WJTA Jet News
Water Jet Technology Association
SEPTEMBER 1994
Published by the Water Jet Technology Association for the benefit of its members

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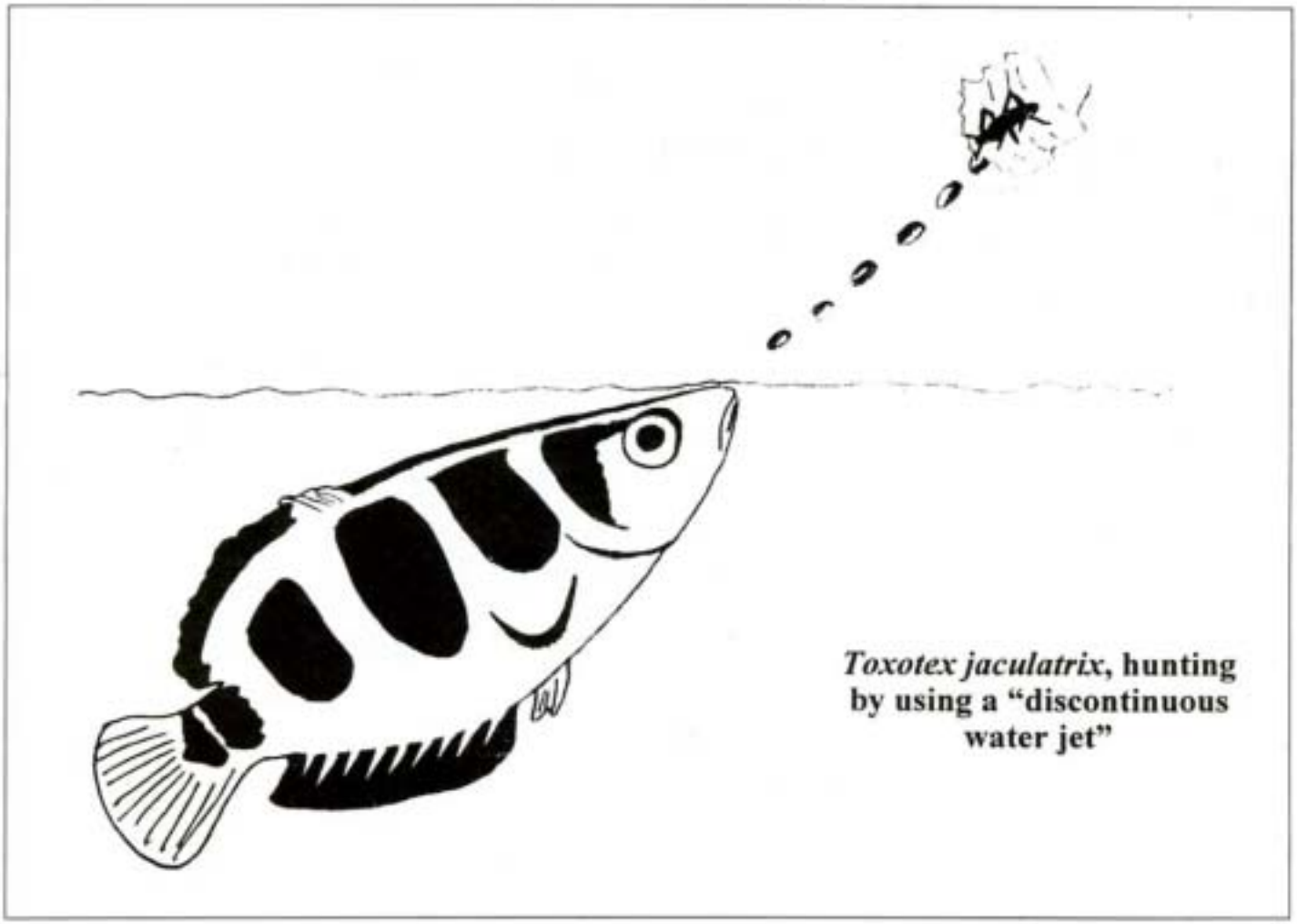
Water Jet Blasting In Nature

By: Andreas W. Momber, University of Kentucky, Lexington, Kentucky



***Toxotex jaculatrix*, hunting by using a "discontinuous water jet"**

In many technological fields scientists and engineers follow the example of the developments of nature. Important examples for this connection of technique and nature, which is called bionic, are the helicopter - dragon fly, and the concrete TV-tower - blade of straw. The general philosophy behind this research field is the suggestion that in the course of some million years nature has found optimum solutions for many "technical" problems. So it is obvious to look if the jet blasting principle is used in nature, especially in the animal kingdom.

A process that is comparable with jet blasting is the so-called "spitting" of some fish species, among them *Colisa chuna, Colisa lalia* and *Toxotes jaculatrix*. *Toxotes jaculatrix* uses the generated water jet only for spitting for feeding. The other species show spit behavior in case of nest building, fry tending, and owing to excitement.

(continued on page 4)

Call For Papers

8th American Water Jet Conference

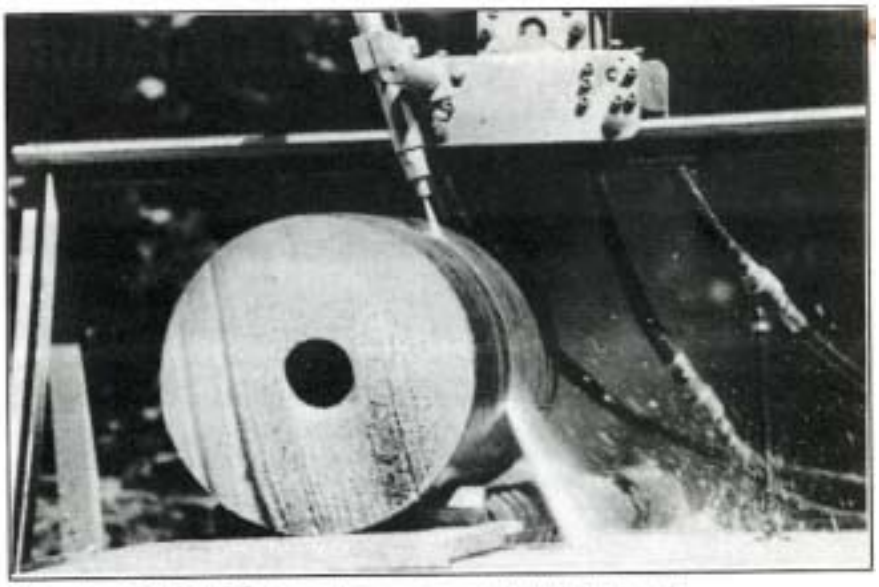
The 8th American Water Jet Conference will focus on the most up-to-date industry advances in water jetting equipment, techniques, and applications. Commercial and academic authors are encouraged to submit titles and abstracts for consideration.

To submit an abstract(s), complete the submission form on page 5 of this issue and forward to the attention of the Conference Coordinator at the WJTA Office. **Abstracts must be submitted no later than November 1, 1994, to ensure consideration.**

WJTA Administration

Water Jets Disarm Weapons

By: George Savanick, Ph.D. and Paul Rozycki



Russian Rocket Motor. Photo courtesy of ALBA Industrie and Umweltschutzservice GmbH, Lübeck, Germany.

There is a lot of unwanted ammunition in the world. Disposal of some of it is required under disarmament treaties and some of it is left over from bygone wars.

Safe disposal is complicated by the large quantity and variety of this ammunition. In addition it is often not possible to remove fuses or otherwise disassemble the ammunition.

Water jet technology has emerged as a solution for this problem. Jets can cut any kind of ammunition and can remove the explosives from the casing.

ALBA Industrie & Umweltschultzservice GmbH of Lübeck, Germany has developed two water jet cutting systems for disposing of ammunition. The first is a high pressure water jet system to wash out explosives from shells and rockets. The other system is a high pressure abrasive jet system for cutting through the ammunition or rockets.

The high pressure water jetting system uses a rotating lance which enters into the body of the ammunition through an opening and emits a jet which erodes and washes out the filler. It washes out the explosive filler from mortar and artillery ammunition, hollow charges and mines, or bombs and warheads. It is also used to remove solid propellant from rocket motors. These jets have a maximum pressure of 500 bars (7,300 psi) and a maximum discharge of 150 liters per minute (40 gpm).

The high pressure abrasive jet cutting system uses abrasives such as corundum. It can cut holes in armored vehicles and can cut various weapons and ammunition including mortar and artillery shells, mines, bombs, warheads and rocket motors filled with explosives. The system can cut shell fuses that cannot be removed from the shell. It operates at a maximum pressure of 330 bars (4,380 psi) and a maximum water discharge of 70 liters per minute (18 gpm) and consumes 4 to 8 kg per minute of abrasives.

See additional photographs on page 4.

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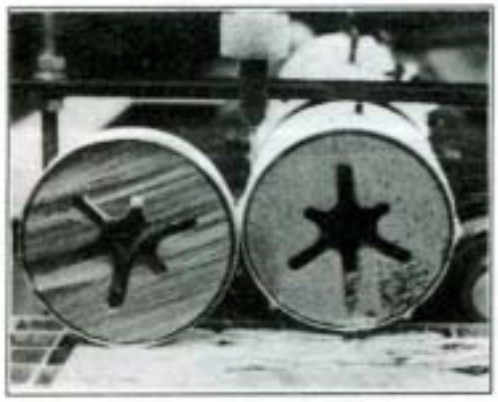
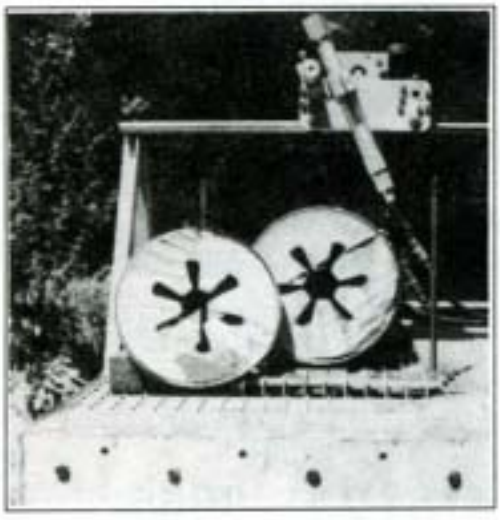
Water Jets Disarm Weapons,

from page 2. Photographs courtesy of ALBA Industrie and Umweltschutzservice GmbH, Lübeck, Germany

Nike Hercules Rocket Motor



Rocket Motor (Russian)



Russian Rocket Motor

(continued on page 7)

New Ball Valve Offers Extended Service Life

Autoclave Engineers has introduced a new 3-way ball valve incorporating a unique ball seat design. The new seat design reduces the open/close torque requirements and allows for compression adjustments, thereby providing a longer service life. The 3-way valve utilizes a 1/4" orifice ball to divert flow from the bottom inlet connection to either of the two side outlet connections.

Autoclave Engineers' new ball valve is designed for on-off high flow applications using liquids or most gases. The valve is rated per ANSI B31.3 for pressures to 20,000 psi, temperatures to 500° F and is available in O.D. connection sizes from 1/8" to 9/16," with a variety of connection types.

All wetted parts in this valve are stainless steel with poly (amide-Imide) ball seats. The valve features a blowout proof stem with Teflon packing and a positive locking device on the packing gland.

Autoclave Engineers Fluid Component Division markets valves, fittings and tubing, liquid pumps, gas boosters and air amplifiers, and instrument manifold valves.

For more information, write **Autoclave Engineers Group, 2930 West 22nd Street, Box 5051, Erie, PA 16512 or call (814)838-5700 or Fax (814)838-5811.**

Water Jet Blasting In Nature,

continued from page 1

Toxotes jaculatrix (t.j.) lives on the coast of southern Asia. It prefers to live in the mixing waters of estuaries, but also exists in pure fresh water or pure salt water and in mangrove marshes. Spitting is not the main way for feeding, but rather an alternative and complemented method, respectively. The fish picks up a certain amount of water in its mouth. As a result of contact pressure of opercle, the water volume is pressurized and transported through a tube. This tube is created by a gutter in the palate on the upper side and the tongue on the lower side. Consequently, from the "technical" point of view, one can discern "pressure generator" (opercle) and "orifice" (spitting tube). It is very interesting to note that this fish is able to vary shape and size of the orifice. Also it was observed that *Toxotes jaculatrix* generates a controlled salvo of single drops of high frequency. Both have been dreams of some researchers in the field of water jet cutting for many years.

The generation and application of spitting jets in case of the Family *Anabantidae (C. chuna, C. lalia)* is similar to that described before. *Anabantidae* lives in southern Asia, too, but lives in pure fresh water. Unlike *Toxotes jaculatrix* these species use spitting jets not only for prey hunting, but also for other reasons. For example it is known that masculine *Colisa chuna* frequently render the collecting of eggs after spawning easier by spitting water.

It is also known that some whale species look for food by using jets of water to remove mire from the ocean floor. Very popular is the behavior of the octopus, which generates water jets for driving shafts. German reference literature about the spitting of fishes is available from the author.

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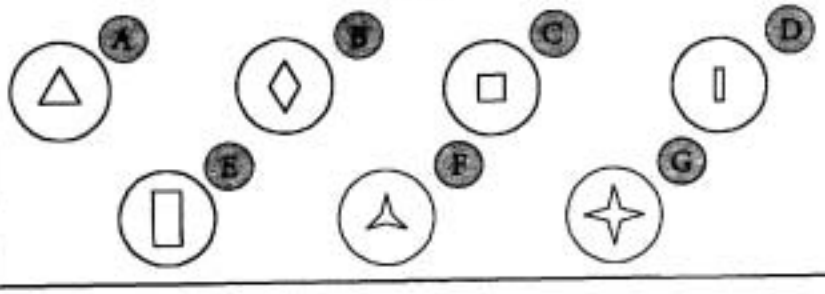
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21		
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
2.0	0.036	1.0	1.4	1.7	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.3	3.5	3.6	3.7	3.9	4.0	4.1	4.2	4.4	4.5		0.925	2.0
2.5	0.041	1.3	1.8	2.2	2.5	2.8	3.1	3.3	3.5	3.8	4.0	4.1	4.3	4.5	4.7	4.8	5.0	5.2	5.3	5.4	5.6		1.034	2.5
3.0	0.046	1.5	2.1	2.6	3.0	3.4	3.7	4.0	4.2	4.5	4.7	5.0	5.2	5.4	5.6	5.8	6.0	6.2	6.4	6.5	6.7		1.133	3.0
3.5	0.048	1.8	2.5	3.0	3.5	3.9	4.3	4.6	4.9	5.3	5.5	5.8	6.1	6.3	6.5	6.8	7.0	7.2	7.4	7.6	7.8		1.224	3.5
4.0	0.052	2.0	2.8	3.5	4.0	4.5	4.9	5.3	5.7	6.0	6.3	6.6	6.9	7.2	7.5	7.7	8.0	8.2	8.5	8.7	8.9		1.308	4.0
4.5	0.055	2.3	3.2	3.9	4.5	5.0	5.5	6.0	6.4	6.8	7.1	7.5	7.8	8.1	8.4	8.7	9.0	9.3	9.5	9.8	10.1		1.388	4.5
5.0	0.058	2.5	3.5	4.3	5.0	5.6	6.1	6.6	7.1	7.5	7.8	8.3	8.7	9.0	9.4	9.7	10.0	10.3	10.6	10.9	11.2		1.463	5.0
5.5	0.060	2.8	3.9	4.8	5.5	6.1	6.7	7.3	7.8	8.3	8.7	9.1	9.5	9.9	10.3	10.7	11.0	11.3	11.7	12.0	12.3		1.534	5.5
6.0	0.063	3.0	4.2	5.2	6.0	6.7	7.3	7.9	8.5	9.0	9.5	9.9	10.4	10.8	11.2	11.6	12.0	12.4	12.7	13.1	13.4		1.602	6.0
6.5	0.066	3.3	4.6	5.6	6.5	7.3	8.0	8.5	9.2	9.8	10.3	10.8	11.3	11.7	12.2	12.6	13.0	13.4	13.8	14.2	14.5		1.668	6.5
7.0	0.068	3.5	4.9	6.1	7.0	7.8	8.6	9.3	9.9	10.5	11.1	11.6	12.1	12.6	13.1	13.6	14.0	14.4	14.8	15.3	15.7		1.731	7.0
7.5	0.071	3.8	5.3	6.5	7.5	8.4	9.2	9.9	10.6	11.3	11.9	12.4	13.0	13.5	14.0	14.5	15.0	15.5	15.9	16.3	16.8		1.791	7.5
8.0	0.073	4.0	5.7	6.9	8.0	8.9	9.8	10.6	11.3	12.0	12.6	13.3	13.9	14.4	15.0	15.5	16.0	16.5	17.0	17.4	17.9		1.850	8.0
8.5	0.075	4.3	6.0	7.4	8.5	9.5	10.4	11.2	12.0	12.8	13.4	14.1	14.7	15.3	15.9	16.5	17.0	17.5	18.0	18.5	19.0		1.907	8.5
9.0	0.077	4.5	6.4	7.8	9.0	10.1	11.0	11.9	12.7	13.5	14.2	14.9	15.6	16.2	16.8	17.4	18.0	18.6	19.1	19.6	20.1		1.962	9.0
9.5	0.079	4.8	6.7	8.2	9.5	10.6	11.6	12.6	13.4	14.3	15.0	15.8	16.5	17.1	17.8	18.4	19.0	19.6	20.2	20.7	21.2		2.016	9.5
10.0	0.081	5.0	7.1	8.7	10.0	11.2	12.2	13.2	14.1	15.0	15.8	16.6	17.3	18.0	18.7	19.4	20.0	20.6	21.2	21.8	22.4		2.069	10.0
11.0	0.085	5.5	7.8	9.5	11.0	12.3	13.5	14.6	15.6	16.5	17.4	18.2	19.1	19.8	20.6	21.3	22.0	22.7	23.3	24.0	24.6		2.170	11.0
12.0	0.089	6.0	8.5	10.4	12.0	13.4	14.7	15.9	17.0	18.0	19.0	19.9	20.8	21.6	22.5	23.2	24.0	24.7	25.5	26.2	26.8		2.266	12.0
12.5	0.091	6.3	8.8	10.8	12.5	14.0	15.3	16.5	17.7	18.8	19.8	20.7	21.7	22.5	23.4	24.2	25.0	25.8	26.5	27.2	28.0		2.313	12.5
13.0	0.093	6.5	9.2	11.3	13.0	14.5	15.9	17.2	18.4	19.5	20.6	21.6	22.5	23.4	24.3	25.2	26.0	26.8	27.6	28.3	29.1		2.359	13.0
14.0	0.096	7.0	9.9	12.1	14.0	15.7	17.1	18.5	19.8	21.0	22.1	23.2	24.2	25.2	26.2	27.1	28.0	28.9	29.7	30.5	31.3		2.448	14.0
15.0	0.100	7.5	10.6	13.0	15.0	16.8	18.4	19.8	21.2	22.5	23.7	24.9	26.0	27.0	28.1	29.0	30.0	30.9	31.8	32.7	33.5		2.533	15.0
20.0	0.115	10.0	14.1	17.3	20.0	22.4	24.5	26.5	28.3	30.0	31.6	33.2	34.6	36.1	37.4	38.7	40.0	41.2	42.4	43.6	44.7		2.925	20.0
25.0	0.129	12.5	17.7	21.7	25.0	28.0	30.6	33.1	35.4	37.5	39.5	41.5	43.3	45.1	46.8	48.4	50.0	51.5	53.0	54.5	55.9		3.271	25.0
30.0	0.141	15.0	21.2	26.0	30.0	33.5	36.7	39.7	42.4	45.0	47.4	49.7	52.0	54.1	56.1	58.1	60.0	61.8	63.6	65.4	67.1		3.583	30.0
35.0	0.152	17.5	24.7	30.3	35.0	39.1	42.9	46.3	49.5	52.5	55.3	58.0	60.6	63.1	65.5	67.8	70.0	72.2	74.2	76.3	78.3		3.870	35.0
40.0	0.163	20.0	28.3	34.6	40.0	44.7	49.0	52.9	56.6	60.0	63.2	66.3	69.3	72.1	74.8	77.5	80.0	82.5	84.9	87.2	89.4		4.137	40.0
45.0	0.173	22.5	31.8	39.0	45.0	50.3	55.1	59.5	63.6	67.5	71.2	74.6	77.9	81.1	84.2	87.1	90.0	92.8	95.5	98.1	100.6		4.388	45.0
50.0	0.182	25.0	35.4	43.3	50.0	55.9	61.2	66.1	70.7	75.0	79.1	82.9	86.5	90.1	93.5	96.8	100.0	103.1	106.1	109.0	111.8		4.625	50.0
55.0	0.191	27.5	38.9	47.6	55.0	61.5	67.4	72.8	77.8	82.5	87.0	91.2	95.3	99.2	102.9	106.5	110.0	113.4	116.7	119.9	123.0		4.851	55.0
60.0	0.199	30.0	42.4	52.0	60.0	67.1	73.5	79.4	84.9	90.0	94.9	99.5	103.9	108.2	112.3	116.2	120.0	123.7	127.3	130.8	134.2		5.067	60.0
65.0	0.206	32.5	46.0	56.3	65.0	72.7	79.6	86.0	91.9	97.5	102.8	107.8	112.6	117.2	121.6	125.9	130.0	134.0	137.9	141.7	145.3		5.274	65.0
70.0	0.216	35.0	49.5	60.6	70.0	78.3	85.7	92.6	99.0	105.0	110.7	116.1	121.2	126.2	131.0	135.6	140.0	144.3	148.5	152.6	156.5		5.473	70.0
75.0	0.223	37.5	53.0	65.0	75.0	83.9	91.9	99.2	106.1	112.5	118.6	124.4	129.9	135.2	140.3	145.2	150.0	154.6	159.1	163.5	167.7		5.665	75.0
80.0	0.230	40.0	56.6	69.3	80.0	89.4	98.0	106.6	113.1	120.0	126.5	132.7	138.6	144.2	149.7	154.9	160.0	164.9	169.7	174.4	178.9		5.851	80.0
85.0	0.237	42.5	60.1	73.6	85.0	95.0	104.1	112.4	120.2	127.5	134.4	141.0	147.2	153.2	159.0	164.6	170.0	175.2	180.3	185.3	190.1		6.031	85.0
90.0	0.244	45.0	63.6	77.9	90.0	100.6	110.2	119.1	127.3	135.0	142.3	149.2	155.9	162.3	168.4	174.3	180.0	185.5	190.9	196.2	201.2		6.206	90.0
95.0	0.251	47.5	67.2	82.3	95.0	106.2	116.4	125.7	134.4	142.5	150.2	157.5	164.5	171.3	177.7	184.0	190.0	195.8	201.5	207.0	212.4		6.376	95.0
100.0	0.258	50.0	70.7	86.6	100.0	111.8	122.5	132.3	141.4	150.0	158.1	165.8	173.2	180.3	187.1	193.6	200.0	206.2	212.1	217.9	223.6		6.541	100.0
105.0	0.264	52.5	74.2	90.9	105.0	117.4	128.6	138.9	148.5	157.5	166.0	174.1	181.9	189.3	196.4	203.3	210.0	216.5	222.7	228.8	234.8		6.703	105.0
110.0	0.270	55.0	77.8	95.3	110.0	123.0	134.7	145.5	155.6	165.0	173.9	182.4	190.5	198.3	205.8	213.0	220.0	226.8	233.3	239.7	246.0		6.861	110.0
115.0	0.276	57.5	81.3	99.6	115.0	128.6	140.8	152.1	162.6	172.5	181.8	190.7	199.2	207.3	215.1	222.7	230.0	237.1	244.0	250.8	257.1		7.015	115.0
120.0	0.282	60.0	84.9	103.9	120.0	134.2	147.0	158.7	169.7	180.0	189.7	199.0	207.8	216.3	224.5	232.4	240.0	247.4	254.6	261.5	268.3		7.166	120.0
125.0	0.288	62.5	88.4	108.3	125.0	139.8	153.1	165.4	176.8	187.5	197.6	207.3	216.5	225.3	233.9	242.1	250.0	257.7	265.2	272.4	279.5		7.313	125.0
130.0	0.294	65.0	91.9	112.6	130.0	145.3	159.2	172.0	183.8	195.0	205.5	215.6	225.2	234.4	243.2	251.7	260.0	268.0	275.8	283.3	290.7		7.458	130.0
135.0	0.299	67.5	95.5	116.9	135.0	150.9	165.3	178.6	190.9	202.5	213.5	223.9	233.8	243.4	252.6	261.4	270.0	278.3	286.4	294.2	301.9		7.600	135.0
140.0	0.305	70.0	99.0	121.2	140.0	156.5	171.5	185.2	198.0	210.0	221.4	232.2	242.5	252.4	261.9	271.1	280.0	288.6	297.0	305.1	313.1		7.740	140.0
145.0	0.310	72.5	102.5	125.6	145.0	162.1	177.6	191.8	205.1	217.5	229.3	240.5	251.1	261.4	271.3	280.8	290.0	298.9	307.6	316.0	324.2		7.877	145.0
150.0	0.315	75.0	106.1	129.9	150.0	167.7	183.7	198.4	212.1	225.0	237.2	248.7	259.5	270.4	280.6	290.5	300.0	309.2	318.2	326.9	335.4		8.011	150.0

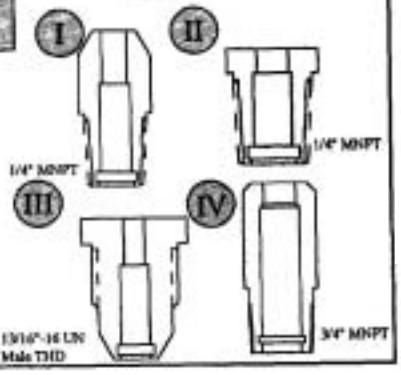
Each square is actual flow in US gallons/min thru the nozzle. (GPM)

To Size Nozzle: Choose nozzle no. from chart. Select shape and holder desired*(ex. 10,000 psi @ 10.3 gpm is nozzle no. 6.5)(Describe nozzle shape by letter and holder by numeral)

SHAPES



HOLDERS



8th American Water Jet Conference

August 27-30, 1995 • JW Marriott Hotel • Houston, Texas • USA

First Announcement And Call For Papers

Impressive progress and a fast-growing understanding of the diversified applications of water jet technology is generating a growing excitement in the industry. New techniques and applications are being developed and current ones are being improved upon. Water jet technology, now being used in nearly all types of industry — manufacturing, mining, construction, concrete, stone, aerospace, engineering, process, and medical industries — continues to expand at a rapid pace.

The **8th American Water Jet Conference** will focus, from a practical and scientific viewpoint, on the most up-to-date industry advances in water jetting equipment, techniques, and applications. Some of the areas to be addressed include but are not limited to:

- **Contractor Applications and Processes**
- **Jet Mechanics**
- **Jet-Material Interaction**
- **Safety and Environmental Protection**
- **Process Modeling and Control Studies**
- **Excavation, Tunneling, and Mining Applications**
- **Drilling Applications**
- **Rock Cutting**
- **Cleaning and Coating Removal**
- **Construction and Non-Manufacturing Applications**
- **Manufacturing Processes**
- **Advanced Industrial Applications**
- **Components and Systems**
- **Novel Jets and Applications**
- **High Pressure Equipment and Systems**
- **Abrasives, Water, and the Environment**
- **Advances In High Pressure Technology**
- **Market and Future Needs**

Commercial and academic authors are encouraged to submit titles and abstracts for consideration. To submit an abstract(s), please complete the Abstract Submission form on the back of this sheet and forward to the attention of the Conference Coordinator at the Water Jet Technology Association. **The deadline date for submission of abstracts is November 1, 1994.**

An Abstract Review Committee consisting of six referees, chosen from the Organizing Committee and the International Advisors, will review the abstracts. Authors will be advised by **January 31, 1995**, regarding the decision of the Abstract Review Committee.

The 8th American Water Jet Conference is organized by the **Water Jet Technology Association** and is endorsed by the **International Society of Water Jet Technology**. The Water Jet Technology Association looks forward to providing this forum and to your involvement and participation.

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*August 27 is reserved for a Waterjet "Short Course" and Conference Reception.

Mail completed form and abstract, **NO LATER THAN NOVEMBER 1, 1994**, to: **Conference Coordinator, 8th American Water Jet Conference, Water Jet Technology Association, 818 Olive Street, Suite 918, St. Louis, MO 63101-1598, USA, telephone: (314)241-1445, fax: (314)241-1449.**

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9/16"	0.552 x 0.250 0.552 x 0.312 0.552 x 0.359	30,000 20,000 10,000
3/4"	0.740 x 0.437 0.740 x 0.515	20,000 10,000
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(2) O.D. tolerances $^{+.005}_{-.000}$
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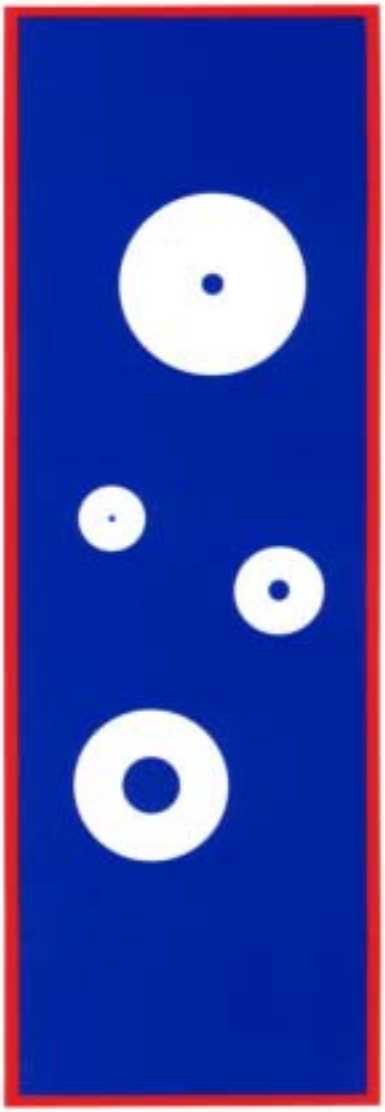

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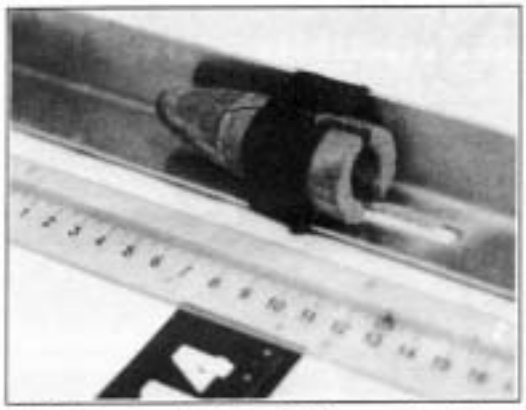
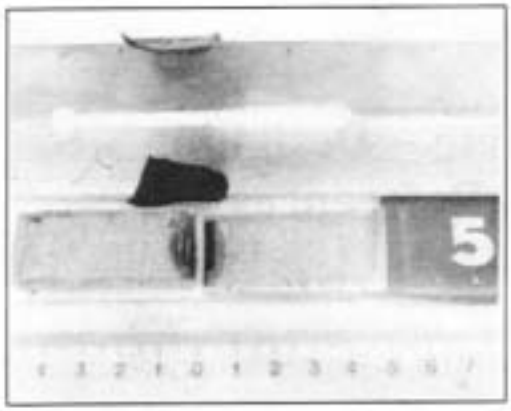
Water Jets Disarm Weapons,

from page 2. Photographs courtesy of ALBA Industrie and Umweltschutzservice GmbH, Lübeck, Germany



Detonator for fuse (Warsaw Pact)



Detonator (East German)

Russian tank grenade

Russian tank hand grenade

(continued on page 9)

Water Jet Robot Cleans Heat Exchangers In Nuclear Power Plants

By: George Savanick, Ph.D. and Paul Rozycki

Foster Miller Inc. in cooperation with Consolidated Edison, EPI, ESEERCO, Public Service Electric and Gas and Northern States Power, has developed CECIL, a teleoperated robot which accesses remote areas within steam generator in a nuclear power plant. CECIL provides visual inspection, removes sludge from the tube sheet with a 6000 psi water jet, retrieves foreign objects and collects sludge samples. CECIL is controlled remotely by an operator stationed in a low radiation area.

CECIL travels along a monorail installed in the blowdown lane of the steam generator. The water jetting system, TV camera, sampling tool, and retrieval are housed in a thin (less than 1/3 inch) flexible lance (Figures 1, 2). This lance travels down each intertube lane cleaning and inspecting the tube bundle. The individual stainless steel tubes are 3/4 inch in diameter. These tubes are arranged in rows separated by lanes 3/8 inch wide.

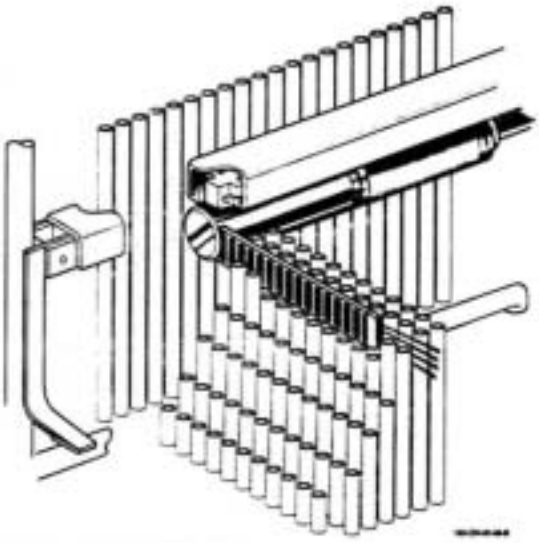


Fig. 1 Cecil 4 General Arrangement

Periodic cleaning of tube bundles is necessary because corrosion products form during operation and promote degradation of the tubes which could lead to leakage. If and when tubes break, forced outages are incurred which can take up to 14 days and cost $0.5 million per day to plug and repair. If enough tubes have been damaged and plugged, the steam generator must be replaced. Total cost for this can exceed $100 million.

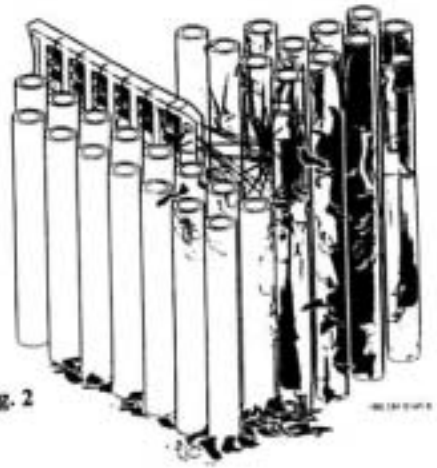


Fig. 2

Before the advent of CECIL it was difficult to address corrosion problems effectively. Conventional blowdowns with compressed air have not been effective in preventing accumulation.

(continued on page 11)

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36,000 psi Water-Jet System

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Model 36200 delivers 6 gpm at 36,000 psi
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- ☐ NLB Model 36200 Ultra high-pressure pump
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Accessories

- ☐ Ultra high-pressure discharge hose
- ☐ NLB NCG 36-250R air-powered rotating lance
- ☐ NLB FC 36-250 foot control valve
- ☐ Assorted nozzles and flex lances for tube and pipe cleaning

Mounting Package

Unit comes mounted on heavy-duty steel skid with sound attenuating enclosure. Easy-lift access doors provide ample access to pump and engine areas. Access panels at back of unit open to expose operating controls, gauges and valves. Discharge high-pressure hose connec-tions and compressed air hose connection conveniently located at back of unit.

Skid Mounting

- ☐ Size: 167.5" long x 66" wide *(4.25m long x 1.68m wide)*
- ☐ Weight: 10,300 lbs. approximate *(4672 kg)*

Trailer Mounting

- ☐ Tandem axle design
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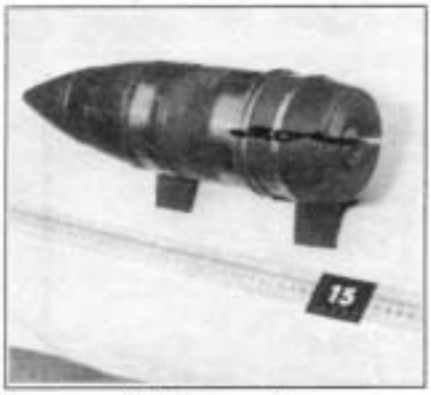
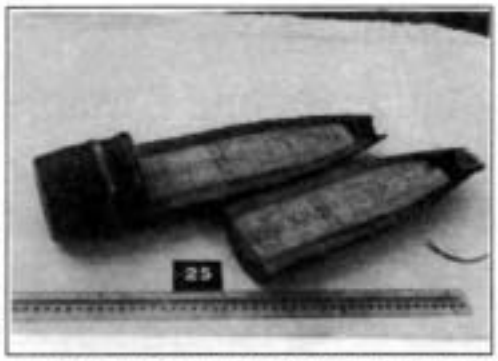
Water Jets Disarm Weapons,

from page 2. Photographs courtesy of ALBA Industrie and Umweltschutzservice GmbH, Lübeck, Germany

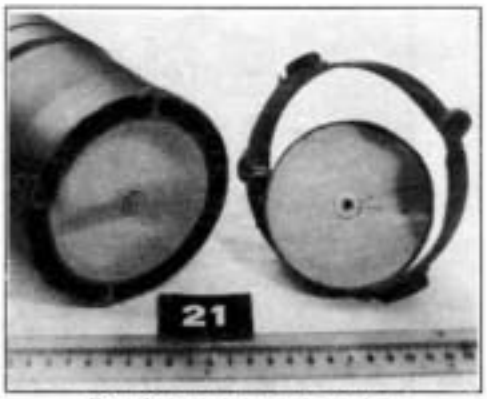


Tank grenade

Russian water bomb (mine) filled with 32 kilograms of TNT cut to open top for TNT washouts.



A Russian artillery shell with a detonator



Russian tank attack rocket

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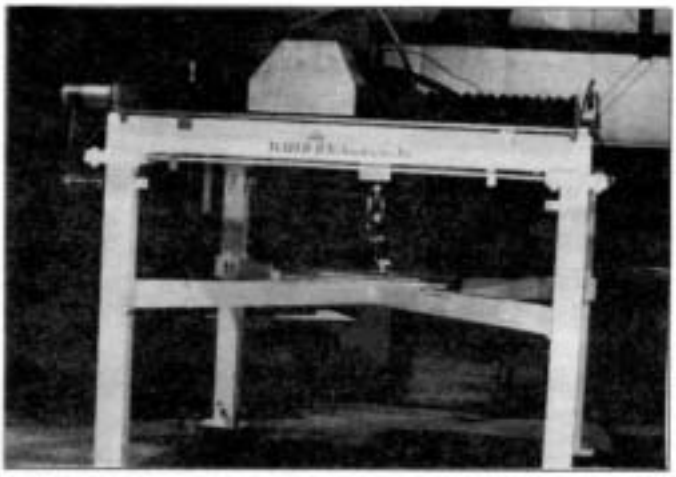

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Manufactured by Robotics, Inc., 1985. 300 hours total time since new. Excellent machine in mint condition.

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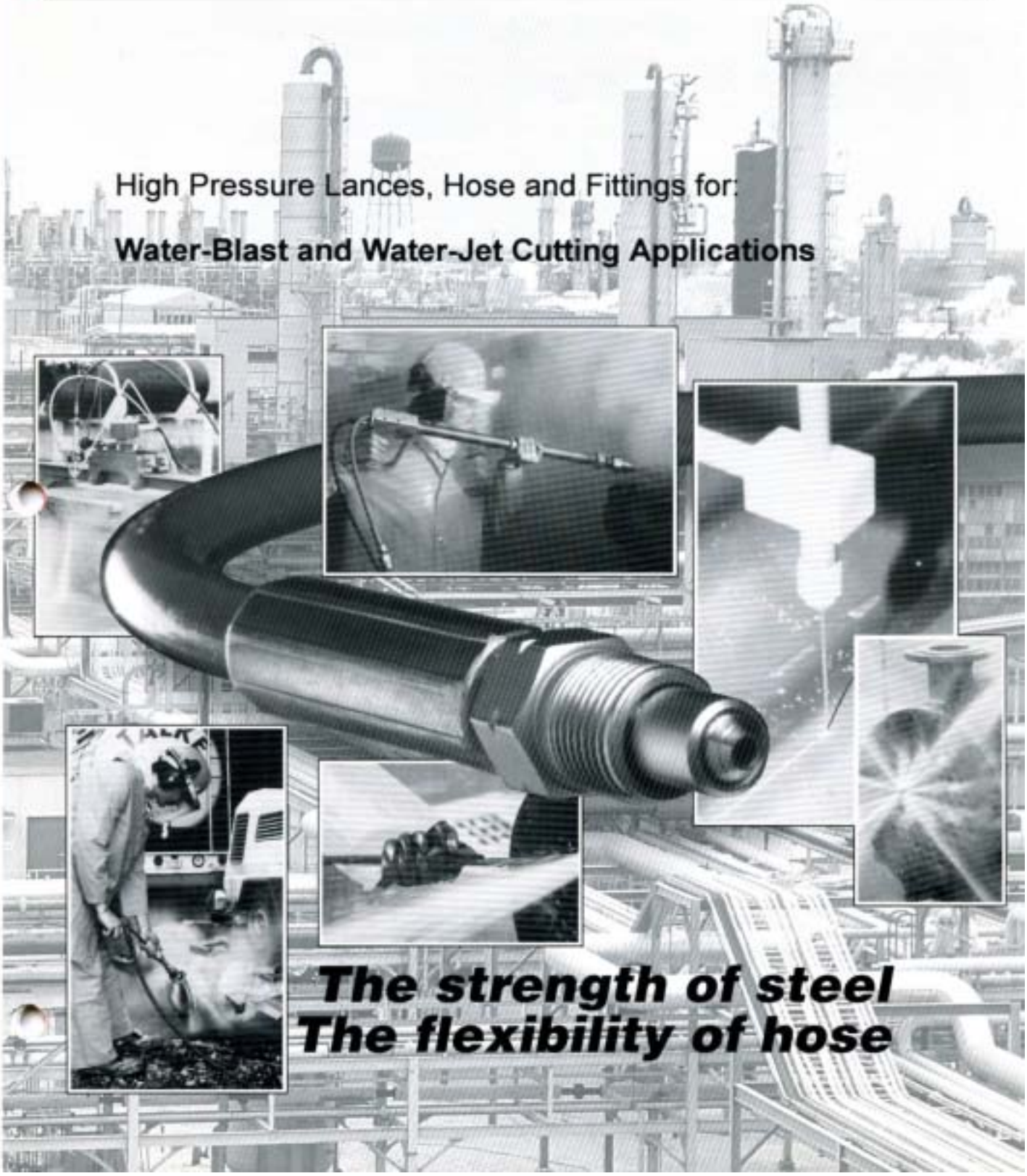

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1/2" I.D. with a 8,875 psi working pressure.

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Rogan and Shanley has answered the demand for a more durable and reliable hose in a corrosive environment by releasing a new line with stainless steel wire reinforcing. The hoses are constructed with all stainless steel wire, stainless steel end fittings, sea-water resistant polyurethane outer cover and a core material specially compounded for high chemical resistance. Applications include; water blasting, food processing, chemical injection and with a high external collapse pressure, the hoses are well suited for deep sea use. As with all ***Rogan and Shanley*** hoses, they are available in long continuous lengths.

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See Rogan and Shanley's catalog for detailed information.

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A "must have" for professionals with no time to lose.

New 500 hp Water Jetting Unit Introduced By Butterworth

Butterworth Jetting Systems, Inc. has announced the addition of a new 500 horsepower Liqua-Blaster unit to their line of high pressure water jetting equipment.

The new 1000 Series unit is designed to provide reliable, safe operation and is equipped with the field proven, low maintenance Partek Quintuplex pump (QF-450HB or QF-450S) and designed to provide water jet blasting power with pressures up to 20,000 psi.

The QF-450HB high pressure fluid end produces flow rates ranging from 43.2 gallons per minute at 20,000 psi to 54 gpm at 15,000 psi while the medium pressure fluid end, QF-450S, offers flow rates from 66 gpm at 12,500 psi to 153 gpm at 5,000 psi. Pump crankshafts are forged steel and the power end is equipped with a reduction gear assembly manufactured by Butterworth.

Other features include separate oil circulation, cooling and filtration systems for both power end and gear box as well as rupture disc and relief valve assemblies. The QF-450HB pump utilizes the patented Partek Inline fluid end design while the QF-450S is fitted with Butterworth's new Sectionalized fluid end. Standard with each pump model are suction stabilizers, 100 mesh y-stainers and 5-50 micron bag filter systems.

The 1000 Series Liqua-Blaster is ideal for high energy applications such as concrete demolition, tube bundle cleaning, vessel cleaning, runway cleaning, roadway stripe removal and multi gun operations.

For more information contact: **Dennis Williams, Butterworth Jetting Systems, Inc., 3721 Lapas Drive, P.O. Box 230312, Houston, Texas 77223-0312 or call (713)644-3636 or (800)231-3628, fax: (713)643-1514.**

Water Jet Robot Cleans Heat Exchangers In Nuclear Power Plants, from page 7

Conventional water jet lancing does not remove all the corrosive sludge that builds up on the tubesheet. This is because conventional lancing can apply water jets only from accessible regions of the steam generator secondary side at the perimeter of the tube bundle. The kinetic energy of the water jets dissipates with increasing distance from the nozzle. Deep within the tube bundle at a distance from the nozzle the sludge is not effectively removed. In addition, water jets directed from the periphery are blocked by the first row of tubes. This creates "shadow" zones of sludge left between the tubes.

CECIL, with its ability to access remote areas within a steam generator, advances the art of tube bundle cleaning. CECIL reduces time lost from shutting down generators for cleanup, reduces maintenance costs, lessens tube damage from corrosion, improves steam generator life, improves safety, and reduces personnel exposure to radiation. Consequently, real and potential savings for nuclear energy plants are well into the millions of dollars.

Figures 1 and 2 are courtesy of Foster Miller Inc., Waltham, MA