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JANUARY 1998

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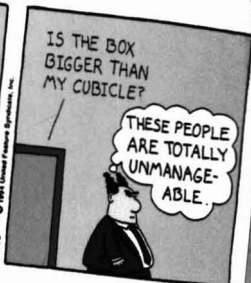
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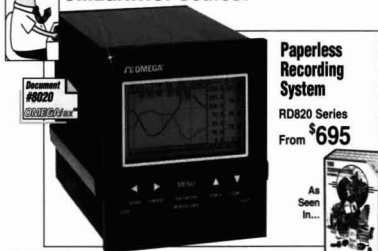
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1. Which of the following MISCELLANEOUS SERVICES AND PRODUCTS do you plan to purchase in the next 12 months? (select all that apply)

- 800 Air Pollution Controls
- 801 Air Quality Instrumentation
- 802 Analytical Laboratory Services
- 803 ASTs and USTs
- 804 Environmental Consulting
- 805 Environmental Insurance
- 806 Environmental Software
- 807 Fans, Blowers & Aerators
- 808 HazMaterials Transportation
- 809 Hazardous Waste Containers & Storage Structures

- 810 Industrial Hygiene Equipment
- 811 ISO 9000/14000 Certification
- 812 Package Wastewater Treatment Sys.
- 813 Personal Protective Clothing & Equipment
- 814 Process Controls
- 815 Pumps, Pipes & Valves
- 816 Remediation Services
- 817 Sludge Dryers & Disposal
- 818 Spill Cleanup Products
- 819 Test Kits
- 820 Training: EPA & OSHA
- 821 Wastewater Treatment Chemicals & Equipment
- 822 Water Quality Instrumentation

2. What is your projected budget for the product(s)/service(s)?

- 823 over \$200,000
- 824 \$100,001-\$200,000
- 825 \$50,001-\$100,000
- 826 \$10,001-\$50,000
- 827 \$5,000-\$10,000
- 828 under \$5,000

3. How immediate is your need for the selected products/services? (select one)

- 829 3-6 months
- 830 7-9 months
- 831 10-12 months
- 832 over 12 months

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- A Corporate responsibility for Pollution Control
- B Manage all Pollution Control Operations at this location
- C Supervise sub-group in Pollution Control Operations
- D Provide professional consulting service on Pollution Control
- E Provide staff environmental service on Pollution Control
- Z Other _____

(29) Petrol. & Coal (38) Instr./meas./analyze/controlling

- (30) Rubber/Plastic
- B Mining
- D Engineering & Contracting
- E Utilities, public, private & cooperative
- F Govt. including municipal or district sanitary water or wastewater treatment sys. or plants
- Type of Govt.:
- G City H County I State J Federal
- K Transportation
- O Training
- Z Misc. Services _____

- C Chemicals
- D Parts & equipment for maintenance operation & control
- E Services/Consulting
- F None of the above _____

E. What types of Pollution Control are you responsible for? (check all that apply)

- A Air B Water
- C Noise D Solid Waste Disposal
- E Industrial Hygiene
- F Toxic & Hazardous Material
- G Energy Control/Energy Conservation
- H None of the above _____

B. Type of Business (check only one):

- A Manufacturing. If manufacturing, please check the appropriate SIC (check only one):
- (20) Food (31) Leather
- (21) Tobacco (32) Stone/Clay/Glass
- (22) Textile (33) Primary Metal
- (23) Apparel (34) Fab. Metal
- (24) Lumber & Wood (35) Mach., except Elect.
- (25) Furniture (36) Elect & Electron
- (26) Paper Mach
- (27) Print/Publish (37) Trans. Equip.
- (28) Chemicals (39) Miscellaneous Mfg.

C. Number employed at this location:

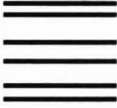
- A 1-19 B 20-49 C 50-99
- D 100-249 E 250-499 F 500-999
- G 1000-1499 H 1500-2499 I 2500 and up

D. In your job function do you recommend, specify or purchase? (check all that apply)

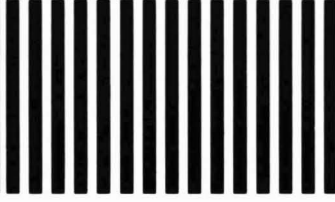
- A Pollution Control Equipment
- B Instrumentation

F. Which of the following publications do you receive personally addressed to you? (check all that apply)

- A Pollution Engineering
- B Environment Today
- C Environmental Solutions
- D Pollution Equipment News
- E The National Environmental Journal
- F Water Environment & Technology
- G None of the above _____



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About the cover:

The state of Louisiana and the U.S. Environmental Protection Agency have lauded Marathon Oil Company for its recent implementation of several programs that drastically cut its hazardous waste and air emissions. Turn to page 12 to find out how Marathon Oil Company and five other exemplary facilities are simultaneously saving money and the environment.

Photo courtesy of Marathon Oil Company.

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Hot-Dogging in Washington

"Laws are like sausages. They're OK as long as you don't see how they're made."

—Mark Twain

In a town like Washington, D.C., where pollsters and political action committees reign supreme, law makers often perform interesting political acrobatics.

For example, in November the new stricter air quality standards for ozone and particulate matter, which were promulgated last summer by the U.S. Environmental Protection Agency, withstood an attack by Sen. James Inhofe (R-Okla.). Through some adroit maneuvering, Inhofe was able to attach an amendment to the fast-track trade legislation (S1269) that would have reestablished the old less rigorous rules for ozone and particulate matter and prevented the EPA from setting any new standards for four years. The Republican senator introduced the amendment late in the day when only a few senators were present in the chamber and obtained unanimous agreement to attach it to the trade bill.

Democrats and environmental groups claimed they'd been blindsided by Inhofe's stratagem and asserted he'd violated Senate protocol. Inhofe defended himself by pointing out he had publicly stated that his vote in favor of the trade bill was contingent on the inclusion of the amendment.

In response to wide-spread criticism, Sen. Trent Lott (R-Miss.), Senate majority leader, consented to remove the amendment from the fast-track bill. At this point the air quality standards are looking at an uncertain future in the House when Congress' second session begins this month.

Such attempts to introduce legislation with minimal debate only reinforce the American public's increasingly cynical attitude toward elected officials and the legislative process. When there's a perception that our nation's laws aren't being adopted in an open fashion with adequate provisions for discussion, our democratic society is not well served.

But, in welcome contrast, the latest major Superfund reform bill introduced in the House in November by Rep. Michael Oxley (R-Ohio) stands out as an example of politicians trying to cooperate with one another and rise above partisan grandstanding. The Superfund Reform Act (HR 3000) has gathered sizable bipartisan support—including 18 Democrats and 18 Republicans who are co-sponsors of the bill.

To be sure, Oxley's bill contains certain controversial provisions like one that specifies that generators and transporters of waste would only be liable if their wastes "contributed significantly" to cleanup costs. Some critics interpret this provision as forcing the federal government to go back and relitigate the cases of numerous companies to determine whether their waste contribution was "significant."

Despite such complaints, Oxley remains optimistic. According to Oxley, the effort to promote Superfund reform "shows that Republicans and Democrats can agree to move forward on common goals ... I hope this bill signals a new spirit of bipartisan cooperation on the contentious Superfund issue."

After the recent periods of gridlock in Washington, we Americans want to see our elected officials working creatively together to pass new laws that are good for both the environment and the U.S. economy.

Angela Neville

Angela Neville, JD, REM
Editor, *Environmental Protection*

Environmental PROTECTION

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White House Working to Reduce Global Warming

KYOTO, Japan—President Clinton stands behind an international agreement reached in Japan to reduce emissions of carbon dioxide and five other gases that are believed to be responsible for an increase in global warming. Under the agreement, the United States during the next 15 years would bring its emissions 7 percent below their 1990 level.

It's still not clear what role emerging industrial giants, such as China and India, will play to reduce their emissions.

"We still have to press for meaningful participation by key developing nations," Vice President Al Gore said, "This is a global problem that will require a global solution."

Used Motor Oil Recycled Globally

WASHINGTON, D.C.—The American Petroleum Institute studied 11 countries to find out what is being done to recycle used motor oil. The research found a range of programs, and the potential for increased recycling in many of the countries.

Japan, Mexico, the Philippines, Thailand and the Republic of Trinidad and Tobago are learning more about the issue and designing programs to address it. Brazil has a mandated program that varies significantly at the local level. France and Germany have centralized programs. Sweden uses a decentralized approach. In South Africa, manufacturers of motor oil subsidize the collection and recycling program.

Although each country's approaches may be different, almost all rely on the collection of used motor oil at service and repair shops. Another similarity the study reveals is the high potential for increased motor oil recycling in many of the countries if the factors that currently inhibit recycling can be overcome.

Biodiesel Made from Beef Tallow Is Fuel for Buses

KANSAS CITY, Mo.—Eight Kansas City buses are the first to be part of a test using biodiesel made from beef tallow. The test includes four buses fueled with B20, a blend of 20 percent biodiesel and 80 percent diesel fuel, and four buses fueled with 100 percent diesel fuel.

The study is trying to find out if the use of biodiesel can help improve air quality and promote economic development.

Director of the National Biodiesel Foundation, Deborah Boldt, said that the use of fossil fuels needs to be reduced in order to help lower air pollutants.

"Biodiesel is helping to reduce pollutants such as carbon dioxide, hydrocarbons and particulate matter," Boldt said. "Biodiesel through tests like this one, is helping to improve air quality in the city and around the world. An exciting aspect is that this Kansas City test model can be replicated in other cities."

According to University of Missouri-Columbia professor Dr. Donald Van Dyne, more than 6,000 jobs could be generated if a biodiesel plant that produced 100 million gallons of biodiesel annually was opened in the Kansas City area. Van Dyne says the increase in employment would not only be in jobs directly related to biodiesel, but in all sectors of the market.

The drivers of the biodiesel buses say they do not operate any differently than diesel-fueled buses.

Fish Farming Isn't Environmentally Sound

NEW YORK—The Environmental Defense Fund released a report called "Murky Waters: The Environmental Effects of Aquaculture in the United States." It includes details on environmental degradation caused by the U.S. fish farming industry and strategies and technologies available to make fish farming safer for the environment.

About 25 percent of all the fish consumed by humans worldwide is now farmed. The report states that most large U.S. fish farms are aquatic feedlots. They can produce large quantities of waste directly released to natural bodies of water. These wastes have the potential to contribute to current problems from nutrient pollution.

Lead author of the report, Dr. Rebecca Goldberg, said, "Aquaculture need not harm the environment, however, and some forms of fish farming are inherently less polluting than others."

Goldberg also points out that there are a number of technologies and practices being used by some fish farmers that reduce or eliminate environmental problems caused by aquaculture.

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SAFETY-KLEEN now provides 24-hour environmental, health and safety information services and data transmission through the majority acquisition of 3E Company.

RETEC, a subsidiary of Thermo Remediation Inc., announced the acquisition of RPM Systems Inc. RPM develops environmental management systems and environmental management information systems for multinational corporations.

VERATECH Attachments appointed L.B. Smith Inc., Newman Equipment Inc. and Rexco Equipment Inc. to represent their line of demolition and recycling attachments.

Rust Environment & Infrastructure placed a new leachate pretreatment facility in operation at the Iris Glen Environmental Center in Johnson City, Ten.

Russell-Stanley expands its operations and geographical market coverage

into Canada. The company merged with Hunter Drums Limited, a Canadian manufacturer of industrial containers.

Celsis International entered a five-year global distribution agreement with Becton Dickinson and Company for systemSURE, a portable rapid hygiene monitoring system.

Hardy Instruments will provide on-board computer systems and automatic container identification using radio frequency identification for the Garland County, Ark.'s waste collection operations.

The Texas Pollution Prevention Partnership was selected second place in the National Pollution Prevention Roundtable's First Annual Most Valuable Pollution Prevention Awards.

Berryman & Henigar won an Award of Merit from the Florida Chapter of the American Planning Association. The honors come from the company's work on the Old Bellamy Road Historic Designation and Restoration Project.

ECS Underwriting is providing the comprehensive environmental insurance program purchased by Lowry Redevelopment Authority in Denver, Colo. The insurance program is guaranteed to expedite cleanup activities of 1,866-acres, formerly Lowry Air Force Base.

Degussa AG's automotive catalyst operations in Europe attained QS-9000 certification.

Robert D. Goldman was named the new president of Lexicon Environmental Associates Inc.

Excel Partnership Inc. announced the acquisition of Technicomp. Together, they now offer over 100 distinct products and services.

Watson-Marlow Inc. appointed John A. Beahm to the position of marketing communications manager.

Mark Aiken was named district sales manager for **OPW Fueling Components**. His territory includes Colo., Utah, Wyo., N.M. and El Paso, Texas.



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FACILITIES OF THE YEAR

*Our award winners prove that
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Compiled by Angela Neville, JD, REM

Environmental Protection proudly pays tribute to an elite group of facilities recognized for their environmental leadership. Diverse in many ways, our winners include six different types of facilities located across the United States that each deal with unique pollution control problems. But, they all share one thing in common—innovative approaches to tackling environmental challenges. By imaginatively handling air pollution, wastewater and hazardous waste, these facilities demonstrate that eco-friendly business practices can promote impressive cost savings.

Marathon Oil Co.

In the spring of 1997, Marathon Oil Company's Louisiana Refining Division received the Louisiana Governor's Award for Pollution Prevention and in 1995, the U.S. Environmental Protection Agency's Region 6 Environmental Excellence Award for Waste Minimization. These awards were based on several projects.

ASO Neutralization Project—The acid soluble oil (ASO) neutralization project involves the installation of processing equipment required to neutralize ASO, which is an ignitable hazardous waste stream generated by the refinery's Hydrofluoric Acid Alkylation Unit. The new system neutralizes the ASO into a useful refinery product and a non-hazardous waste stream (calcium fluoride sludge). Prior to installing this system, the ASO was burned in the Alkylation Unit's reboiler.

Hydrogen fluoride air emissions were reduced by 47 tons per year. The neutralizer also eliminated the generation of 3,927 tons per year of hazardous waste, which represented 65 percent of the refinery's total annual waste.

"This new equipment allows a hazardous waste stream to be converted into a useful product benefiting both the community and Marathon," Larry M. Echelberger, division manager of Marathon, said. "Personnel are aware of the potential environmental impact of their activities and strive to reduce or eliminate waste and emissions wherever possible."

Early Reduction Project—The Louisiana Refining Division (LRD) was the only refinery and one of only four industrial facilities in the United States to participate in the EPA's Early Reductions Program under the Clean Air Act regulations. Under the program, the LRD committed to enforceable reductions in toxic emissions. The LDR reduced air toxics by 131,000 pounds per year (40 percent) compared to those emitted in 1991, the baseline year. By achieving these reductions prior to 1994, the LRD is approximately four years ahead of the Clean Air Act mandated maximum achievable control technology (MACT) compliance schedule for petroleum refineries.

Thermal Desorption Unit Project—Since 1992, the refinery has operated a thermal desorption unit that is used to dry hazardous oily wastewater sludges while recovering clean oil. This unit was

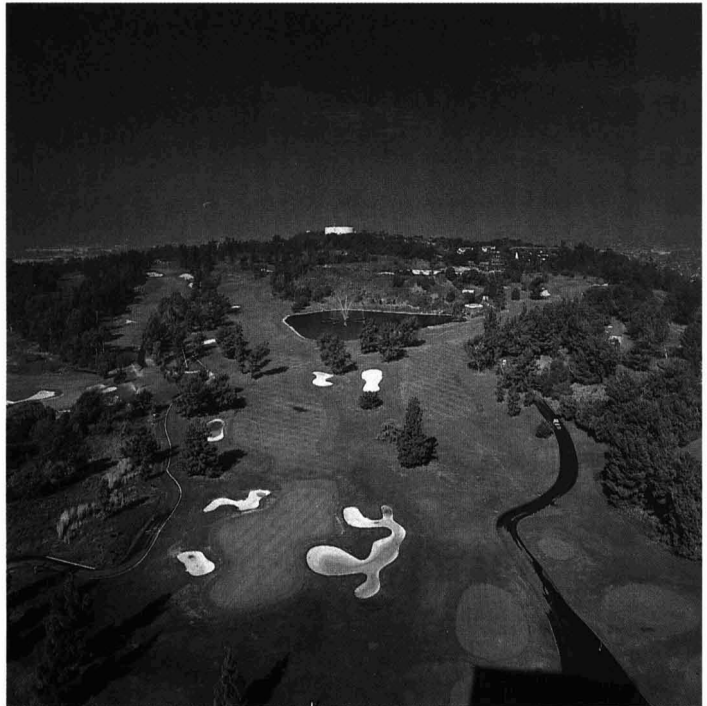
the first of its kind to be approved for operation under operating conditions specified by the Louisiana Department of Environmental Quality (LDEQ).

Previously, wastewater sludges were dewatered through a plate and frame filter press that required the addition of large amounts of lime, thereby increasing the net amount of dewatered sludge. The dewatered sludge was then shipped off-site for incineration. With the addition of the thermal desorption unit, the lime addition was eliminated and the dried stream meets universal treatment standards for on-site treatment using the

result, landfill space and resources are conserved.

Industry Hills Recreation and Conference Center

In today's tough economic and regulatory environment, successful end uses of landfills are hard to find. The Industry Hills Recreation and Conference Center is one such example of how an end use development with a landfill gas management system can be accomplished. Evidence of the development's success is the project's receiving the prestigious "Outstanding Civil Engineering Achieve-



Industry Hills Recreation and Conference Center

refinery's permitted land treatment unit. In 1997, the waste stream was delisted by the LDEQ and this delisting now allows for the off-site disposal of the dried waste into a nonhazardous landfill.

With the approval of the delisting petition, the refinery's annual hazardous waste generation has been reduced by over 90 percent from 1991 figures. Additionally, the dryer has recovered over 175,000 barrels of clean oil that was previously incinerated as a hazardous waste or placed directly on the land.

Waste Recycling—Over 1,200 tons of wastes have been recycled or reused. As a

ment Award" by the American Society of Civil Engineers in 1981 and the 1997 Gold Landfill Gas-to-Energy Award by the Solid Waste Association of North America.

The Industry Hills Recreation and Conference Center Landfill Gas Management System is situated within two of Southern California's most prestigious golf courses. The development also contains a conference center, Olympic-size swimming pool, tennis complex, equestrian center, laundry facility and an 11-story hotel. The 617 acre site, of which approximately 155 acres were

Facilities of the Year

used for a sanitary landfill between 1951 and 1969, is located approximately 10 miles east of Los Angeles. About 3.6 million tons of municipal wastes were disposed of in the landfill, with an average fill depth of about 35 feet.

The landfill gas management facilities consist of two main systems designed by SCS Engineers, beginning in 1974. The first prevents the accumulation of methane gas beneath on-site structures and migration beyond property lines. Migrating landfill gas is collected and then destroyed at a blower/

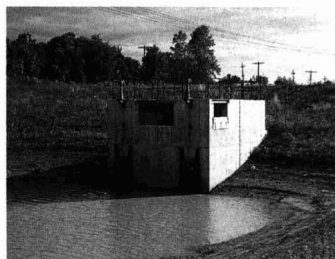
flare station capable of burning 500 standard cubic feet per minute.

The second system is designed for landfill gas recovery. While the system aids in landfill gas migration and surface emissions control, it supplies medium Btu fuel for convention center boilers, water heaters at the Olympic-sized pool and a laundry complex. The process facility compresses and cools the landfill gas to remove free liquids and is capable of supplying approximately 2,103 mmBtu per month of fuel. This saves the city of Industry approximately

\$10,000 to \$15,000 a month by displacing natural gas.

Operation and maintenance of the system is regulated by strict guidelines from a number of different state and local enforcement agencies. In addition to these strict guidelines, the design engineers have developed numerous operational criteria that present unique challenges to the facility's operators. Some of the major challenges are health and safety; coordination with numerous on-site personnel like security guards and ground maintenance crews; odor control; and maintenance repair and access.

Allen's Creek Stormwater Drainage Improvement Facility



Allen's Creek Stormwater Drainage Improvement Facility

Allen's Creek Stormwater Drainage Improvement Facility, located in Pittsford, N.Y., received the 1997 Project of the Year Award from the New York Chapter of the American Public Works Association. It has 160 acre-feet with 40-acre-feet retention capacity. The 20-foot-high earthen dam features a 20-foot-by-20-foot concrete control structure with internal and external weirs, and 290-cubic-feet-per-second design discharge. The total project cost was \$980,000.

The storm water management facility was put into operation in 1995. The final wetland grading and planting was accomplished in 1996.

The project site was within a flood plain and required disturbance of the stream bed. Close coordination with the N.Y. State Department of Environmental Conservation, the U.S. Army Corps of Engineers, Monroe County Agencies and Oak Hill and Irondequoit Country Clubs was required to obtain the necessary approvals and permits to proceed with the project. A complete wetlands delineation and ecology study was conducted as part of the environmental impact statement for the project. One of the goals of the

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project was to reestablish some of the wetland plant life that was existing at the site as well as some of the native species in the wetland buffer zones.

The project netted several benefits. The decrease in flood frequency caused a decrease in environmental and economic damage due to flooding. Pollutant loadings from a 10.5-square-mile watershed were reduced, which helped to improve downstream water quality to Irondequoit Bay. Wetland areas and circulation through the pond have also improved water quality. The pond retains a wetland area and creates deep water habitats. These areas are beneficial to native and migratory wildlife by providing a useful habitat.

Marine Corps Air Station, Cherry Point, and Naval Aviation Depot



Marine Corps Air Station, Cherry Point, and Naval Aviation Depot

The Marine Corps Air Station (MCAS), Cherry Point, N.C., and its largest tenant command, the Naval Aviation Depot (NAVAVNDEPOT), have received numerous awards for their commitment to the environment. Most recently, MCAS and NAVANDEPOT received the 1997 Renew America's Award for Environmental Sustainability and the 1996-1997 North Carolina Governor's Award for Excellence in Waste Reduction.

Both command posts are characterized as the largest Marine Corps Air Station in the world and the largest single-sited industry in eastern North Carolina.

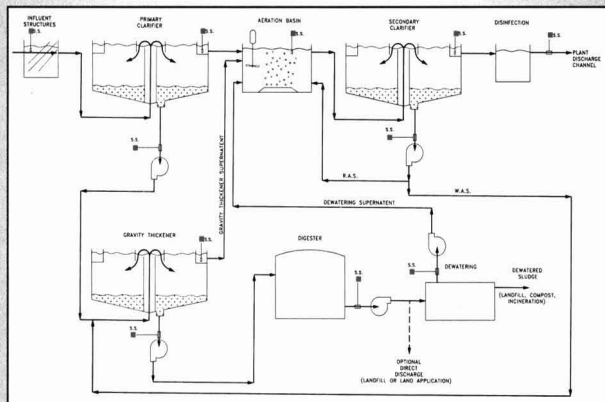
L.D. Cooke, the director of the MCAS Environmental Affairs Department, compares the combined posts to a small city

with a lot of industry and a very busy international airport with 60,000 operations per year. The command posts are populated by 10,000 Marines and sailors, their 13,500 dependents, and more than 6,500 civilian employees for a total population of approximately 30,000.

MCAS and the NAVAVNDEPOT created a multi-faceted, aggressive and innovative pollution prevention management

program. Pollution prevention has been made a priority and by initiating programs like hazardous waste management, qualified recycling, Naval Industrial Fund Recycling, household recycling and wood waste recycling. Environmental stewardship and awareness, and pollution prevention are taught and practiced, whether it is curbside recycling in base housing, fuel spill prevention practices

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Facilities of the Year

on the flight line, emission scrubber maintenance on the coal-fed steam plant, or eliminating ozone depleting substances in the facilities' industrial practices.

In order to reduce the costs of solvent disposal, solvent recycling was implemented as the used solvent elimination (USE) program. A contract was awarded to recycle spent solvent and refill parts cleaning machines with clean solvents. A total of 57,974 gallons of solvent have been recycled, generating a savings of \$347,844 in cost avoidance during the fiscal years 1995 through 1996. In 1993, about 62 percent reduction in hazardous waste was achieved over the base year of 1985.

After an exhaustive study, a non-hazardous solvent that would satisfy the aircraft maintenance requirements was adopted for use. In 1995, MCAS began using a non-hazardous cleaning solvent in all parts washers aboard the air station, thereby reducing hazardous waste generations by over 236,000 pounds per year. By using a non-hazardous solvent, MCAS will save \$120,000 over the life of the 3-year contract. Hazardous waste generation was reduced in one year by almost 40 percent.

City of Chandler Industrial Process Water Treatment Facility



City of Chandler Industrial Process Water Treatment Facility

Building the industrial process water treatment facility (IPWTF) was the only way the groundwater-dependent desert city of Chandler would have ample water supply to serve a new plant—one of the world's largest microchip manufacturing facilities. In this instance, necessity truly proved to be the mother of invention. Due to the unique design of the facility, Black & Veatch, an international engineering firm, won the 1997 American Academy of Environmental Engineers Superior Achievement Award.

The City of Chandler built the 2.3 million gallon per day (mgd) IPWTF to treat wastewater from the plant's two wastestreams and then inject it into the groundwater supply, recharging up to 90 percent of the plant's initial usage. The IPWTF is one of the first facilities in the United States to use reverse osmosis (RO), a water treatment process that adds pressure to force water through a semi-permeable membrane, to reclaim the industrial process water and treat it to potable standards.

Disposal of reject water from the treatment facility's RO processing presented challenges. Because Arizona is not coastal, discharge to sea water was not an option. The solution—reject

(Continued on page 42.)



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WASTEWATER TREATMENT: ON- OR OFF-SITE?

Organically modified clay provides an economical solution to treating wastewater on-site.

By George R. Alther

Oily wastewater, such as storm-water runoff, industrial process water and produced water from oil drilling is often stored on-site in large tanks and hauled to processing centers, where it is cleaned and discharged.

Several states have enacted limits of 10 parts per million (ppm) maximum for discharge of free oil and grease into surface waters. Discharge limits are also governed by National Pollutant Discharge Elimination System (NPDES) regulations. This has increased the volume of water that must be treated before discharge, resulting in rising costs for the generator, even though there are many such facilities nationwide. Hazardous wastewater, as defined under the Clean Water Act and the Resource Conservation and Recovery Act, is more difficult and even more expensive to dispose.

The standard approach to date has been to haul contaminated water in 5,000-gallon tank trucks to processing facilities. As long as the wastewater contains no hazardous constituents, there is no shortage of such processing plants in most areas of the country. Facilities that accept hazardous wastewater are rare.

Costs for hauling wastewater are around \$85 an hour. If the water is considered hazardous costs increase sharply. In California transportation costs are reported to be 16 cents a gallon.

Treatment and disposal costs of non-hazardous oily wastewater range from 10 cents to 45 cents a gallon, depending on the oil content. If metals need to be removed, it increases up to 65 cents a gallon. If the water contains hazardous

components, it can cost as much as \$1.00 a gallon. Liability due to potential accidental spills also becomes a factor when transporting such water.

One economical method for on-site treatment of wastewater has become popular. A combination of granular organically modified clay (organoclay) and activated carbon filters, is often much more economical than hauling the wastewater by tank truck. Activated carbon alone removes only 5 percent to 10 percent of oil based on its dry weight,

By using organoclay and activated carbon in combination, operations costs are lowered by 50 percent or more.

but 20 percent or more of volatile organic compounds (VOCs) such as benzene. Organoclay has a capacity for oil of 50 percent to 60 percent of its weight, seven times more than activated carbon, but much lower for VOCs. By using organoclay and activated carbon in combination, usually one tank organoclay and two tanks carbon, operations costs are lowered by 50 percent or more. Organoclays are in general very efficient at removing low solubility chlorinated hydrophobic organic compounds.

Calculations show that this method

becomes economical for wastewater volumes as low as 30,000 gallons, depending on their complexity. The equipment may include an oil/water separator, bag filters, carbon absorbers that hold both organoclay and carbon, and possibly ion exchange systems for metals. This equipment may be mobile and trailer-mounted, or it may be stationary. In either case, it is moved from site to site.

The equipment operator must know how to break an emulsion. The contractor brings the equipment on-site, and a crew works 24 hours per day, seven days a week, until the job is finished. Costs range from 3 cents to 6 cents a gallon, which translates into a 10-fold cost decrease compared to conventional hauling.

For example, someone stores 30,000 gallons of wastewater containing 20 parts per million (ppm) of oil and 5 ppm of benzene. Hauling costs are \$85 an hour, driving time is 10 hours because of the distance to the nearest disposal facility that will accept hazardous wastewater. It takes six trucks to dispose of the water (See Table 1).

In the above scenario, two 55-gallon drum filters containing 250 pounds of organoclay and 160 pounds of activated carbon set up on a pickup truck, where used. The amount of oil in the water is 5 pounds, requiring only 9 pounds of organoclay. One hundred and sixty pounds of carbon suffices to remove 1.3 pounds of benzene. Disposal costs for the 500 pounds spent media, which is hazardous, are approximately \$500. Thermal desorption, if available, is only \$40 a ton, plus freight.

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Wastewater Treatment: On- or Off-Site?

What is Organoclay?

Organoclays are composed of bentonite clay that is modified with quaternary amines. The nitrogen end of the amine is ion exchanged for sodium and calcium ions onto the surface of the bentonite platelets. After some 30 percent of the clay's surface is coated with the amines, the bentonite becomes hydrophobic and organophilic.

In water the amines become activated, standing perpendicular to the clay surface. When oil droplets or hydrophobic chlorinated hydrocarbons approach the clay platelets, they dissolve into the amine or vice versa, a reaction called partition. They are now fixated to the clay surface by Coulombic forces.

Activated carbon and membranes are porous. The pores become blinded by molecules of equal or larger size, disturbing their intended function. Ion exchange resins are quickly exhausted and oxidized by oil, resulting in lower removal capacity and frequent costly regeneration.

The organoclay is blended with anthracite to prevent early plugging of the interstitial pores by oil.

Applications Of Organoclays

Environmental applications include groundwater cleanup at old disposal sites and underground storage tank sites, where the water is contaminated with fuels.

Industrial applications include air compressor condensate, cooling water, vibrotory deburring and metal finishing, gas compressors, boiler blowdown, boiler feed water, metal casting, general manufacturing process water and stormwater.

Most applications have been in groundwater remediation at Superfund sites, underground storage tank sites, landfill leachate cleanup, and dewatering of contaminated sites during construction.

Oil companies flood fuel pipelines with water to hydrostatically pressure test the connections. The flood water is often hauled away to a treatment center to remove fuel contaminants.

**Table 1:
Cost Analysis of a Typical Situation**

Hauling

Transportation Costs:	
\$85/hr, 10 hours, 6 trucks	\$5,100
Treatment Costs:	
\$0.65/gallon, 30,000 gallons . . .	\$19,500
Total Costs	\$24,600

On-site

Treatment Costs:	
With organoclay/activated carbon \$0.15/gal (because of hazardous components)	\$4,500

Cost differential, on-site vs. hauling:
On-site is five times less than hauling.

Organoclays also lower the chemical oxygen demand (COD) and biochemical oxygen demand (BOD). COD encompasses all oxidizable organic and inorganic compounds, including oil and grease.

Suppose a facility has a discharge limit for COD of 50 ppm and 100 ppm for oil. Its COD content is 60 ppm and its oil is 15 ppm. The operator, thinking that his oil and grease content meets discharge standards, searches for another way to reduce the COD. He does not realize that removing the oil would make him be in compliance. The organoclay lowers the BOD, but the efficiency is not predictable. Since bentonites are natural ion exchange resins, they also remove small amounts of heavy metals. The amine chains adsorb hexavalent chrome and arsenite. However, the efficiency is again unpredictable due to competition by organic contaminants. A more effective method to remove heavy metals is by coprecipitation with iron at a pH of 7.8.

Disposal

Disposal of spent, nonhazardous organoclay is either through landfilling, fuel blending, asphalt plants or stabilization. As long as the clay passes the liquid paint filtration test, it can be disposed of in the

**Table 2:
Wastewater Analysis Before and After Treatment**

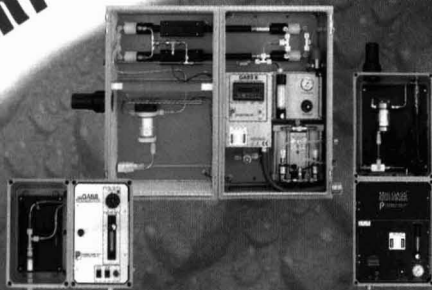
Chemical	Influent Concentr. Microgram/L	Effluent Concentr. Microgram/L
Benzene	19,430 or less	9.88
Toluene	8,835 or less	3.93
Ethyl Benzene	1,560 or less	ND
Total Xylene	7,130 or less	9.23



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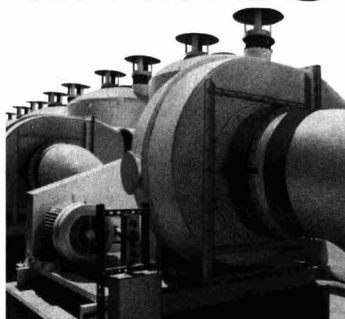
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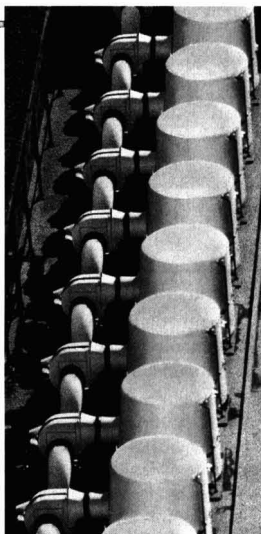


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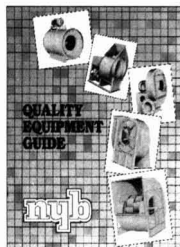
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Wastewater Treatment: On- or Off-Site?

dumpster in the back yard of the facility, whose contents are landfilled in municipal nonhazardous landfills. It is wise to check with local, state and federal regulations before choosing the disposal method. Spent organoclay can be handled in the same manner as floor absorbent clay in automobile repair facilities and machine shops.

Case History

Creamer Environmental Inc., Hackensack, N.J., was contracted to treat 3 million gallons of wastewater that was stored in a gas holder at a former manufactured gas plant. Such systems consist of huge steel tanks erected on concrete slabs. This tank contained gas and contaminated water that sat on top of 1.5 feet of coal tar. The water was part of the original seal that contained the gas in the telescoping tank. The purpose of removing the water was to facilitate the removal of the tar. An oily sheen was found floating on the water and adhering to the tank walls. The water was contaminated with polycyclic aromatic hydrocarbons, oil, benzene, toluene, ethylbenzene and xylene (BTEX) and heavy metals. Only benzene and xylene needed to be removed to pass local discharge limits, which are 134 parts per billion and 74 (ppb), respectively.

The treatment system that was installed included an oil/water separator, bag filters to remove suspended solids and two granular activated carbon (GAC) vessels that could hold 6,000 pounds of GAC each. It is important to note that the activated carbon alone was not able to clean up the water sufficiently to meet discharge limits, in addition to being spent within three days.

When the first vessel was filled with 9,000 pounds of organoclay, discharge limits were met and the organoclay lasted several weeks. One organoclay changeout and two subsequent carbon replacements were required to clean up the 3 million gallons of water (See Table 2).

After the water was removed, diesel fuel was sprayed onto the walls of the tank to loosen the oil. The tar was pumped into a fractionator. The tank bottom and walls were pressure washed with hot water that included a detergent. This wash water was also passed through the organoclay/carbon treatment system and discharged, with satisfactory results.

Organoclay/carbon systems are also used to clean up bilge waters in ports and railroad tank car and tank truck wash water. Such facilities easily spend

\$5,000 a month or more on water and discharge to the sewer, often resulting in a payback of one year or less.

In this case the organoclay removes the oil, the carbon removes the detergents and reverse osmosis removes salts.

The contractor must obtain a complete chemical analysis of the wastewater, even if other contaminants are below discharge limits. Otherwise, he will size the treatment system too small to be economical, resulting in frequent changeouts. The accessibility of the water tank and the terrain must be considered, as

well as seasonal weather changes.

Organoclay technology is the missing link between oil/water separators and activated carbon, making on-site treatment of stored wastewater economical. If industrial wastewater can be economically recycled by using organoclay technology, the ultimate goal of zero discharge has been realized.

George Alther is the president and founder of Biomin Inc. in Ferndale, Mich.

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ON THE ROAD TO 1998

*Environmental executives predict what
we will find on our journey.*

Compiled by Marion Petty

Each January, *Environmental Protection* magazine asks leading environmental professionals to predict what trends they see for the coming year. The participating executives come from diverse backgrounds and this year tackle such subjects as regulatory trends, the job market, pollution prevention (P2) trends and business opportunities overseas for U.S. firms. Take a look at what they have to say.

**Ann Foster, Product Applications
Regulatory Affairs Manager, Hach
Co., Loveland, Colo.**



Concern about outbreaks of *Cryptosporidium*, a microbial pathogen, in the public water supply is driving review and revision of turbidity regulations as prescribed in the Microbial and Disinfection

By-Product rule. There are no definitive data linking low turbidity water with a reduced risk of exposure to *Cryptosporidium*. Yet, the U.S. drinking water customer, expecting the best tap water in the world, demands action to reduce contamination. Regulatory agencies are responding by considering a lower maximum turbidity level and more frequent monitoring in drinking water treatment plants.

This regulatory action will influence the design of turbidimeters by requiring ease of calibration and reliable performance for low-level measurement. Turbidimeter manufacturers will need to train customers in the proper use of their equipment to achieve accurate low-level measurement. The likelihood of more frequent measurement, made at each filter, will increase the market demand for turbidimeters. These developments—lower measurement levels, more frequent measurements, expanded customer training—all will have a marked effect on the turbidimeter market during the next three to four years.

**John W. Brookes, Senior Vice
President, Business Development,
SGS International Certification
Services Inc., Rutherford, NJ**

The year 1998 will undoubtedly see further growth in the demand for ISO 14001 consulting, registration and training services. Despite the present lack of short-term financial justification



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for many companies to invest in their environmental management systems, SGS ICS is experiencing a rapidly growing demand from a broad spectrum of organizations. Pressures for regulatory recognition, preferred financial arrangements and stock value assessment are adding to the existing drivers of customer demand and improved corporate image.

We at SGS ICS see that American in-

dustry is lagging behind the rest of the world in its adoption of the ISO 14001 standard. Businesses in Eastern Europe, Mexico and many Asian countries have registered for ISO 14001 certification in part to fend off a perceived threat of its use as a non-tariff trade barrier by Western industry. It is now the domestic demand in those countries driving the ISO 14001 market through the cus-

tom-supplier chain and, ironically, the first serious ISO 14001 impact in the United States will be (as it was for ISO 9000 before it) the inability of U.S. businesses to tender for overseas contracts without accredited registration for ISO 14001. Domestic pressure will also mount through 1998 as more major U.S.-based purchasing organizations become registered and drive their suppliers to provide similar assurance of sound environmental management practices.

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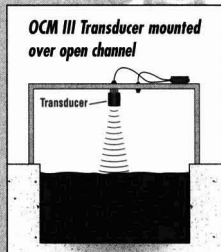
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Tom Hobson, Managing Director and Co-Owner, Abanaki Corp., Oil Skimmer Div., Chagrin Falls, Ohio



Some analysts have been predicting that 1998 will be a down year for environmental product manufacturers in the United States. Whether or not this is true, I believe

there are plenty of opportunities awaiting American environmental companies in Europe, Asia, Australia, Latin America and even Africa. A 1992 report by the World Resources Institute described the industrial regions of Central Europe as "so choked by pollution that the health of children is impaired and the lives of adults shortened" (adapted from Industry, Technology and the Environment: Competitive Challenges and Business Opportunities, OTA-ITE-586).

Certainly having strong products and market presence in the United States does not guarantee success in overseas markets. With proper planning and technique, a successful environmental products company in the United States can find success in foreign markets.

Conducting business overseas means having two essential ingredients: partnerships with in-country distributors and active support of these partners through training, prompt technical support and presence at international trade shows. The biggest assumption here is that a good partner firm can be located. Utilizing resources like the U.S. Chamber of Commerce and the U.S. embassies is a good way to find prospective partners. Soliciting at in-country trade shows, through trade publications or through your own Web site can be equally effective.

However, finding a partner is just the beginning. The key to making this relationship work is strong support—and lots

of it. Accessibility by e-mail, phone or fax are important on a daily basis, but trips overseas for training and troubleshooting sessions, as well as joint sales calls, are just as important. The nature of the environmental business is such that when a problem arises, it must be dealt with immediately. An overseas partner's customer support service is completely dependent on your prompt and effective support.

Be prepared to learn from a partner. Every country has its own idiosyncrasies. What works in the United States may not work in other countries. Unlike the United States, trade shows are an utter necessity overseas. And also unlike the United States, mail ordering as a result of an advertisement is virtually unheard of in foreign markets. Likewise, the Internet has not yet become an important selling medium in most other countries—although it doesn't hurt to have a presence. Face-to-face meetings are therefore essential. The environmental trade show provides a forum to meet and solicit potential customers. With in-booth support from U.S. environmental companies these shows can also lend credibility to your distributor and help sales.

**Norman I. Norrish, President,
Golder Associates Inc., Atlanta, Ga.**



Clients today are selectively procuring environmental services while at the same time demanding increased value for their expenditures. Environmental

consulting firms must accept and react to the balance of supply and demand in this maturing market sector. However, with any market that is as sizable as this one, there are opportunities for the agile companies.

At Golder Associates, our strategy includes:

- Anticipating the cultural and regulatory differences of other countries into which our clients are diversifying while delivering professional services to a consistent standard anywhere in the world.

- Utilizing new technologies to replace expensive historic environmental cleanup solutions and maintaining a credible reputation with regulatory agencies to better serve as a client advocate. This strategy is driven by domestic clients' needs to reduce operating costs or to reduce liabilities on their balance sheet.

- Being better "problem solvers" or "problem preventers," rather than specialty "technocrats," by understanding the entire project from the client's perspective and proposing an integrated set of services, or "service package," that meets the client's regulatory, liability, financial and operational objectives.

At Golder Associates, we are confident that a global company delivering a combination of cost-effective and innovative services will have a secure place in the environmental market.

**Dale Sands, Vice President,
Rust Environment & Infrastructure,
Columbia, SC**



The environmental services market is undergoing a significant transition that will continue for the balance of this decade. This transition is reflected by the shifting needs of the client base, the changes in the supplier base and the evolution of a more process-oriented

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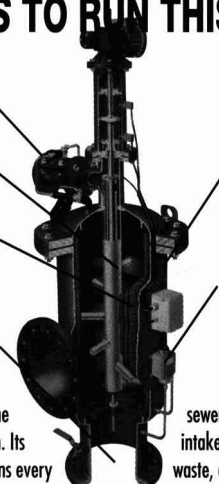
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approach to environmental issues.

In 1998, the environmental market in the United States will decline slightly from that of 1997, with decreases occurring in many areas and growth in far fewer service areas. Fewer large-scale federal programs are expected. Industrial and commercial establishments will continue the trend of reducing the number of suppliers to develop stronger, strategic relationships with a single consulting engineer. Domestically, certain regions, such as the Midwest, will provide more opportunities. Internationally, the mar-

ket is picking up slowly as multinational firms selectively upgrade operations.

The market is still driven largely by regulations. It comprises some subsets that continue to grow, such as site investigation and restoration, Title V air quality and permit compliance, wastewater design and permitting, and waste management and compliance activities. For example, site assessment work due to Superfund or multisite investigations is declining but will grow in the brownfields area. The number of new investigations or studies from

Resource Conservation Recovery Act (RCRA)-based or Superfund-based actions will decline. The growth in brownfields is slow and very selective in geographic markets.

An emerging subsegment, driven by economics, is the process-oriented approach for pollution prevention, waste minimization and process redesign that affects all components of manufacturing. Enhanced environmental management systems also will create some market demand, due to the growth of ISO 14000 and client/supplier relationships that work together to identify environmental costs and develop ways to reduce these costs.

While the overall market is declining, there is still good opportunity for the growth of consulting firms that are client-focused, highly strategic and adaptable to the emerging and evolving needs of the client base and for clients to enlist strategic partners in their environmental efforts.

**Dr. James W. Morentz,
Chief Executive Officer of Essential
Technologies Inc., Rockville, Md.**



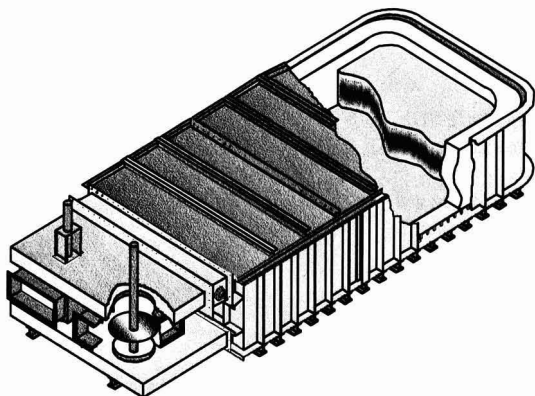
Consolidation. That is the trend of the year in the environmental software business. Soon to be gone are the mom-and-pop software providers with a single-purpose solution that was difficult to sustain.

Another will be the divisions of environmental consulting companies that thought it would be easy to write some software and sell it with services. In their place will be a small number of sophisticated software houses that specialize in delivering software as their core competency and are staffed by designers with environmental, health and safety (EH&S) experience.

The resulting products will provide continuity in the field by assuring progressive, evolutionary development from one generation of software to the next and by assuring interoperability from single-user systems to local and wide area networks, as well as enterprisewide client/server and Internet/Intranet products. Only larger firms will be able to underwrite the multiplicity of development requirements needed to fulfill these needs. Only these survivors will be able to handle the globalization of the EH&S information management marketplace. Only they will be

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able to effectively team with consulting firms and system integrators to provide the total solution to corporate needs—whether that solution is for software, software and services or complete outsourcing. And, most importantly, with the emergence of a dominant firm will come the recognition on the part of the market that EH&S information management is a business process that deserves attention, thus leading to explosive new demands in the industry. Consolidation means focus, which means growth.

**Len Blatnica, MSA Co.,
Pittsburgh, Pa.**

During the past few years we have witnessed a change in the business climate surrounding companies supplying environmental instrumentation, particularly for continuous emissions monitoring. In the early 1990s, a number of companies entered the market with expectations that regulatory compliance with the Clean Air Act (CAA) would be their main marketing tool.

A large number of orders were booked, which gave the impression of a very strong market. When actual installation occurred, along with the task of complying with the purchased specification, these same companies incurred unexpected expenses. Other potential customers, hesitant to comply with the CAA until U.S. Environmental Protection Agency enforcement could be enacted, took the opportunity to further investigate their process streams to better understand the source of the emissions. Rather than simply reporting the amount of emissions, the tactic was now to take corrective action early in the process.

This served to further diminish the sales volume, particularly for those suppliers who were not directly manufacturing environmental instrumentation but incorporating it into their systems.

Today it is apparent that many of the talented engineers who worked in this field during the last five years have departed for more growth-oriented markets, lessening chances for a strong comeback by many of the companies.

**Daniel A. Pryor, Vice President and
General Manager, EIT, Exton, Pa.**

As the Internet revolutionizes communication and information-sharing, public disclosure will become one of the hottest regulatory issues of 1998.

In the past, much publicly available environmental information was difficult to obtain and understand. Few people had the time and persistence required to get and interpret data from such sources as the Toxic Release Inventory (TRI).

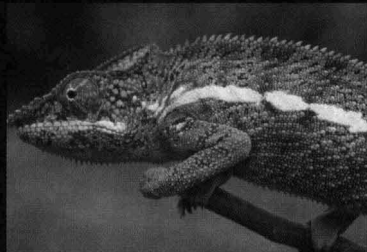
All this has changed. As households and businesses throughout the United States and the rest of the world have gained Internet access, World Wide Web sites have become a widely accepted vehicle for information sharing. The EPA has endorsed this trend, putting a wide variety of legislation, guidance, and environ-

mental information on its Web site.

Soon, detailed plant-by-plant data on releases, permits and possibly even processes will be a mouse click away. As rules such as the risk management program increase community involvement in the regulatory process, more and more members of the general public—as well as the media and competitors—will examine this information.

Some of the information is likely to generate lawsuits and controversies as the media and public interpret and misinterpret the data. Plant security and

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On the Road to 1998

competitive issues are also likely to come up. A lively dialogue about the benefits of broad public disclosure will ensue. Already, the chemical industry has challenged the EPA's expansion of the TRI.

All this will make for an interesting 1998.

Stephan DeLuca, Division Manager, INFICON, East Syracuse, NY

In the past few years, the environmental market for analytical instrumentation has been flat to declining, notwithstanding the EPA's promotion of new technology

development. In this stagnant market, a potential growth area is portable, on-site or field instrumentation.

The primary advantages of on-site analysis are informed decision-making and immediate action based on analytical results. The familiar, frustrating time delays in getting answers and added costs for sending samples to laboratories could be eliminated, but somehow are still tolerated by a high technology industry in this age of instant information. On-site analysis also avoids complicated sample handling

procedures and removes the potential for sample degradation.

Technological advances have made it possible to get high-quality analytical data in the field. Products such as portable gas chromatographs and gas chromatograph/mass spectrometer (GC/MS) systems, field FTIR instruments and portable X-ray analytical systems are commercially available. Unfortunately, these instruments still have a reputation for being "screening tools" rather than reliable analytical devices.

To move the analytical paradigm from laboratory measurement to on-site analysis, the real capabilities of field equipment must be made clear. The EPA's Environmental Technology Verification (ETV) program is an excellent vehicle for demonstrating how field portable instruments can surpass laboratory instruments in acquiring meaningful results on-site.

Raising awareness of the potential of field analytical devices through ETV data will be helpful, but the key to acceptance of field instruments is the availability of EPA-approved (or mandated) methods for on-site analysis. The EPA currently has an initiative to develop a protocol for performance based methods (PBMs). One PBM using direct interface GC/MS for on-site emission testing of volatile organic compounds has been posted on the EPA's EMTIC bulletin board.

The continuing development of PBMs and the commitment of the EPA to certify instrument performance through the ETV will greatly enhance the applicability and acceptance of field instrumentation. **EP**

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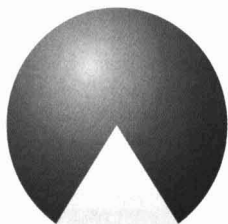
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TRAINING: WHICH METHOD IS BEST?

Choosing the right media for environmental compliance training can guarantee your company better prepared employees and a more cost-effective compliance program.

By Mike King, CHMM, REA, REP

Certain environmental regulations require that owners and operators of regulated facilities train their employees. While environmental regulations focus on sources of pollution, certain regulations require that employees working at or with pollution sources be trained. This training usually revolves around what the employee needs to know or do for the pollution source to be properly controlled. This training may involve focusing on work practices, such as "Best Management Practices," that minimize the chance of pollution. Training may also involve response to emergencies such as spills or accidents that threaten the environment. Environmental, health and safety (EH&S) managers are responsible for identifying employees who should be trained and delivering adequate initial training and, in most cases, refresher training.

Regulations

Table 1 lists several environmental regulations that include training requirements along with a brief description of the required content.

The Resource Conservation and Recovery Act (RCRA) regulations require training of employees at generator sites who handle hazardous waste (40 Code of Federal Regulations (CFR) 262.34(a) for Large Quantity Generators and 40 CFR 262.34(d) for Conditionally Exempt Small Quantity Generators). RCRA also requires training for all employees at treatment, storage and disposal facilities (40 CFR 265.16/ 264.16). RCRA training must inform workers who handle hazardous wastes about proper accumulation, containerization, labeling, manifest-

ing and emergency response measures.

The Clean Water Act (CWA) regulations require training at facilities that store or handle larger quantities of oils, petroleum or petroleum-derived products where a release could threaten surface waters (40 CFR 112.7(e)(10)). This training must inform employees who work around oils about how to operate and maintain oil handling equipment to minimize the chance of a spill or leak.

Training media are the methods and settings used to deliver instruction to the student. The training media must be tailored to the audience, to the objectives of the training and to fit within the budget.

Also under the CWA, all wastewater treatment facilities built with federal funds must conduct adequate training of all treatment plant workers (40 CFR 35.835-7(b) and 920-3(b)). Many states have developed wastewater treatment plant worker certification training programs to comply with this requirement.

There are also training requirements for facilities in certain Standard In-

dustrial Classification (SIC) codes that require National Pollutant Discharge Elimination System (NPDES) permits in connection with stormwater discharges (see U.S. Environmental Protection Agency or state General Permit conditions). Stormwater training should focus on the everyday work practices that help avoid stormwater pollution, such as spill avoidance, clean-up and storage of raw materials where they cannot contact stormwater or snow melt.

Regulations promulgated under the Clean Air Act (CAA) require training under the new Accidental Release Prevention section of the Clean Air Act Amendments of 1990 (CAAA '90). This regulation, effective in 1999, will require extensive employee training to prevent accidental releases of any of 140 acutely hazardous substances (40 CFR 68.54 and 68.71).

Important Training Variables

When deciding how compliance training can best be conducted, there are three variables that largely determine training quality:

- **Effectiveness:** Did each student receive and understand the information required to be covered under the respective regulation?

- **Convenience:** Did each student receive training when it was most convenient or did training disrupt normal work activities?

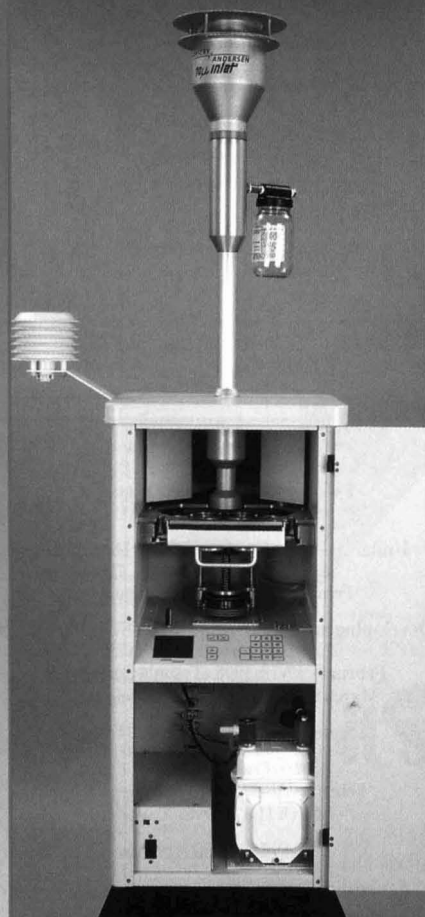
- **Ability to measure understanding and retention:** Did each student retain the required understanding so that proper work practices became routine?

The trainer's job is to optimize these three variables within a (usually) very tight budget.

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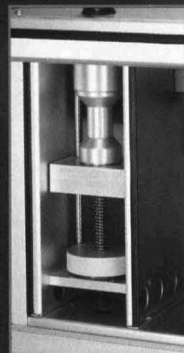
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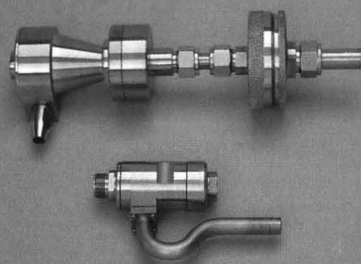


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Table 1: Examples of Environmental Training Requirements

Regulation	Program	Typical Training Content
Resource Conservation and Recovery Act	Hazardous Waste Generators (LQGs, SQGs)	Inspections, contingency plans, emergency response
	Treatment Storage and Disposal Facilities	Inspections, contingency plans, emergency response, waste feed cut-offs
Clean Water Act	SPCC Plans	Oil spill prevention
	Oil Pollution Act of 1990	Oil spill response
	NPDES Permits	Best management practices (BMPs)
Toxic Substances Control Act	Asbestos O&M	Inspections and correct work practices
	Lead Paint Removal	Correct work practices
	Industrial Refrigerant Leak Repair (Chlorofluorocarbons)	Regulatory requirements, verification testing, record keeping and reporting
Federal Insecticide, Fungicide and Rodenticide Act	Pesticide Worker Protection Standard	Pesticide safety, proper work practices
Clean Air Act	Accidental Releases	Similar to OSHA Process Safety Management

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Training: Which Method is Best?

Training Media

One of the variables that impacts cost-effectiveness is the training media. Training media are the methods and settings used to deliver instruction to the student. The training media must be tailored to the audience, to the objectives of the training and to fit within the budget.

Only a few years ago, the conventional classroom was about the only medium available. The information age has brought new media/delivery options.

In order of generally increasing unit cost (as opposed to the more meaningful cost per student), the media commonly available to compliance trainers today are:

- Mail-out information;
- Video-based training (VBT);
- Classroom training;
- Drills and exercises; and
- Computer-based training (CBT).

See Table 2.

Choosing the Best Media

No single medium is right for every training situation. Therefore, most trainers develop hybrid programs selecting the most cost-effective medium for each facility, audience and regulation. Sometimes the choice is simple. For example, under the Oil Pollution Act of 1990, "significant harm" facilities are required to conduct annual drills and exercises to simulate spill responses.

In most cases, however, the trainer has the freedom to choose his or her media. When the trainer has a choice, he or she should know how each medium lends itself to specific training situations.

The big advantage of mail-outs is their low cost. Mail-outs/e-mail are an inexpensive method to communicate simple, straightforward information to large numbers of employees. The primary drawback of mail-outs is the inability of the trainer to easily measure understanding and retention of the information.

If large numbers of employees require uniform but more detailed information and descriptions of correct procedures, video-based training (VBT) is often an effective method. The visual presentation of pollution sources and proper work practices is usually more effective and is retained longer than written or spoken descriptions.

Selecting the best training method becomes more difficult when either the training audience is widely dispersed or works on varying schedules or when training needs differ significantly. In these situations, each employee must be able to

**Table 2:
Comparisons of Various Training Media**

Media	Cost per Employee Trained	Effectiveness	Convenience	Ability to Measure Understanding
Mail-Outs	\$	↘	↗++	↘
VBT	\$	✓	✓	↘
CBT	\$\$	↗+	↗+	↗+
Classroom	\$\$	↗++	↘	↗+
Drills & Exercises	\$\$\$	↗+++	↘	↗+++

↘	Poor
✓	Fair
↗+	Average
↗++	Above Average
↗+++	Excellent
\$	Low Cost
\$	Medium Cost
\$\$	High Cost
\$\$\$	Highest Cost

access tailored training when and as needed. Here convenience becomes the driver and computer-based training (CBT) is

often the best delivery option. Employees working anywhere in the world at any time can log on and take one or more training

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Training: Which Method is Best?

modules. Also, the training can be interactive to enhance retention and record performance.

The primary drawback of CBT is the initial cost. CBT is very expensive to develop and a common delivery platform must be available to all employees who need training.

Where the employee population has broadly similar needs but diverse applications, conventional classroom training may still be the best delivery method. A skilled and knowledgeable trainer can deliver a session that provides all trainees with commonly needed information. At the same time, the classroom setting allows the trainer to answer questions, discuss options and address specific problem areas. However, classroom training can be very expensive in situations when all the costs of delivering several classes over a long period of time are considered.

Finally, when effectiveness is the paramount concern, drills and exercises are, almost without exception, the best training method. Hands-on exercises are the best method for conveying the sight,

sound and feel of the desired work practices. Student retention of work practices is usually best when he or she has actually performed them.

On the downside, exercises are usually the most expensive training method over the long-term, even exceeding CBT. Drills and exercises are usually only justified where affected employees absolutely must perform their duties correctly. Training of emergency responders is one requirement that often justifies the high cost of drills.

Choosing the correct training media is far from simple. It takes careful analysis of each training requirement and a judicious balancing of advantages and costs. However, the payoff for a properly delivered training program will be a better trained work force and a more cost-effective environmental compliance program. **EP**

Mike King, CHMM, REA, REP, is a principal and environmental engineer at EXCAL Environmental in Niwot (near Boulder), Colo.

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cepts screen sizes from 10 micron to 500 micron. It is ideal for industries such as steel, pulp and paper, agriculture, mining, automotive and food processing. The 4500 model can also be used as a R/O filter. A variety of control options, body and component materials are available. **Amiad.**

Circle 58 on card.

The Type S is constructed with a durable, reinforced synthetic polymer disc. The fluid serves as its own seal for low-torque operation. **Schlumberger Measurement Division.**

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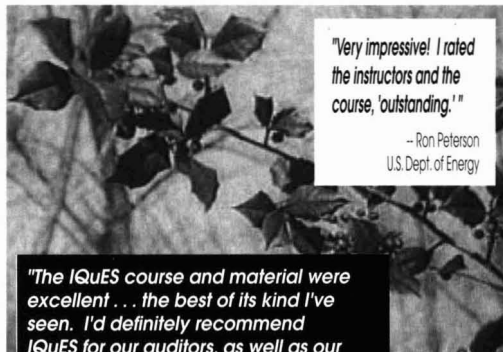
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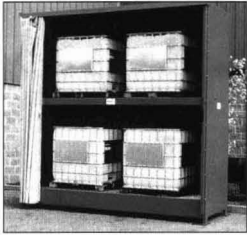
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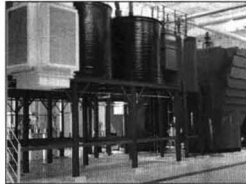


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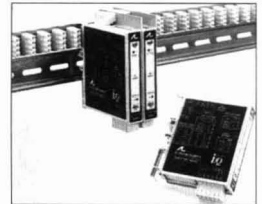


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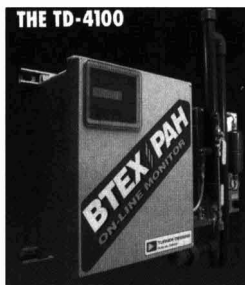


it can exceed 1,000,000 cycles at ambient temperature/300 psi or 500,000 cycles at 200 degrees Celsius/300 psi. The diaphragm permits sampling at sub-ambient pressures. The valve is held together by a single screw and locating pins insure proper alignment. Valco Instruments Co. Inc.

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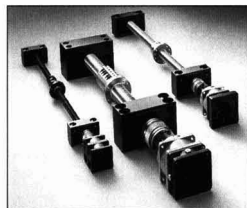


bricants, heat transfer oils and BTEX in water. The monitor detects leaks, verifies treatment and controls processes for managing contaminated water. Features include de-aerator system, alarm-setting software, site prep guide and more. Turner Designs.

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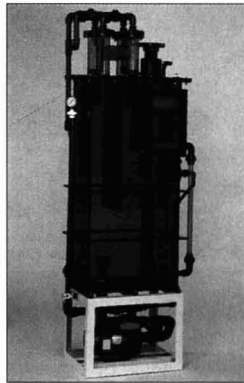


two sampling pumps and two bottles eliminate any possibility of cross contamination between the first flush and the composite sample. A rain gauge, two sample pickup hoses and a battery charger are also included. **Global Water.**

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Circle 73 on card.

Web Site

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ment. The site includes technical information on groundwater monitoring. The information is continually updated and can be found at www.geotechenv.com. **Geotech Environmental Equipment.**

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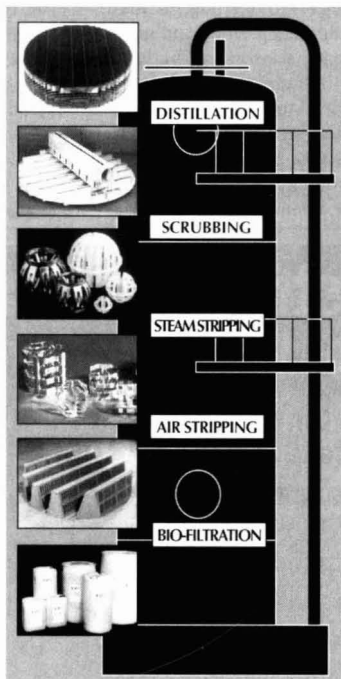


to provide an easy and safe method to sanitizing and disinfecting water. The system consists of a 3-inch calcium hypochlorite tablet with 65 percent available chlorine. The automatic chlorinators eliminate the potential of hazardous gas cylinder leaks or liquid bleach spills. PPG Industries.

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Boilers, Cleaver Brooks

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Boilers, Bryan Steam Corp.

Circle 48 on card.

Boilers, Kewae Mfg. Co. Inc.

Circle 49 on card.

Vacuum blowers, New York Blower

Circle 50 on card.

Boilers, Parker Boiler Co.

Circle 51 on card.

Flares, McGill Inc.

Circle 52 on card.

City of Chandler Industrial Process Water Treatment Facility

Engineering services, Black & Veatch

Circle 53 on card.

Reverse osmosis system, Ionics, Inc.

Circle 54 on card.

Ultrafiltration system, Pall Corp.

Circle 55 on card.

Allen's Creek Stormwater Drainage Improvement Facility

Engineering services, Galson Engineers

Circle 56 on card.

Easterly Wastewater Treatment Plant

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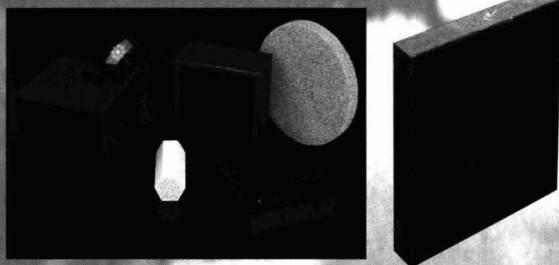
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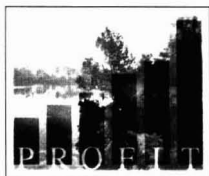


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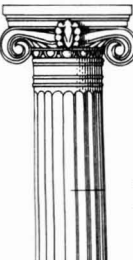
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Network Environmental Systems, Inc., 10933 Trade Center Drive #108, Rancho Cordova, CA 95870. (800) 837-2384, FAX: (818) 853-8626. <http://www.nes.hazmat.com>. OSHA - EPA - DOT Training Manuals for sale.

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1/98 BUYING PLANS SURVEY - ANNUAL BUYING INTENTION SURVEY

1. Which of the following MISCELLANEOUS SERVICES AND PRODUCTS do you plan to purchase in the next 12 months? (select all that apply)

- 800 Air Pollution Controls
- 801 Air Quality Instrumentation
- 802 Analytical Laboratory Services
- 803 ASTs and USTs
- 804 Environmental Consulting
- 805 Environmental Insurance
- 806 Environmental Software
- 807 Fans, Blowers & Aerators
- 808 HazMat/Materials Transportation
- 809 Hazardous Waste Containers & Storage Structures

- 810 Industrial Hygiene Equipment
- 811 ISO 9000/14000 Certification
- 812 Package Wastewater Treatment Sys.
- 813 Personal Protective Clothing & Equipment
- 814 Process Controls
- 815 Pumps, Pipes & Valves
- 816 Remediation Services
- 817 Sludge Dryers & Disposal
- 818 Spill Cleanup Products
- 819 Test Kits
- 820 Training: EPA & OSHA
- 821 Wastewater Treatment Chemicals & Equipment
- 822 Water Quality Instrumentation

2. What is your projected budget for the product(s)/service(s)?

- 823 over \$200,000
- 824 \$100,001-\$200,000
- 825 \$50,001-\$100,000
- 826 \$10,001-\$50,000
- 827 \$5,000-\$10,000
- 828 under \$5,000

3. How immediate is your need for the selected products/services? (select one)

- 829 3-6 months
- 830 7-9 months
- 831 10-12 months
- 832 over 12 months

SUBSCRIPTION INFORMATION

YES, I would like to receive/continue to receive *Environmental Protection*.

NO, I'm not interested at this time.

Signature _____ Date _____

Title _____

Business Phone (_____) _____ FAX No. (_____) _____

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NAME _____

COMPANY _____

ADDRESS _____ Home Bus.

CITY _____ STATE _____ ZIP _____ ZIP+4 _____

A. Function which best describes your activity in Pollution Control (check only one):

- A Corporate responsibility for Pollution Control
- B Manage all Pollution Control Operations at this location
- C Supervise sub-group in Pollution Control Operations
- D Provide professional consulting service on Pollution Control
- E Provide staff environmental service on Pollution Control
- Z Other _____

- (29) Petrol. & Coal
- (30) Rubber/Plastic
- (38) Instr./meas./analyze/controlling

- C Chemicals
- D Parts & equipment for maintenance operation & control

- B Mining
- D Engineering & Contracting
- E Utilities, public, private & cooperative
- F Govt. including municipal or district sanitary water or wastewater treatment sys. or plants
- G City
- H County
- I State
- J Federal
- K Transportation
- O Training
- Z Misc. Services _____

- C Agriculture
- L Consulting
- M Insurance
- N Labs
- P Real Estate

- E Services/Consulting
- F None of the above _____

E. What types of Pollution Control are you responsible for? (check all that apply)

- A Air
- C Noise
- E Industrial Hygiene
- F Toxic & Hazardous Material
- G Energy Control/Energy Conservation
- H None of the above _____
- D Water
- D Solid Waste Disposal

B. Type of Business (check only one):

- A Manufacturing. If manufacturing, please check the appropriate SIC (check only one):
- (20) Food
- (21) Tobacco
- (22) Textile
- (23) Apparel
- (24) Lumber & Wood
- (25) Furniture
- (26) Paper
- (27) Print/Publish
- (28) Chemicals
- (31) Leather
- (32) Stone/Clay/Glass
- (33) Primary Metal
- (34) Fab. Metal
- (35) Mach., except Elect.
- (36) Elect. & Electron Mach.
- (37) Trans. Equip.
- (39) Miscellaneous Mfg.

C. Number employed at this location:

- A 1-19
- D 100-249
- G 1000-1499
- H 1500-2499
- I 2500 and up
- B 20-49
- E 250-499
- F 500-999
- J 2500 and up

D. In your job function do you recommend, specify or purchase? (check all that apply)

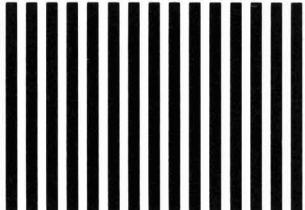
- A Pollution Control Equipment
- B Instrumentation

F. Which of the following publications do you receive personally addressed to you? (check all that apply)

- A Pollution Engineering
- B Environment Today
- C Environmental Solutions
- D Pollution Equipment News
- E The National Environmental Journal
- F Water Environment & Technology
- G None of the above _____



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