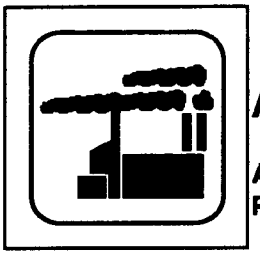
United States Environmental Protection Agency | Office of Research and Development Washington DC 20460 | EPA/600/N-93/005 March 1993 Vol. 10

EPA ORD ENGINEERING HIGHLIGHTS

A bimonthly compilation of EPA's Office of Research and Development engineering research activities and results and related research activities in pollution prevention and mitigation. To discuss any of these activities, contact the ORD lead person listed below. For general information, contact Charlotte Bercegeay of the Office of Environmental Engineering and Technology Demonstration, Phone: 919-541-2482.

INSIDE



AIR

Assistance to Thailand for Air Pollution Emergency

The Thai Embassy requested urgent technical assistance from EPA for an air pollution emergency in the Town of SobPad and its immediate vicinity in Lampang Province, Northern Thailand. The emergency was caused by 11 power plants that were burning lignite. The Air and Energy Engineering Research Laboratory (AEERL) provided air pollution control technology expertise, leading a five-member Environmental Action Team to Thailand to evaluate air pollution problems related to the Mae Moh Power Plant in Lampang Province and recommend alternative measures for addressing these problems. Other experts on the mission included an epidemiologist from the Health Effects Research Laboratory/ORD, two monitoring specialists from the World Health Organization, and a control technology specialist from DOE's Pittsburgh Energy Technology Center. The 2-week mission began on January 10, 1993. Upon the team's return, two presentations on their findings were given to the ASEAN Council and the U.S. AEP principals. (Richard Stern, AEERL, 919-541-2973)

Cooperative Research and Development Agreement for Research on NO_x Technologies

Through the Federal Technology Transfer Act (FTTA), a Cooperative Research and Development Agreement (CRADA) was signed between AEERL and Nalco Fuel Tech to investigate the combination of selective noncatalytic reduction (SCNR) and selective catalytic reduction (SNR) technologies for NO_x research. AEERL and Nalco Fuel Tech will cofund research at the AEERL

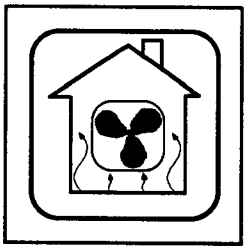
flue gas cleaning laboratory that investigates injection of NOxOUT*, a urea-based solution, for in-furnace NO_x reduction in series with a down-sized catalyst reactor for further in-duct NO_x reduction. This combined NO_x reduction system would be applicable to both new and retrofit boilers and could have a significant role in meeting the standards of the Clean Air Act Amendments of 1990 (CAAA). The optimal combination of SNCR and SCR may provide a less expensive option for NO_x control than is currently available. (Brian K. Gullett, AEERL, 919-541-1534)

NO_x Emissions Reduced for New Coal-Fired Boilers

The CAAA require NO_x emission standards for many existing utility boilers and revised emission performance standards for new boilers. An EPA-sponsored demonstration of a low-NO_x firing system at Virginia Power's 180 MWe Yorktown unit 2 will provide valuable data for policymakers responsible for preparing and enforcing these standards. NO_x emissions from the tangentially coal-fired boiler were reduced to 0.3 pounds per million Btu. This is half the amount currently allowed for new tangentially fired boilers. The "low-NO_x concentric firing system" (LNCFS-Level 2) was designed specifically for tangentially fired boilers, and the test showed that the technology works. Additionally, the test identified design, operating, and maintenance issues that utilities need to understand before installation. The test lasted 1 month and consisted of short-term runs at optimum firing conditions. A 42% reduction in NO_x emissions was achieved when the boiler ran at full capacity, and a 34% reduction, when it ran at intermediate capacity. The boiler rarely runs at less than intermediate capacity. Continued operation of the boiler is planned to fully assess the long-term performance of this low-NO_x system. (David G. Lachapelle, AEERL, 919-541-3444).

10 MWe ADVACATE Evaluation Completed

ABB-Flakt completed the initial evaluation of ADVACATE sorbent used with the Moist Dust Injection concept at TVA's Shawnee 10 MWe pilot plant. Although long-term tests were not conducted due to equipment problems, 90% SO_2 removal was achieved at a Ca/S of 1.5 on a 2.7% sulfur coal (1800 ppmv SO_2) for a several-day period. Based on this information, ABB-Flakt is negotiating with a utility for a 130 MWe demonstration. TVA plans to evaluate ADVACATE sorbent with several injection concepts over the next 2 years for possible commercial use in the TVA system, as well as supporting design of a 10 MWe equivalent system for a Department of Defense facility under the Strategic Environmental Research and Development Program (SERDP). Because the Shawnee facility is hosting a Clean Coal Demonstration in FY 93, SERDP and ABB-Flakt's demonstrations will depend heavily on AEERL to operate the 0.7 MWe ADVACATE pilot plant at Research Triangle Park for support. (Charles B. Sedman, AEERL, 919-541-7700)



INDOOR AIR QUALITY

International Study on Indoor Air Emissions

AEERL was one of 20 laboratories (6 from the United States and 14 from Europe) that participated in a study to compare emissions from indoor materials and products using small environmental test chambers. The study was directed by the Commission of the European Community's (CEC's) Joint Research Center in Ispra, Italy; AEERL served as the U.S. coordinator. Test protocols were based on methods developed at AEERL and published by the American Society of Testing and Materials. The study results will provide data on the accuracy and precision of emission rates determined from small chambers. Preliminary evaluation of the study data indicates that interlaboratory variability is modest for a slowly decaying source (e.g., floor tile). Data for a rapidly decaying source (e.g., wax) show much greater variability between laboratories. The study results are expected to provide valuable insight into small chamber testing and yield recommendations for improving the testing protocols. Final study results are to be presented jointly by the CEC and EPA at the INDOOR AIR '93 conference in Helsinki, Finland, in July 1993. (Bruce Tichenor, AEERL, 919-541-2991).

Cooperative Research Agreement To Study HVAC System

AEERL recently entered into a cooperative research agreement with the American Society of Heating, Refrigerating, Air-Conditioning Engineers, Inc. (ASHRAE) to evaluate the location, magnitude, and significance of the types of pollution sources in heating, ventilating, and air-

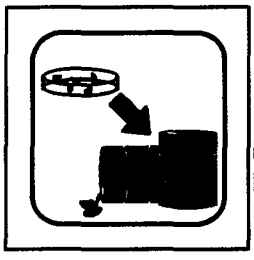
conditioning (HVAC) systems. Recent studies have shown that HVAC systems are among the primary sources of indoor air pollution, and the components may constitute major contributors to the "sick building syndrome." Research will be conducted to identify and quantify pollutants emitted by HVAC systems into occupied spaces and to identify how design, operation, and maintenance may affect emissions of the pollutants. AEERL will characterize the indoor environment of a multistoried, multiuse building by providing engineering analysis and HVAC system monitoring. AEERL has already completed basic HVAC system characterization and will be installing newly developed data-logging equipment that will provide system and space monitoring parameters. (Russell Kulp, AEERL, 919-541-7980)

Test Method for In-duct Air Cleaners

AEERL has developed a method for determining the efficiency of in-duct particle air cleaners as a function of particle diameter. The method is based on the use of a polydispersed artificial aerosol of potassium chloride combined with measurement of upstream and downstream particle size distribution and particle concentration. Used to evaluate the performance of numerous commercially available air cleaners designed for home and small commercial applications, the method is being extended to cover systems designed for large commercial applications. The test method is being evaluated by ASHRAE as a possible replacement for current standard methods of evaluating particulate air cleaners. Research is also under way to extend the method to evaluation of in-room air cleaners. (L. E. Sparks, AEERL, 919-541-2458)

Preventing Radon Entry into Crawl Space Houses

AEERL completed an analysis of available data on the full range of alternative techniques for preventing radon entry into crawl space houses, to develop improved mitigation techniques. Extensive review of the database was combined with an analysis of the flow dynamics in crawl space houses and the mechanisms by which the techniques appear to operate. The analysis also included rigorous estimates of the installation and operating costs of the various techniques. This evaluation confirmed observations that submembrane depressurization (SMD) is likely to provide the greatest radon reductions in the living area in houses where this technique can be applied. Crawl space depressurization is the second most effective but is less reliable and appears to be less widely applicable than SMD. Crawl space pressurization appears applicable only in isolated cases. Natural ventilation of the crawl space gives only moderate reductions (<50%) in living areas, and sealing the floor between the crawl space and the living area gives essentially no reduction. Sealed barriers over the crawl space floor also give limited reductions. Although SMD has the highest installation cost, it has one of the lowest annual operating costs and appears to be the most cost-effective approach for many (but not all) cases. A detailed paper describing this analysis was accepted for publication in a peer-reviewed journal, *Indoor Air*. (Bruce Henschel, AEERL, 919-541-4111)



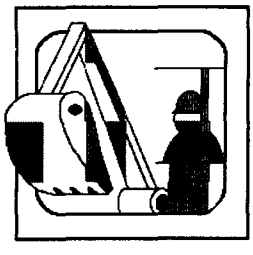
BIOREMEDIATION

Field Initiative to Biovent Polyaromatic Hydrocarbons at Reilly Tar Site

In November 1992, the Risk Reduction Engineering Laboratory (RREL) SITE Demonstration Program initiated a pilot-scale bioventing field demonstration for polyaromatic hydrocarbon (PAH) bioremediation at the Reilly Site in St. Louis Park, MN. Bioventing is a biological treatment process that uses low-rate atmospheric air injection to treat contaminated unsaturated soil in situ. The air flow provides a continuous oxygen source that enhances the growth of aerobic microorganisms naturally present in soil. Low-rate, low-pressure air injection allows the soil to be oxygenated with minimal volatilization to the atmosphere of volatile organic compounds that may be present in the soil. This demonstration will be the first attempt to bioremediate larger molecular weight hydrocarbons by bioventing. Because of the strong partitioning of PAHs to soil, their availability and consequently the rate of degradation are expected to be low. The target removal rate over the 3-year period is 27% as demonstrated by soil core analysis. Successfully achieving this removal rate would project total cleanup to a period of 10 to 15 years. Because of existing land use of the site by the community and cost considerations, Region V has indicated that a cleanup period in this range would be more desirable than any short-term remediation procedures requiring excavation and above-ground treatment of contaminated soil. (Paul T. McCauley, RREL, 513-569-7444)

EPA To Evaluate Bioremediation of Soil Contaminated with Creosote

Final details are being negotiated for a CRADA under the provisions of the FTTA, between the James Graham Brown Foundation, Louisville, KY; RREL; and the U. S. Department of Agriculture's Forest Products Laboratory (FPL). A two-phase research project is being planned to evaluate bioremediation of soil contaminated with creosote compounds and pentachlorophenol (PCP) found in wood-preserving wastes. The first phase will consist of treatability studies comparing inoculated fungal and indigenous organism (bacterial) treatment using bench-scale pans. The Brown Foundation will contribute $142,000 toward this phase of the work, which will be conducted primarily under the supervision of RREL researchers. If the results of the Phase I studies indicate fungal treatment is more efficient in biodegrading creosote compounds than are indigenous organisms, a Phase II field study will be initiated in the summer of 1993 at a wood-treating site owned by the Brown Foundation in Louisville. FPL will assume the lead role in the second-phase work with technical assistance from RREL and the Brown Foundation. The Brown Foundation will fund out-of-pocket costs of this phase up to $400,000, plus contribute in-kind services. RREL and FPL have been cooperatively researching fungal biodegradation of creosote compounds and PCP for the past 4 years. The Brown Foundation and its consultant, Remediation Technologies, Inc., Seattle, WA, have employed indigenous microorganism treatment to clean up two other wood-preserving sites for which the Foundation was responsible. The CRADA being developed for this project is a first-time effort to comprehensively compare these two land treatment approaches for remediating and detoxifying soil contaminated with wood-preserving chemicals. (Richard C. Brenner, RREL, 513-569-7657)



SITE REMEDIATION

SITE Demo on Pneumatic Fracturing Extraction and Hot Gas Injection

A Phase I SITE Demonstration was performed on a pneumatic fracturing extraction (PFE) and hot gas injection (HGI) technology system developed to increase the number of fractures in subsurface soil and rock formations where conventional in situ soil vapor extraction is limited due to low permeability geologic strata. The process was successfully demonstrated on a shale formation containing trichloroethylene (TCE) at the Derelco Business Center in Somerville, NJ. Preliminary data indicate orders of magnitude increases in permeability and subsequent similar increases in contaminant removal rates. Phase II, involving the evaluation of an integrated system including catalytic oxidation of extracted contaminant vapors, is currently planned for evaluation during 1993. (Uwe Frank, RREL, 908-321-6626)

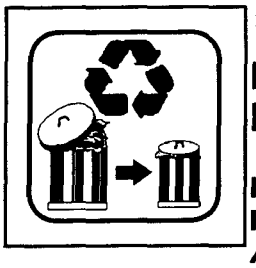
HAZARDOUS WASTE

Emergency Safety Vent Tests Completed

AEERL has completed a series of bench-scale parametric tests examining operational parameters that can be used to minimize the impact of emergency safety vent (ESV) openings. ESV's are safety devices supplied on rotary kiln incinerator systems that directly vent the incinerator emissions to the ambient air in the event of a significant system failure, such as a power outage, failure of the induced draft fan, or an over pressure from the primary combustion chamber. In the event of an ESV opening, all waste being fed into the incinerator is immediately cut off; any materials remaining behind in the system will continue to burn out for a period of time. EPA's Office of Solid Waste funded a study to examine the parameters (such as kiln rotational speed or air in-leakage) that incinerator operators can control in order to minimize worker exposure to incinerator off gases, including acid gases and organics. Metals were not included in the scope of these tests. Species that were monitored included O_2, CO, CO_2, NO, hydrocarbons, soot, and HCl. Several grab samples were taken and analyzed for organic products of incomplete combustion (PICs). Tests were also performed to examine the effect of adding a flare in the ESV. Preliminary results indicate that the addition of a flare is extremely effective in minimizing organic compounds released into the atmosphere in the event of an ESV opening. A statistical analysis of the other parameters is under way. The draft final report will be completed in April 1993. (Paul Lemieux, AEERL, 919-541-0962)

Metal Aerosol Transformations and Control in Incineration Systems

Many toxic metals identified by Resource Conservation (RCRA) and CAA regulations, and associated with waste streams, readily vaporize at incineration temperatures and form small particles that are most difficult to collect in conventional particulate control systems. AEERL in-house and extramural-sponsored research examined metal transformations in laboratory scale combustors in order to explain this behavior and develop new control techniques. These studies have yielded insight into the mechanisms of metal aerosol evolution. Preliminary results also suggest that common naturally occurring inorganic materials can be used as in-duct sorbents to capture volatile toxic metals. One set of tests that injected kaolinite into a combustion system doped with lead resulted in an approximate 99% reduction in the submicron lead mass concentration. These results are significant in that they suggest that sorbent injection can be used to capture toxic metals much as it is currently used to capture acid gases. (William P. Linak, AEERL, 919-541-5792).



POLLUTION PREVENTION

Innovative Clean Technologies Program Recipient Wins *R&D 100 Award*

RREL's Innovative Clean Technologies Program, managed in conjunction with the Office of Small and Disadvantaged Business Utilization, awarded a $25,000 grant to Earth Safe Industries, Inc., to promote pollution prevention among small businesses. Earth Safe Industries received the award for development of NoTox, a nontoxic chemical substitute for formaldehyde in the biological sciences and medical field. NoTox has been tested as a histological fixative and is being validated as an embalming fluid. In addition to its antimicrobial capabilities, its performance characteristics appear to be superior to formaldehyde, with anatomical specimens having a more pliable texture amenable to the separation of layers of tissue and muscle fiber for anatomical study. Occupational exposure to formaldehyde and phenol fumes is eliminated. (Contact: Kenneth Stone, RREL, 513-569-7474)

Sources of Key Nonprocess Solvents Targeted for Pollution Prevention

A preliminary evaluation of nonprocess solvent use for 15 source categories was completed in support of the Consumer/Commercial Products Report to Congress. This report was mandated for completion during November 1993 by Title I of the CAAA. The definition of consumer and commercial products contained in the CAAA includes traditional consumer products as well as nontraditional ones such as paints, coatings, and solvents, used in commercial and industrial facilities. Nontraditional consumer/commercial product emissions were estimated for selected industrial and commercial operations such as textile manufacturing, machine shops, furniture repair and restoration, roofing, and "quick print" facilities. These estimates were provided to EPA's Office of Air Quality Planning and Standards (OAQPS) and will have an impact on the first internal review draft of the report expected in March 1993. During future phases of this project, several source categories will be analyzed in greater detail to produce better estimates of the types, locations, and volumes of nonprocess solvent emissions and to identify and demonstrate pollution prevention opportunities to reduce these emissions. (Michael Kosusko, AEERL, 919-541-2734)

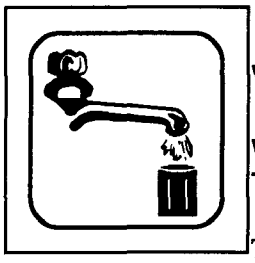
Organic Material Recycling by Pulp and Paper Industry

As outlined by the Environmental Defense Fund and the National Wildlife Foundation settlement agreement, the EPA is investigating process changes and pollution prevention strategies for the pulp and paper industry. A sampling effort was completed in October 1992, at Alabama Pine Pulp, Clairborne, AL. The EPA sampled this plant's pulping, bleaching, and wastewater treatment technologies. The technologies evaluated at this point included the Kamyr or extended cooking process, which removes lignin from pulp prior to bleaching. This increases the quantity of organic material recycled and burned in the recovery boiler for energy recovery rather than being removed in the bleach plant as in the conventional process. The extended cooking process also decreases the amount of bleaching chemicals required, thereby reducing the likelihood of forming and discharging chlorinated organics. The key analytes of concern are volatile organics, chlorinated dioxins and furans, chlorinated phenolics, adsorbable organic halogens, organic halides, chemical and biological oxygen demand, total

suspended solids, and color. Samples collected are currently being analyzed; a draft report of the test was completed in December 1992. (Thomas J. Holdsworth, RREL, 513-569-7675)

Waste Minimization Assessment Series with New Jersey Completed

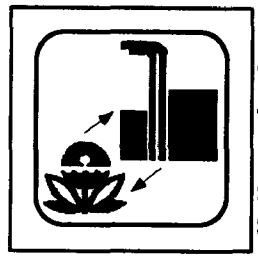
Under a cooperative agreement between RREL and the New Jersey Department of Environmental Protection and Energy, the New Jersey Institute of Technology completed 30 research briefs on pollution prevention options identified at various industrial facilities within the State of New Jersey. The facilities cover nine industries including paint manufacturing, motor vehicle maintenance, printing, plastics, metals, refrigeration, air conditioning equipment, electrical utility, and chemical formulations. These research briefs are available for distribution from the ORD Publications Unit, Cincinnati, Ohio, 513-569-7562. (Mary Ann Curran, RREL, 513-569-7837)



WATER

World's Largest Advanced Water Treatment Facility Dedicated

This sytem evolved from a pilot study starting in 1977 between the City of Cincinnati and EPA with a $3 million research grant. RREL has played a major role in conducting and supporting research since that time. The granular activated carbon (GAC) system will entrap and adsorb chemical contaminants. After 15 to 20 minutes of contact with the carbon particles, the water can be chlorinated at a much lower dosage than in traditional plants and then distributed into the system. The new system will provide protection against spills in the Ohio River and remove raw water contaminants which interact with chlorine to form potentially carcinogenic by-products. The GAC will cost consumers an additional $.06/1000 gal for treated water (drinking water in Cincinnati currently costs $.33/1000 gal). It should, however, provide insurance that Cincinnati will meet not only the current drinking water standards but also any foreseeable standards past the year 2000. (Robert Clark, RREL, 513-569-7201)



TECHNOLOGY TRANSFER

Stationary Combustion NO_x Control Symposium

The 1993 Joint Symposium on Stationary Combustion NO_x Control, cosponsored by AEERL and the Electric Power Research Institute, will be held May 24-27 in Miami. The strong response to the call for papers—69 papers and 7 poster presentations were selected out of 120 abstracts submitted—indicates the high level of interest in NO_x control technologies for utilities as well as industrial sources. Utility applications of both traditional combustion modifications such as low-NO_x burners and postcombustion technologies such as selective catalytic reduction will make up the majority of sessions. In addition, the symposium will include sessions covering fundamental advances in NO_x formation and control, and field test results of natural gas reburning, including the joint EPA-Ukrainian-Russian reburning project now under way in the Ukraine. (Charles A. Miller, AEERL, 919-541-2920)

Life-Cycle Analysis Guidance Manual Available

RREL has completed work on a guidance manual that will advance the understanding and application of life-cycle assessment (LCA). LCA can be used as an objective technical tool to evaluate the environmental consequences of a product, production process, package, or activity holistically from cradle to grave. The document provides scientifically oriented, consensus-based guidelines on the conduct of the inventory component of LCA. It includes a brief discussion on the history of LCAs, the basics of LCA methodology, the procedural framework for conducting life-cycle inventory, and descriptions of the life-cycle stages. It will be of interest to a broad audience including manufacturers, consumer interest groups, and policymakers. Printed copies of the manual (EPA-600/R-92-036) are expected to be available in February 1993. (Mary Ann Curran, RREL, 513-569-7837)

Determination of Nine Haloacetic Acids in Finished Drinking Water

A poster session was presented by RREL at the 1992 AWWA Water Quality Technology Conference, in Toronto, Canada. Whenever natural organic matter is chlorinated, significant concentrations of chlorinated haloacetic acids (HAAs) are produced. When present in the water, bromide ion shifts the distribution of HAAs to include brominated species. Because HAAs in drinking water are suspected of having an adverse health effect, analytical techniques have been developed to detect and measure them. A method that was originally developed by RREL for the measurement of mono-, di-, and trichloracetic acid was modified to include the six brominated HAAs. These include mono-, di-, and tribromoacetic acid, and dibromochloro-, and dichlorobromo-, and bromochloroacetic acid. These brominated acids are formed during the disinfection of water with chlorine in the presence of bromide ion. The method is currently available as EPA/EMSL Method 552. (Ron Dressman, RREL, 513-569-7202)

Video on Protective Clothing

An EPA videotape, "Shedding Some Light on Pesticide Protection," is used to educate agricultural workers on the proper use of protective clothing. Actual footage of agricultural workers shows pesticide contamination on workers and dramatically demonstrates the importance of protective clothing. The video will be distributed to state cooperative extension services and should motivate workers to change their behavior in regard to improved selection and use of personnel protective clothing and equipment. (Carolyn R. Esposito, RREL, 908-906-6895)

Report on Revised Emissions Estimation Methodologies

AEERL has published a report that presents the development of improved and streamlined EPA emission estimation methods for stationary combustion area sources by the Joint Emissions Inventory Oversight Group research program. These sources include categories traditionally labeled "other stationary source combustion." Existing methodologies are summarized (if any exist), and then proposed algorithms are presented. Emission factors and data sources required to implement the new methodologies are introduced in each chapter. The program office is expected to implement these improved methodologies in their guidance for development of future emissions inventories (EPA-600/R-92-239, Dec. 1992). (Sue Kimbrough, AEERL, 919-541-2612)

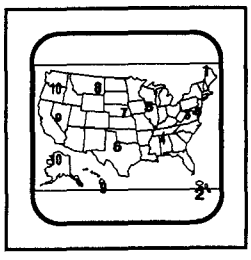
Indoor Air Source Catalog

The "Catalog of Materials as Potential Sources of Indoor Air Emissions. Volume I: Insulation, Wallcoverings, Resilient Floor Coverings, Carpet, Adhesives, Sealants and Caulks, and Pesticides" presents a classification system for products found in the indoor environment. The catalog provides the foundation for a systematic analysis of the role of materials in influencing indoor air quality. These products are organized on the basis of the Standard Industrial Classification system and the Architect's MasterSpec Code TM. Each section of the catalog presents sales and usage data, qualitative data on product composition, and quantitative and qualitative data on emissions rates and emissions factors for volatile organic compounds, based on currently available information. This catalog is a valuable resource for researchers and architects interested in developing emission testing plans, experimental design parameters, test protocols, and for presenting the data. It also presents a clear message that many product categories are not well studied with respect to their potential impact on indoor air quality. (James White, AEERL, 919-541-1189)

Lead Recycling 1992 Directory

The Lead Industries Association, Inc., has published the Lead Recycling 1992 Directory. This 8-page document contains a 2-page matrix that identifies the forms of lead scrap that are accepted by 35 U.S. and Canadian lead recycling facilities. Included in the 29 forms of lead scrap are lead paint removal debris (12 facilities); firing range soils (11 facilities); lead slag (13 facilities); and lead-bearing Superfund cleanup materials/wastes (7 facilities). For each of the lead recycling facilities, an address, contact name, and telephone number are provided. The Lead Recycling 1992 Directory is available from Lead Industries Association, Inc., 295 Madison Avenue, New York, NY 10017; telephone 1-800-922-LEAD. (Mike Royer, RREL-Edison, 908-321-6633)

*U.S. Government Printing Office: 1993 — 750-071/60199



REGIONAL OR STATE ASSISTANCE

Assistance to Texas Water Commission

The Texas Water Commission's New Technologies Task Force will evaluate a concept for heating and cooling that utilizes the Texas public water systems. Three demonstration installations will incorporate heat pumps with underground pipes connected to municipal water systems. Concerns were raised regarding the allowance of potable water to flow through a heat exchanger and then return to the mains. The commission intends to conduct the testing for 3 months and has invited EPA to participate in the evaluation. (Edwin Geldreich, RREL, 513-569-7232)

Pilot-Scale Treatability Test at New Jersey Site

The King of Prussia (KOP) site in southern New Jersey is contaminated with sludge material high in chromium, copper, and nickel. The Record of Decision specified volume reduction and application of soil washing for this site. The EPA assisted Region II in conducting a pilot-scale treatability test. The demonstration was run at a fixed facility in Moerdijk, The Netherlands. The 7-hour test used 160 tons of soil excavated in New Jersey and shipped to The Netherlands. The test soil will be returned to the site. Data collected in this test will support the remedial design. (Michael Borst, RREL, 908-321-6631)

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