposite end of the South Arm. Commencing in 2000, a system of illumination will be erected along the top chord of the entire structure. The existing coating system is an aged red lead alkyd. After surface preparation, an overcoat of Modified Overbased Crystalline Calcium Sulfonate (MOCCS) coating will be applied to the entire structure. CN North America, the Government of Canada, and the Quebec Government have set aside $60 million as the reclamation budget for the entire structure.

Surface Preparation

The revised contract specification called for all surfaces on the bridge to be prepared to WJ4-SC2. A WJ4-SC2 surface shall have all loose rust, loose mill scale, and loose coatings, uniformly removed. The SC2 (surface contaminant) levels are less than 7 ug/cm^2 chloride contaminants, less than 10 ug/cm^2 of soluble ferrous ion levels, less than 17 ug/cm^2 of sulfate contaminants, as verified

(continued on page 12)

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New Products

ESAB Introduces New Vision PC Control For Cutting Systems

ESAB Cutting Systems introduces the new Vision PC Windows®-based CNC cutting machine controller. By incorporating Microsoft's Windows 98 operating system, this exceptionally user-friendly controller brings the power and versatility of the latest PC-based hardware and Windows-based software to cutting machine process and motion control. Vision PC is available on new ESAB waterjet and laser, plasma and oxyfuel cutting equipment, and may be retrofitted to many brands of older machines.

Station control and process control are integrated into the ergonomically designed operator's panel, enabling the most technologically advanced process control in the industry. Programmable station selection turns on cutting or marking stations via the part program and provides the basis for ESAB's exclusive Process Parameter Programming. This powerful option automates selection of correct cutting speed, torch height, kerf, gas pressures and other cutting parameters.

Vision PC combines an industrial-based CPU, 10.4 color LCD, 4 Gigabyte hard disk drive and 3.5 diskette drive. Other hardware features like the eight-position joystick, hand wheel and speed potentiometer put necessary controls at the user's fingertips for easy operation.

The Vision PC enhances ease of use and productivity with such features as menu-driven operation, real-time tool path display and kerf override. Among its other innovative software tools:

- **Graphical Displays** in the shape library, part program editor (with zoom), nesting editor, and during program execution. A cursor indicates the running point so an operator can track torch movement, even when cutting underwater.
- **Plasma Pre-Stop** improves consumable life by shutting off the plasma arc slightly prior to reaching the end of the cut.
- **Kerf Preview** permits checking for kerf interference before running a part, and includes a zoom function for complex nests.
- The **Zoom While Running** feature provides a close-up view of real-time graphics while cutting large, complex nests.
- **Multi-Level Return to Start** makes it easy to back up to the beginning, or to any previous pierce point within an interrupted program.
- **Return To Contour** makes it easier to pick up lost cuts or service the cutting head in the middle of a part.
- **Joystick Contouring** makes it easy to move the machine forward or backward along the cutting path in order to resume the cut after an interruption.
- **Creep Speed** improves oxyfuel piercing by moving the torches at reduced speed during the pierce.

The Vision PC also shares advanced features found on other ESAB Vision controls, including multi-tasking; program parking; program continue after power failure; shape library; plate alignment; pierce test; program scaling and rotation to virtually any size or angle; and more. Among its optional features are high speed bi-directional serial communications; multiple cutting areas, in which each area can be set up with its own software limits and home position; and on-screen timers and counters for tracking consumable life, machine running time and other shop management data.

For more information on the Vision PC, contact ESAB Cutting Systems at (843)664-5618.

CRS Power Flow Introduces New "Aqua Prep System"

CRS Power Flow introduces new line of "Aqua-Prep" ultra-high pressure surface preparation tools. The first tool in this series is the hand-held "UHP Surface Prep Tool." The light weight unit (only 39 lbs./18 Kg) uses the same advanced swivel technology found in all of the CRS Vulcan Rotary Control Guns. The unit is rated for up to 40,000 psi (2750 bar) with a flow of 7 gpm (26.5 lpm). This versatile tool increases and eliminates productivity much of the labor required to manually blast surfaces with conventional rotary control guns. The new "UHP Surface Prep Tool" features some of the most advanced technology found on the market today.

This versatile tool increases productivity and eliminates much of the labor required to manually waterblast surfaces with conventional rotary control guns. The new "Aqua Prep System" surface preparation tool features some of the most advanced technology found in the market today.

Features include:

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(continued on page 19)

Reduce Set-Up Time, Eliminate Guesswork

ESAB Vision Controller with Data Generator automates process parameter programming to enhance repeatability, eliminate the need for special programs and allow customization. The Data Generator is a 32 bit Windows application that runs on the Vision PC in the background.

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ESAB's **Vision PC** CNC controller for waterjet cutting combines remarkable ease of operation with powerful software tools like real-time tool path display and kerf-on-the-fly with kerf-override to offer the most technologically advanced control in the industry. This Windows-based controller features menu-driven operation, color LCD display, 8-position joystick, hand wheel, hard drive, 3.5" floppy drive, and speed potentiometer for easy operator use. Station and process control are integrated in a single ergonomic operator's panel. A 333 mHz processor and advanced features such as multi-level return, zoom while running, and program continue after power failure further add to the power of this control.

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ESAB's exclusive Process Parameter Programming features the unique **Data Generator Program** that automatically optimizes cutting speed and cornering based on material type, thickness and desired cut quality. These settings are saved as a file that can be recalled at will, greatly reducing set-up time on repeat runs. Kerf, speed, dynamic axial pierce times, corner deceleration and corner acceleration are all set automatically.

ESAB's abrasive cutting nozzle with diamond orifice technology provides maximum cutting speeds with reduced operating costs and extremely simple maintenance. A cutting head with standard Z-axis slide, programmable Z-axis or Z-axis with height control can easily be combined with a Vision PC retrofit.

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Coating Restoration On The Quebec Bridge, from page 8

by field or laboratory analysis using reliable, reproducible test equipment. The WJ4–SC2 is achieved using high pressure water cleaning at 5000 psi, using a zero degree-rotating tip at a 6-inch standoff from the surface.

In the Splash Zone, which is defined as 15 feet above the road deck and railway system and 29 feet each side of the bridge center line from under the road deck to the bottom chord, a WJ3L-SC2 was specified for areas of corroded steel. A WJ3L surface shall be cleaned to a matte finish with at least two-thirds of the surface free of all visible residue (except mill scale), and the remaining one-third containing only randomly dispersed stains of previously existing rust, coating, and foreign matter. The "L" defines Light Flash Rust that is allowed on all surfaces cleaned to WJ3. A WJ3L-SC2 is achieved using a 40,000-psi ultra high-pressure waterjetting unit at a two to three-inch standoff distance.

Spraying of coating.

Containment

The Quebec Bridge posed some unique challenges for the scaffold designers. The wind load restrictions made it impossible to use traditional containment materials. When waterjetting was specified, these restrictions were eased. Negative pressure was no longer required and the heavy weight-bearing

(continued on page 15)

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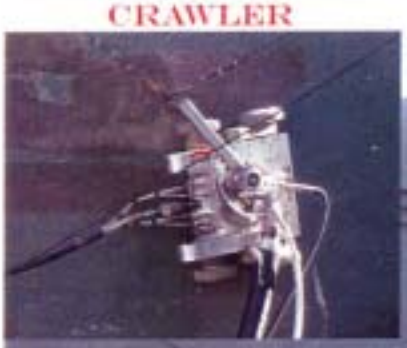

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4.0 mm	10.3 mm	2160 bar	5400 bar	130 mm	0.234 Kg/m

Outer Cover
Polyamide (PA)

Pressure Support
4 layers of high-tensile steel wire

Inner Core
Polyoxymethylene (POM)

Working Temperature -22° F to 140° F [-30°C to +60°C]

Color: grey, other colors upon request

ID	OD	Working Pressure	Min. Burst Pressure	Min. Bend Radius	Weight
0.20 inch	0.44 inch	26100 psi	65250 psi	6 inch	0.175 lbs/ft
5.0 mm	11.2 mm	1800 bar	4500 bar	150 mm	0.260 Kg/m

Outer Cover
Polyamide (PA)

Pressure Support
4 layers of high-tensile steel wire

Inner Core
Polyoxymethylene (POM)

Working Temperature -22° F to 140° F [-30°C to +60°C]

Color: grey, other colors upon reques

ID	OD	Working Pressure	Min. Burst Pressure	Min. Bend Radius	Weight
0.25 inch	0.50 inch	21750 psi	55100 psi	7 inch	0.198 lbs/ft
6.3 mm	12.6 mm	1500 bar	3800 bar	180 mm	0.295 Kg/m

Welcome WJTA New Members

Corporate

CRC - Evans Rehabilitation Systems
Andy Santalucia
Sid Taylor
Dave Nicholson
11601 N. Houston - Rosslyn Road
Houston, TX 77086
Phone: (281)999-2185
Fax: (281)999-7155

Main Industries, Inc.
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Phone: (843)744-9020
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Newport News, VA 23607
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Dale Martin
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Florian Aberle
Jamie Seboth
Kim Merritt
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Ft. Lauderdale, FL 33311
Phone: (954)484-1110
Fax: (954)484-1140

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Salomon De Snaijer
Arco Den Hollander
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Fax: (435)863-4551

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Concurrent Technologies Corporation
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Phone: (814)269-6484
Fax: (814)269-6847

Ingersoll-Rand Receives Certification

Ingersoll-Rand Company's Waterjet Cutting Systems Business Unit has received ISO 9001 certification for its Baxter Springs, Kansas location. The inspection and audit was conducted over four days in August 1999 by TUV Certification.

The unit first applied for ISO 9001 certification in June 1999 and was granted immediate approval based on their outstanding scores. The inspectors found no negative findings, which is quite rare during this type of inspection. Inspectors went through the 20 elements for 9001 certification which included contract review, design control, document and data control, purchasing, inspection and testing. The whole process took a few months, which is much faster than it takes many groups to get certified.

The unit has not had any major operational changes from what they have been doing for the past few years and the decision to apply for ISO 9001 certification was made at the end of 1998. The unit began documenting procedures and results at the end of 1998 in preparation for the audit. The application was then submitted to the registrar, two months in advance of the inspection.

For more information, call toll-free 1-800-826-9274, or visit the company's Web site: www.ingersoll-rand.com/waterjet

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

Thames Barrier Repairs, from page 1

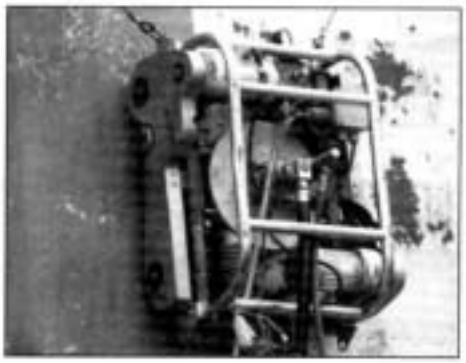
dumped its load of sand and gravel, then sank onto the gate where it sat for several days atop its load. This caused paint failure and premature corrosion on the flat face of the gate. The failure of this gate could have had potentially disastrous effects on London, with flooding damage estimated at UK£21 billion (21 billion pounds sterling) and extensive loss of life.

The UK's Environment Agency had several requirements for any repairs that were undertaken on the damaged gate. The barrier gate could not be taken out of service and had to be able to be closed at any time with a one-hour notice to the cleaning contractor. In addition, there could be no environmental pollution or potential release into the environment during the surface preparation procedures. The twice-daily 21-foot tides and heavily traveled river created logistics problems for any repair to the gates. Because of these constraints any surface preparation that required stationary staging was rejected.

The solution:

The remotely controlled, vacuum attached JetTrac™ system provided by UHP Projects, Inc. was used to clean and prepare the surface of the gate for recoating. This system uses ultra high pressure (40,000 PSI) waterjets to strip the coatings from the surface. A patented seal allows the remote JetTrac™ crawler to attach itself to the gate using a vacuum supplied by a remote vacuum skid. The paint and water are completely contained in a vacuum shroud and removed down a hose to a vacuum system located on a barge. The JetTrac™ crawler is remotely controlled and can move in any direction in both the horizontal and vertical positions as well as overhead.

UHP waterjetting provided an environmentally safe surface preparation method as well as an excellent way to remove chlorides and other contaminants caused by the constant submersion in salt water. This surface preparation method also eliminated the handling of abrasives over the water and greatly reduced the waste disposal costs of the project.



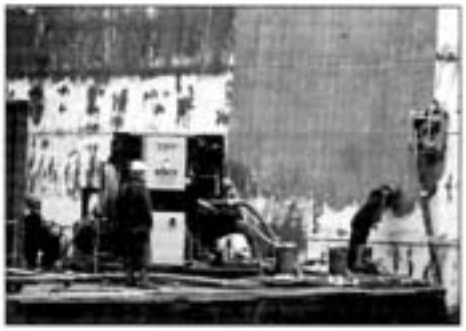
Procedures:

UHP Projects, Inc. supplied the following equipment which was loaded onto a barge and placed at the base of the gate; UHP pump, JetTrac™ vacuum skid, JetTrac™ crawler, filtration system, 185 CFM air compressor, 440V generator, two 5000 gallon tanks for fresh and effluent water storage, necessary painting equipment and materials. A tugboat was on 24 hour standby to move the barge in case of an emergency, and a rescue boat was always available during cleaning operations due to the swift tides. UHP Projects, Inc. staffed the project with a four-man crew.

The project was started with the gate in the vertical (defense) position and the JetTrac™ cleaning the top 25% of the gate surface down to the high tide waterline. A cable support system was designed and installed to allow a self tensioning winch cable from the vacuum skid to run to the top of the gate and back to the JetTrac™ crawler. This allowed the crawler to be lifted and placed onto the gate's surface from the barge deck, and the vacuum could then be applied to hold the crawler to the surface. This winch system also provided a safety backup to catch the crawler if vacuum was lost.

After the top section of the gate was cleaned and painted, the gate was placed in the overhead (maintenance) position. UHP Projects, Inc. designed a lift system that allowed the crawler to be lifted into place from the barge deck to the underside of the gate during any tide level. Vacuum and UHP water pressure was then applied and the crawler would be remotely controlled from the barge deck. The remainder of the gate was cleaned in this position.

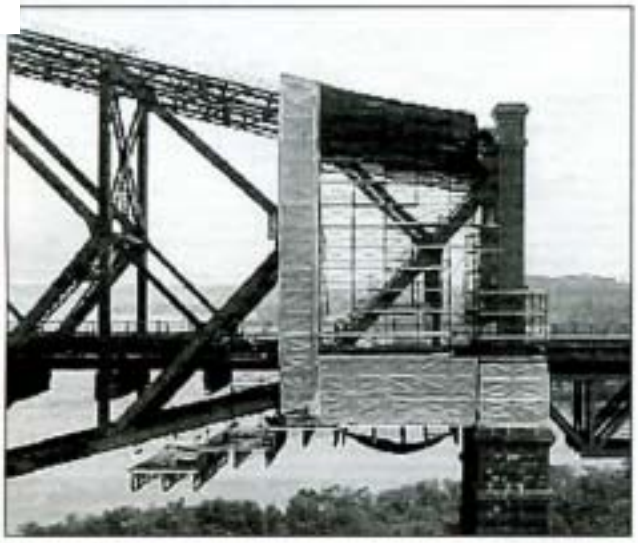
Surface preparation in both gate positions was coordinated to be done on the outgoing tides down to the high tide waterline. Recoating was accomplished on the next incoming tide. In the vertical position this allowed the painter access to the area from the barge. Painting done in the overhead position was accomplished using a small manlift placed on the barge. A two-part high solid epoxy coating from Kemira was used as specified by the Environment Agency. All coatings were applied using a 45:1 airless spray equipment.



The existing coatings to be removed were a 20-50 mil hot applied two-pack epoxy that had been applied at con-

(continued on page 20)

Coating Restoration On The Quebec Bridge, from page 12



Containment structure.

scaffolding became redundant. The tremendously lower level of environmental control required during waterjetting operations reduced the cost (approximately 50%) and also created a safer environment for all concerned personnel. The nvironmental controls comprised light platforms, geo-textile fabric for water filtration and paint chip collection, light weight solid tarps and flow-through tarps. Another feature that had to be built into the containment was that if wind velocities increased above 45 km/h, the tarps had to be dropped quickly on specific members to protect the structure from excessive wind loading. This type of flexibility would have been impossible with traditional negative pressure containment, as it would be impossible to remove all the lead dust and abrasive quickly. The use of water made it possible to preserve this structure within budget, and without compromising service life or the environment.

This article is excerpted from a presentation given at the NACE Northern Conference, Ottawa 1999. Reprinted by permission of the authors, Wayne Senick, Rob Roy and Alain Beaulin.

The entire article on the restoration of the Quebec Bridge is available on the Advisory Council Web site at www.advisorycouncil.org.

Flow Signs $4 Million Contract With Bell Helicopter Textron

Flow International Corporation (Nasdaq: FLOW) today announced it will manufacture and install a multi-process waterjet machine tool system valued at nearly $4 million for Bell Helicopter Textron, the leader in commercial helicopter production and a pioneer of tiltrotor aircraft development. Bell Helicopter Textron, a subsidiary of Textron Inc. (NYSE: TXT), located in Hurst, Texas, will use the system to machine composite structures for its new V-22 and Bell 609 aircraft. Delivery is expected in approximately 9 to 11 months.

The use of waterjet cutting provides two distinct advantages. Waterjets are a non-contact cutting and trimming technology that allow the use of flexible, programmable tooling, instead of expensive hard-tooling for each individual part. As a result, this system dramatically reduces set up time and saves money. Waterjets also eliminate the potential for the delamination of composite materials, which can occur with conventional cutting techniques.

"Acquisition of this state-of-the-art manufacturing technology will provide our customers and shareholders the best value in tiltrotor aircraft development," says Steven Harding, director of general service contracts for Bell Helicopter Textron.

"Our partnership with Bell Helicopter Textron to manufacture their new aircraft, demonstrates FLOW's commitment to providing total solutions to customers," says Ron Tarrant, CEO of Flow International. "It also reflects the continued reliance on ultrahigh-pressure technology within the aerospace industry."

For more information, contact Ron Tarrant, Chairman, CEO and President or Stephen Reichenbach, Executive VP, CFO at 253-850-3500.

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Hydrodemolition In Slovenia

A Swedish Conjet Robot 361 hydrodemolition machine is playing a major role in boosting the electricity generating capacity of three hydro-electric power plants on the Drava River in the Republic of Slovenia. Contractor Gradis is using its Conjet Robot for removing concrete from nine vertical turbine draft tubes. This operation will make way for new reshaped steel linings and larger diameter, more efficient, greater capacity turbine generator sets.

Gradis is working on its Deutschmark 2.9 million contract for client and power station owner Dravske Elektrame Maribor as part of the approximate DM200 million second phase of refurbishing and upgrading three of the Slovenia's chain of eight hydro-electric power plants. These power stations are strategically located along an approximate 100km stretch of the Drava River, which falls about 20m between the upper and lower power stations. The power plants, which operate on the run-of-river storage principle, were built during a 60-year-period from 1918 to 1978 and provide about 23% of Slovenia's electricity. But the ageing power plants' electrical and mechanical equipment is worn out and gradually being replaced over a period of several years.

The hydro power plant at Fala, the first to be commissioned in 1918, was also the first to be upgraded. This plant's original seven turbine generators were replaced with two new, more efficient, ones in 1991. The current second phase of refurbishment, which started in 1996, is centered on the three hydro-electric stations of Dravograd, Vuzenica and Mariborski otok, which were all built during the 1940s and early 1950s. Dravograd's renovation is complete with three new turbine generator sets increasing the power station's total installed output by 31% from 22.8MW to 29.8 MW. One of Mariborski otok's three turbines has also been replaced, but Gradis is currently focusing on removing concrete from the three turbine draft tubes at Vuzenica, before returning to complete its contract on the two remaining turbines at Mariborski otok.

The Vuzenica Power Plant on the Drava River in Slovenia.

One of Vuzenica's three turbine generator sets has already been replaced and Gradis is now removing concrete to increase the diameter of the power station's second turbine draft tube. But before Gradis could put its Conjet Robot to work and make a start on hydrodemolition, the power station's overhead gantry crane had to lift out the old worn out generator and turbine. This operation was followed by another demolition contractor cutting out an approximate 5.25m high section of the turbine's cylindrical to rectangular stainless steel draft tube casing liner, which is embedded in concrete.

Gradis, which is adopting the same hydrodemolition technique for all nine turbines, stands its Conjet Robot on a moveable platform inside the confined 4.65m diameter vertical turbine housing. About a 840mm thickness of concrete had to be cut out round the entire periphery to increase the diameter to 6.33m. This was done using the Robot 361 making three separate circumferential cuts from the working platform set at two different levels. The first two passes removed about 780mm followed by a third and final cleaning cut of about 60mm. About 65m³ of concrete had to be removed from the draft tube by hydrodemolition, which the Robot 361 was able to achieve at about 1m³/hour. The concrete spoil was allowed to fall into the draft tube sump were it was loaded by a mini excavator into a skip and lifted to the surface for disposal.

"Hydrodemolition was specified for this contract," said Gradis technical

(continued on page 18)

Hydrodemolition In Slovenia, from page 17

director Ivan Kosi. "We were aware of Conjet and knew their hydrodemolition equipment would work. Even so we've been very surprised with the Conjet Robot 361 as it has been more productive than we expected and also proved to be very robust and reliable working in a very confined and hostile environment."

All the Robot 361's functions were remotely controlled by the Robot operator working with a bird's eye view high above the cutting area. High pressure water for the Conjet Robot was supplied by a Hammelmann power pack. This consisted of a heat- and sound-insulated ISO container housing a 750hp (550kW) Caterpillar diesel engine driving a pump operating at 1400 bar pressure and flow of 234 litres/minute.

"We have been very pleased with Gradis and their Conjet Robot, which has performed to our expectations," said Dravske Elektrarne Maribor engineer Dušan Rajh, who spent a long time evaluating hydrodemolition prior to starting on the refurbishment programme. "I read an article about Conjet and went to Stockholm to see their equipment working for myself and was very impressed," adds Mr. Rajh. "Our consulting engineers IBE was also in favor of hydrodemolition so the technique was written into the contract specification as the only approved method which would be allowed to remove the concrete in the turbine housings. We would not allow pneumatic breakers to be used as they would have caused cracking and secondary damage to the concrete left behind."

Once Gradis had completed the concrete removal a new and larger 4.85m diameter stainless steel liner casing, reshaped to improve hydraulic efficiency, was positioned in the void, which was backfilled with fresh concrete. This was followed by installing a new four-bladed, variable pitch turbine, built by Litostroj in Slovenia, coupled to a Siemens generator. The new runner, just 200mm larger than the old one and operating at 125 rev/min with the same maximum gross head of 13.65m, is able to accommodate an approximate 15% increase in water flow to just over 183m³/second, raising rated power output of the replacement turbine generator set to 18.6MW. The second turbine generator at the Vuzenica hydro-electric power station went on line effective in May 1999. Completion of the identical third unit, about one year later, will boost the refurbished and uprated plant's total installed power output by nearly 43% to 64MW.

Contractor Gradis is using the Conjet Robot 361 to remove concrete from the turbine draft tubes.

After finishing the hydrodemolition work at Vuzenica, Gradis will move back to complete its outstanding work at Mariborski otok and use the Conjet Robot 361 in an identical manner to remove concrete from the station's two remaining draft tubes. Completion of the second phase of the renovation and upgrading of the upper Drava River hydro power plants will provide not only further electricity generation in those plants but also additional power capacity of roughly 40MW.

For further information, contact Stephen Toms, National Hydro Inc., 5643 Warner Road, Fowlerville, MI 48836, tel: 517-223-0915, fax: 517-223-9525, e-mail: toms@ismi.net, or contact Hammelmann Corp., 600 Progress Road, Dayton, Ohio 46499, tel: 937-859-8777, fax: 937-859-9188, e-mail: mail@hammelmann.com, Web site: www.hammelmann.com

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Commercial and academic authors are encouraged to submit abstracts for possible presentation at the Conference. Watch the *Jet News* for an abstract submission form.

New Products, from page 10

- 7.5 inch (190 mm) cleaning path
- Weighs only 39 pounds (18 Kg)
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The "UHP Surface Prep Tool" cleans down to bare metal, quickly removing rust and coatings from tanks and ships. The UHP waterjet process will clean to NACE/SSPC WJ-1 standards or "near white metal." CRS Power Flow is a leading manufacturer of waterblasting tools and accessories for pressures up to 40,000 psi (2750 bar). For more information on this and other CRS Power Flow products, call 1-800-580-FLOW or (713) 466-6269.

New High-Flow 40,000 Psi Valves For Waterjet Applications

A full line of high-flow),000 psi valves, fittings and bing is now available from High Pressure Equipment Company. This product line is specifically designed for the unique requirements of waterjet cutting and blasting applications.

The new valves feature an 1/8" orifice, allowing for higher flow rates with a standard connection size. The HIP 40,000 psi components are constructed of stainless steel (custom materials are available) and utilize a coned and threaded tubing connection of 9/16" O.D. X 1/4" O.D. All of the new 40,000 psi products are produced in accordance with ISO 9001 certified design and manufacturing operations.

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High Pressure Equipment Company designs, manufactures, and markets products used in the chemical, petrochemical, oil and gas, waterjet cutting and blasting, industrial research and development, general industrial, university and pharmaceutical industries. These products include valves, fittings and tubing, reactors, pressure vessels, intensifiers, gauges, pumping systems, gas booster systems and pressure generators.

For more information, contact High Pressure Equipment Company, 1222 Linden Avenue, Erie, PA, 16505, phone: 814-838-2028, fax: 814-838-6075, e-mail: sales@highpressure.com or visit the Web site: www.highpressure.com

Thames Barrier, from page 14

struction. The JetTrac™ using ultra high pressure waterjetting removed the coating to a SSPC SP 5 - WJ-2 condition with production rates of approximately 200 ft²(18 m²)per hour. An independent paint inspector performed daily tests for chlorides, profile, Holiday detection of holes in the coating, and adhesion. Every effort was made to recoat as soon after waterjetting as possible to minimize flashrusting.

The equipment:

The JetTrac™ system consisted of five components, all of which were loaded onto the barge. The JetTrac™ crawler has a 12-inch diameter UHP nozzle that rotates at 3400 rpm that is enclosed in a vacuum shroud. A 3-inch vacuum hose connects the crawler to the remote vacuum skid and removes all jetting water and paint debris. Four wheels driven by two electric motors propel the crawler in any direction. A patented seal on the crawler allows a complete vacuum seal that contains 100% of waste water and paint debris

A remote 24-volt control box is connected with an umbilical cord to both the crawler and the other components to give the operator control of the crawler's direction, vacuum control, UHP pump control, and winch tensioning. A joystick lets the operator control both the direction and speed that the crawler is moving.

The vacuum skid provides up to 19 inches Hg of vacuum to the system that allows both attachment to the surface and removal of the debris. An onboard pump then removes the liquids/solids from the vacuum separator tank to a filtration system.

UHP Projects, Inc. designed the filtration system to include a course bag filter, and a secondary system that included both pre-filters and diatametious earth filters was used to further filter the water. The water was then pumped into an onboard holding tank, where it was stored and approv by the Environmental Agency prior to

(continued on page 22)

Finally—The Water Blast Hose You've Been Looking for With a Name You'll Never Forget.

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Advances In Hydrodemolition In Sweden, from page 6

)mage still showing in the rough and uneven ..rface or spots of salt, especially where aggregate has been embedded, are showing. When chloride content of the concrete is lower than 0.2% of the aggregate, if struck with a hammer, it should just crack, but stay in place. When chloride content reaches between 0.2% to 0.5% the aggregate will bounce out leaving a matching impression in the concrete, indicating that the bonding is insufficient and more concrete will have to be removed prior to finalizing the specified quality depth.

After the selected removal of the poor concrete, the rough and uneven textured surface has to be thoroughly cleaned with a pressure waterjet before it dries out. The cleaning is essential to prevent risk of delamination at the interface with the fresh concrete. Efficient compaction of the new concrete overlay is also vitally important to prevent formation of air pockets in any depressions created in the old concrete's roughened surface.

Hydrodemolition robot machines are now the only authorized and accepted method of removing damaged concrete from bridge decks and other similar sensitive structures in Sweden and Norway. ..ly, Switzerland, France and the USA are also growing markets for this advanced technology. Hand held waterjetting lances can occasionally complement hydrodemolition machines and are only used on very small areas inaccessible to the purpose built robotic equipment. The hand held waterjetting lance is not as selective and also not as safe or productive as an hydrodemolition robot.

The proven and very successful hydrodemolition repair technique is also preferred and has been extensively used throughout North America, Europe, Russia, the Middle East and South East Asia over the past 15 years. Steel reinforced concrete, weakened and damaged by salt and frost, has been very efficiently removed from airport runways, bridge decks, joints, soffits, pillars and columns, harbor and dock walls, dam faces, tunnel and hydro-electric turbine linings and car parking decks with Conjet's versatile hydrodemolition waterjetting equipment.

For further information contact: Carl Strömdahl or Lars-Göran Nilsson, Conjet AB, P.O. Box 507, S-136 25 Haninge, Sweden. Tel: +46-8-741-)40,Fax: +46-8-741-3960, e-mail: conjet@conjet.se, Internet: http://www.conjet.com

Thames Barrier, from page 20

pumping it to the Barriers waste water system at the end of the project.

A 40,000 PSI Ultra High Pressure pump provided water to the rotating nozzle located on the crawler. These high velocity waterjets strike the surface to be cleaned in the same manner as small solid particles, shearing away un-wanted paint and rust from the surface.

Conclusion:

The recoating of the Foxtrot gate was completed without taking the gate out of service and without any environmental problems. The remote operation allowed the gate to be constantly available in the event of an emergency. The JetTrac™ system performed well under the difficult conditions found along the Thames River and proved to be a viable solution to this recoating problem.

Due to the highly publicized sinking of the Sand Kite, this project received widespread attention in the UK and was featured on the BBC evening news. The visitor's center at the Thames Barrier also displayed photographs and information about the Sand Kite's collision and the repairs using the JetTrac™ system.

Conventional scaffolding was considered for this job by the UK Environmental Agency. The scaffolding option was rejected because the cost was estimated at UK£150,000 (pounds Sterling) and because it would require six weeks to erect and another six weeks to strike the scaffolding.

UHP Projects did not require scaffolding. The work was done under contract for about UK£100,000.

The project was completed in about six weeks at a direct cost savings of UK£50,000 (about 80,000 US dollars). There was an even greater economic benefit because the project time was reduced from twenty-four to six weeks.

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