DOE HAZARDOUS WASTE REMEDIAL ACTIONS PROGRAM (HAZWRAP) WASTE TECHNOLOGY DEMONSTRATION PROGRAM

R. E. Adams
Martin Marietta Energy Systems, Inc.
HAZWRAP Support Contractor Office
P.O. Box 2003
Oak Ridge, Tennessee 37831-7256

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One function of the Department of Energy (DOE) Hazardous Waste Remedial Actions Program (HAZWRAP) is to support the field demonstration of waste treatment technologies, both in-house and commercial, to determine the applicability of these technologies in remediating waste problems common to the DOE Defense Programs (DP) installations. A number of innovative technologies have the potential for dealing with DOE-DP Comprehensive Environmental Response, Compensation, and Liability Act-related and Resource Conservation and Recovery Act-related waste problems more economically and/or in a more socially acceptable manner than do current processes. It is the goal of HAZWRAP to critically review emerging technologies and to demonstrate those with the greatest potential for significant effect on the DOE-DP waste management program.

The Technology Demonstration (TD) Program is sponsored by the DOE Headquarters Office of Defense Waste and Transportation Management (ODWTM) through the Hazardous Waste and Remedial Actions Division (HWRAD). Funding is provided through two major management programs: the Hazardous Waste Compliance Technology Program and the Environmental Restoration Program.

A parallel function of HAZWRAP is to promote and expedite research and development (R&D) of selected new technology ideas, through the laboratory stages, for application in the elimination, minimization, destruction, stabilization, or delisting of hazardous and mixed wastes resulting from DOE-DP activities. The techniques are developed by DOE laboratories in cooperation with other governmental agencies and/or the private sector where applicable. The TD Program supports the field demonstration of these technologies when the R&D is completed. The R&D Program is funded by ODWTM through the Waste Research and Development Division and is managed by HAZWRAP.

The TD Program is managed by HWRAD and the HAZWRAP Program Manager. The HAZWRAP Support Contractor Office, staffed by Martin Marietta Energy Systems, Inc., personnel, supports the HAZWRAP Program Manager and HWRAD in their leadership roles. The program formally interfaces with key representatives of the eight field offices and their contractors, and frequent contact is made to establish and maintain program priorities and direction. These relationships are depicted in Fig. 1.

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HAZWRAP SUPPORT CONTRACTOR OFFICE
Oak Ridge, Tennessee 37831
operated by
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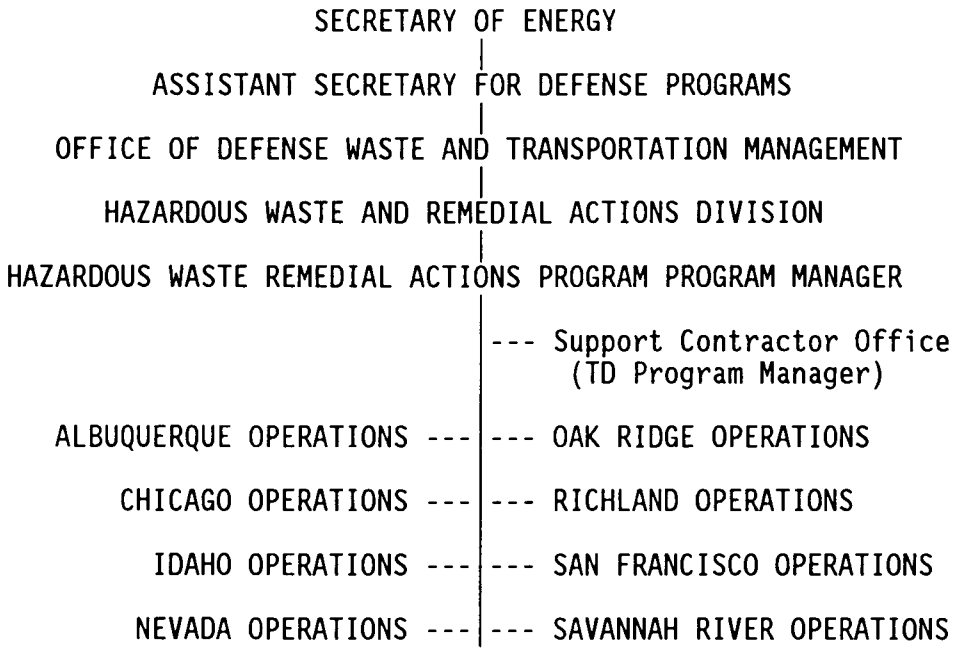

Fig. 1. Organization structure for conduct of the Hazardous Waste Remedial Actions Program.

The TD Program began in FY 1986 when discussions were conducted with DOE Operations Offices concerning their particular waste treatment needs. In October 1986 a team of representatives from the eight field offices and Headquarters met to select candidate waste treatment demonstrations. Of the 18 candidate waste treatment problems presented, 3 were selected for demonstration.

In each of the following years the TD Program Manager convened a meeting of the designated Operations Office representatives to review the progress of each of the ongoing projects and to discuss new candidate projects. Each office was requested to provide information on new, high-priority candidate projects that were evaluated and ranked by the representatives based on criteria reviewed and revised as needed at each meeting. At the conclusion of each meeting, a ranked list of the new candidate projects was established. For projects with a high ranking, the TD Program Manager requested that the proposing site submit more detailed information, including costs, schedule, and technical detail. On the basis of this input, the TD Program Manager reviewed each new candidate project with consideration of cost, schedule, and the project's technical differences and compared it with other new candidate and ongoing projects. The results of the TD Program Manager's deliberations were then communicated to Headquarters as recommendations for funding. These recommendations often included a restructuring of the coming fiscal year budget to accommodate the rapidly evolving needs of DP waste management activities.

Following review and approval of the recommendations by Headquarters and the HAZWRAP Program Manager, the TD Program Manager established contact with the appropriate Operations Offices to develop detailed plans for the project. The sites were encouraged to include in the planning the exploration of private industry for new and innovative technological solutions. A common method for this search was the procurement request for proposal (RFP) process. The TD Program Manager closely followed the progress of each project, ensuring that plans were executed within cost and schedule, the technical intent of the project was maintained, and the transfer of the technology was completed.

In August 1987 a second meeting was convened to select more waste treatment problems for demonstration starting in FY 1988. In July 1988 a third meeting was held that combined the ranking of projects for the Compliance Technology Program and the Environmental Restoration Program for initiation in FY 1989. The TD Program has grown from 4 projects in FY 1987 to 20 projects in FY 1989.

These 20 ongoing technology demonstrations are in various project stages, ranging from recent initiation to nearing completion. These waste treatment technologies relate to the following general technology needs of DOE-DP:

Treatment/Disposal of Hazardous Mixed Wastes
Waste Minimization Methods
Standards/Methods for Site Remediation/Stabilization/Closure
Improved Burial Practices and Waste Forms
Pathways Analysis

Each of the ongoing technology demonstration projects is identified and a brief description of the technology is given in Table I. A more detailed description, including objective, status, and expected project duration, is included in Table II.

Table I. Summary of FY 1989 Technology Demonstration Projects

TREATMENT/DISPOSAL OF HAZARDOUS AND MIXED WASTE

- Supercritical Water Oxidation, Phase IV (ALO/LANL) - Demonstration of certain hydrocarbon oxidation reactions in supercritical water for management of hazardous chemical wastes.
- Gas Cylinder Disposal Plant Development, Phase IV (ALO/LANL) - Demonstration of a process for the safe disposal of the contents of unidentified or damaged gas cylinders.
- Treatment/Disposal of Reactive Metals, Phase IV (CHO/ANL) - Demonstration of a spray-burning process for converting reactive metal wastes to a glass product suitable for land disposal.
- Lead Decontamination (IDO/INEL) - Demonstration of a melt-refining system to decontaminate lead.
- Plasma Centrifuge Reactor (IDO/INEL) - Demonstration of use of high-temperature plasma centrifuge reactor to melt and process entire drums of organic-contaminated soils.
- Hexone Tanks (RLO/WHC) - Demonstration of technologies for treatment and disposal of hazardous organic liquids containing radioactive materials and stored in two deteriorating underground tanks.

WASTE MINIMIZATION METHODS

- Substitution for Chlorinated Solvent Degreasers (ORO/Y-12) - Large-scale demonstration of the substitution of aqueous solvents for chlorinated hydrocarbons currently used, including demonstration of recycling methods for spent aqueous solvents.
- Waste Acid Detoxification/Reclamation, Phase IV (RLO/PNL) - Demonstration of processes that reduce the volume, quantity, and toxicity of metal-bearing waste acids generated from metal-finishing operations.

STANDARDS/METHODS FOR SITE REMEDIATION/STABILIZATION/CLOSURE

- Trichloroethylene (TCE)-Contaminated Groundwater (ALO/KCP) - Demonstration of destruction of TCE contained in pumped groundwater by a hydrogen peroxide, ozone, ultraviolet (uv) light treatment system.
- Central Facilities Landfill-II (IDO/INEL) - Demonstration of technologies for nonintrusive locating and monitoring of buried hazardous wastes and for remediating localized hazardous waste contamination.
- Destruction of Volatile Organic Chemicals (VOCs) in Groundwater (ORO/ORNL) - Demonstration of several technologies for the destruction of VOCs contained in groundwater.
- Low-Level Waste Crib (116-B-6-1) (RLO/PNL) - Demonstration of in situ vitrification (ISV) technology to fix fission products and immobilize or destroy hazardous chemicals in soil at a mixed waste site.
- Gasoline Spill (SAN/LLNL) - Demonstration of vacuum venting technology for recovering and processing gasoline constituents from soil and groundwater.

Table I. (Continued)

STANDARDS/METHODS FOR SITE REMEDIATION/STABILIZATION/CLOSURE (Continued)

- Site 300 TCE Spill (SAN/LLNL) - Demonstration of vacuum venting for the removal of TCE from soil and perched groundwater.
- Groundwater Biological Treatment (RLO/PNL) - Demonstration of groundwater biodenitrification and carbon tetrachloride biodegradation using indigenous organisms.
- C&P Area Burning Rubble Pit (SRO/SRL) - Demonstration of bioreclamation of soil and groundwater contaminated with chlorinated hydrocarbons using indigenous bacteria enhanced by vegetation.

IMPROVED BURIAL PRACTICES AND WASTE FORMS

- Landfill Cap Verification (ALO/SNLA) - Field and laboratory studies to observe and simulate fluid movement beneath a landfill cap; results will be used to validate a model.
- Encapsulation Development - Phase IV (CHO/BNL) - Investigation of encapsulation materials for potential application to hazardous waste disposal.

PATHWAYS ANALYSIS

- In Situ Detection of Organics - Phase IV (SAN/LLNL) - Development of remote fiber spectroscopy system for detecting and monitoring selected hazardous organic compounds.
- Retardation Factors for VOCs (SAN/LLNL) - Demonstration of method for determining VOC distribution coefficients and retardation factors from soil and water samples collected from monitoring wells.

ALO = Albuquerque Operations Office
LANL = Los Alamos National Laboratory
CHO = Chicago Operations Office
ANL = Argonne National Laboratory
IDO = Idaho Operations Office
INEL = Idaho National Engineering Laboratory
RLO = Richland Operations Office
WHC = Westinghouse Hanford Company
ORO = Oak Ridge Operations Office
PNL = Pacific Northwest Laboratory
KCP = Kansas City Plant
ORNL = Oak Ridge National Laboratory
SAN = San Francisco Operations Office
LLNL = Lawrence Livermore National Laboratory
SRO = Savannah River Operations Office
SRL = Savannah River Laboratory
SNLA = Sandia National Laboratory - Albuquerque
BNL = Battelle National Laboratory

Table II. Description of ongoing Technology Demonstration Projects

PROJECT TITLE: SUPERCRITICAL WATER OXIDATION OF HAZARDOUS CHEMICAL WASTES (PHASE IV)

LOCATION: Los Alamos National Laboratory
Los Alamos, New Mexico

PROJECT OBJECTIVE: To demonstrate the feasibility of the supercritical water oxidation concept for the destruction of hydrocarbon and oxygenated wastes.

WASTE PROBLEM: Liquid wastes containing water, hydrocarbons, and oxygenated compounds are common to most DOE-DP facilities. Technology, in addition to incineration, for the destruction of the hazardous chemical contents of these liquid wastes is desired.

TECHNOLOGY: Above a certain temperature and pressure (647 K and 22.13 MPa), water becomes a fluid that is neither a liquid nor a gas but has some of the characteristics of both. In this state, the solvent properties of water reverse so that nonpolar, organic compounds become soluble and inorganic salts become insoluble. Under these conditions, oxidation of hazardous organic chemicals, such as chlorinated solvents and other hydrocarbons, takes place rapidly and completely. Carbon is converted to carbon dioxide, hydrogen is converted to water, and other components of the hazardous hydrocarbon are converted to an oxidized state. No oxides of nitrogen are generated, however. These properties of supercritical water will be utilized in a process tailored to the needs of DOE-DP facilities.

PROJECT INITIATION: 12/88 PROJECT COMPLETION: 9/91

PROJECT STATUS: This is a new project that will demonstrate a waste technology developed by a HAZWRAP R&D project. A demonstration reactor has been designed, and procurement of component parts is under way. Relevant regulatory requirements are being monitored, although no permits appear to be needed at this time. Contact is being maintained with several private companies that have interests in development of this technology.

Table II. (Continued)

PROJECT TITLE: DEVELOPMENT OF A GAS CYLINDER DISPOSAL PLANT (PHASE IV)

LOCATION: Los Alamos National Laboratory
Los Alamos, New Mexico

PROJECT OBJECTIVE: To demonstrate a system for safely disposing of gas cylinders that are damaged or leaking or whose contents are unknown.

WASTE PROBLEM: Most DOE facilities urgently need a practical method of handling and disposing of the contents of leaking or damaged gas cylinders or cylinders whose contents are unknown. Current safety considerations and environmental regulations have made the past practices of cylinder disposal unacceptable.

TECHNOLOGY: Technology exists within the commercial sector for the recontainerization of the contents of leaking or damaged cylinders or of the unknown contents of a cylinder. Contracts will be placed for the design and fabrication of a mobile system to handle one cylinder at a time. The system under consideration consists of a pressure vessel into which the problem gas cylinder is placed. The pressure vessel can be purged with an inert gas or evacuated with a vacuum pump. After the atmosphere of the pressure vessel has been prepared, a hole is drilled into the side of the problem cylinder with a hydraulically driven, remotely controlled drill located within the pressure vessel. Contents of the cylinder are released into the pressure vessel where the gas can be sampled and identified. Once identified, the gas can be repacked into a new cylinder.

PROJECT INITIATION: 12/88 PROJECT COMPLETION: 9/91

PROJECT STATUS: This is a new project that will demonstrate technology developed by a HAZWRAP R&D project. Commercial gas cylinder recontainerization, treatment, and disposing capabilities, both existing and under development, have been identified. Los Alamos is negotiating a contract for handling and disposal of these problem cylinders, which lend themselves to sampling and analysis and subsequent shipment to off-site treatment facilities. Existing recontainerization technology for unknown/unshippable cylinders has been determined to be available from two sources. Several issues related to procurement and testing of these technologies remain to be resolved.

Table II. (Continued)

PROJECT TITLE: TREATMENT/DISPOSAL OF REACTIVE METALS (PHASE IV)

LOCATION: Argonne National Laboratory
Argonne, Illinois

PROJECT OBJECTIVE: To demonstrate a spray-burning process for converting large quantities of reactive metal waste contaminated with radioactive materials into a glass product suitable for land disposal.

WASTE PROBLEM: Large quantities of waste sodium contaminated with radioactive isotopes of cesium, strontium, and sodium are stored at Idaho and at Hanford. It is estimated that approximately 530 tons is stored, and over 20 tons per year is produced at Hanford. Sodium is reactive with both water and oxygen and must be converted into other chemical forms before disposal.

TECHNOLOGY: The integrated glass formation system for disposal of reactive metal wastes will combine a spray-burn system for handling large quantities of reactive metal wastes, a glass-forming powder delivery system, and a cyclonic reactor to generate an appropriate glass product. The glass-forming powder delivery system and the cyclonic reactor, which were developed at Argonne, will be integrated with the spray-burn system available from a commercial vendor. The process will be demonstrated at the facility of a commercial vendor, who will be selected by the DOE procurement process. Successful completion of the demonstration at the vendor facility will be followed by an evaluation of the process at an appropriate waste sodium storage facility.

PROJECT INITIATION: 12/88 PROJECT COMPLETION: 9/91

PROJECT STATUS: This is a new project that will demonstrate technology developed by a HAZWRAP R&D project. Work progressed on the selection process for a subcontractor to perform the demonstration under the technical guidance of ANL. Intent to award a contract was published, and 20 commercial firms expressed interest in performing the demonstration. The Statement of Work and RFPs are being finalized and will be mailed to all potential bidders by July 1, 1989.

Table II (Continued)

PROJECT TITLE: RADIOACTIVE LEAD DECONTAMINATION DEMONSTRATION

LOCATION: Idaho National Engineering Laboratory
Idaho Falls, Idaho

PROJECT OBJECTIVE: To demonstrate melting/refining as a viable method for the decontamination of lead contaminated with radioactive material.

WASTE PROBLEM: Lead, in various forms, sizes, and shapes, has been used as shielding at virtually all DOE facilities dealing with radioactivity. This contaminated lead is subject to Environmental Protection Agency (EPA) regulations and cannot be disposed of through land burial. The only solution is to decontaminate the lead.

TECHNOLOGY: Bench-scale lead decontamination tests that involved beta/gamma surface contamination have been conducted at INEL with excellent results. This demonstration will use a 10-ton facility to melt/refine lead, in various forms and shapes, to reduce uranium contamination to levels that would permit release of lead for reuse or resale.

PROJECT INITIATION: 12/88 PROJECT COMPLETION: 6/90

PROJECT STATUS: This is a new demonstration project started in FY 1989. Necessary equipment and materials have been acquired for conducting small-scale refining tests in July 1989 on lead contaminated with both uranium and radioactive isotopes. Solidification tests will be conducted on the dross generated during these tests.

Table II (Continued)

PROJECT TITLE: PLASMA ARC FURNACE DEMONSTRATION

NOTE: This is a cooperative demonstration effort between the DOE HAZWRAP TD Program and the EPA Superfund Innovative Technology Evaluation (SITE) Program.

LOCATION: DOE Component Development Integration Facility (CDIF)
MSE, Inc.
Butte, Montana

PROJECT OBJECTIVE: To establish the efficacy of the Plasma Arc Furnace technology developed by Retech, Inc., Ukiah, California, to destroy the organic and immobilize the inorganic constituents of hazardous wastes. Phase 1 constitutes the SITE portion of the demonstration and will use soils from the Butte area that contain hazardous organic chemicals and tailings from the mining operations that contain various metals. Phase II constitutes the HAZWRAP portion and will utilize hazardous waste mixtures of interest to DOE.

TECHNOLOGY: This process destroys organic wastes and reduces the volume of inorganic wastes. Solid and liquid wastes are fed into a rotating reservoir within a centrifugal reactor. Wastes are indirectly heated by a plasma torch; the high temperatures achieved during this process volatilize liquid components of the waste and achieve high destruction efficiencies. Organic constituents are converted to carbon monoxide, hydrogen, and hydrochloric acid, and in some cases, to carbon dioxide and water. The volatilized components are captured and treated in a gas scrubber unit. The inorganic constituents of the waste (soils, metals, etc.) are converted to a vitrified mass.

PROJECT INITIATION: 10/88 PROJECT COMPLETION: 1/90

PROJECT STATUS: This is a new demonstration project started in FY 1989. Modifications at the CDIF to prepare a site for the plasma equipment are 70% complete. The Retech Plasma Centrifuge Reactor is scheduled for transport to Butte in mid-June. The EPA tests are scheduled to begin in September 1989.

Table II (Continued)

PROJECT TITLE: HEXONE TANK WASTE TREATMENT DEMONSTRATION

LOCATION: Hanford Reservation
Westinghouse Hanford Company
Richland, Washington

PROJECT OBJECTIVE: To demonstrate technology for the removal and disposal of organic solvents contaminated with radioactive material and contained in underground storage tanks (USTs).

WASTE PROBLEM: Two deteriorating USTs at the Hanford Reservation contain a total of 34,000 gal of a radioactively contaminated hazardous organic mixture, consisting of hexone, normal paraffin hydrocarbons, tributyl phosphate complexes, and water. To comply with both EPA and Nuclear Regulatory Commission regulations, this mixed waste must first be separated into two fractions that can be handled separately. Total radioactivity contained in the two tanks is estimated at 0.25 Ci of mixed fission products.

TECHNOLOGY: This remediation demonstration focuses on three technologies: (1) radioactive decontamination of the liquid through in situ steam stripping or distillation of the organics from the tanks, (2) destruction of the collected organics by incineration, and (3) solidification of the radioactive tars and residuals for subsequent disposal as solid radioactive mixed waste in a permitted area.

PROJECT INITIATION: 5/87 PROJECT COMPLETION: 12/90

PROJECT STATUS: Contents of both USTs have been sampled and analyzed. Pilot-scale tests to select the most efficient method for decontamination of the liquid were conducted; the process selected was distillation. Field-scale equipment has been designed, and fabrication is nearly complete. Five railroad tank cars have been acquired for temporary storage of the cleaned hexone before its incineration. Distillation activities are expected to begin in August 1989. The procurement process for hexone incineration services has started.

Table II (Continued)

PROJECT TITLE: CHLORINATED SOLVENT SUBSTITUTION AT THE Y-12 PLANT

LOCATION: Oak Ridge Y-12 Plant
Oak Ridge, Tennessee

PROJECT OBJECTIVE: To demonstrate the substitution of a nonhazardous degreasing process (using water and a detergent) for a process using a chlorinated solvent currently in use in maintenance operations.

WASTE PROBLEM: Some degreasing operations at the Y-12 Plant utilize a system that uses a chlorinated solvent (HydroSeal) plus freon in an ultrasonic bath. This solvent contains methylene chloride, which is an EPA-recognized carcinogen and which will also soon be covered under DOE Order 5480.10 (Carcinogen Control Program). Successful substitution will reduce chlorinated solvent disposal problems and also demonstrate compliance with waste minimization plans.

TECHNOLOGY: This demonstration will seek a process from the private sector that will replace the current process that uses a chlorinated solvent. Procurement, installation, and testing of the new process are major phases of the demonstration. This project will interface with the nationwide DOE-DP nuclear weapons complex chlorinated solvent substitution programs through established working committees.

PROJECT INITIATION: 12/88 PROJECT COMPLETION: 9/90

PROJECT STATUS: This is a new demonstration project started in FY 1989. Specifications and cost estimates are being prepared on the ultrasonic cleaning system that will be utilized in the demonstration. An outline was prepared and work begun on preparation of a report documenting work that has been conducted over the past several years at the Y-12 Plant on the replacement of chlorinated solvents. Involvement of project personnel with the DOE Chlorinated Hydrocarbon Solvents Coordinating Committee continues.

Table II (Continued)

PROJECT TITLE: TRICHLOROETHYLENE-CONTAMINATED GROUNDWATER TREATMENT DEMONSTRATION

LOCATION: DOE Kansas City Plant
Allied-Signal Aerospace Company
Kansas City, Missouri

PROJECT OBJECTIVE: To demonstrate the destruction of chlorinated hydrocarbons contained in pumped groundwater by liquid-phase treatment with hydrogen peroxide, ozone, and uv radiation.

WASTE PROBLEM: This demonstration is being conducted on TCE-contaminated groundwater located below a tank farm at the DOE Kansas City Plant. The top of the water table lies 10 to 15 ft below the ground surface, and the zone extends downward to a depth of about 35 ft. TCE concentrations in the pumped groundwater reach several parts per million.

TECHNOLOGY: Groundwater is extracted through water recovery wells and is passed through a hydrogen peroxide, ozone, uv treatment system. The cleaned water is being discharged to the city sanitary sewer system.

PROJECT INITIATION: 5/88 PROJECT COMPLETION: 9/90

PROJECT STATUS: The treatment unit has been operational for approximately 12 months. To date, approximately 1.5 million gal of groundwater has been successfully treated. The uv/ozone treatment unit has been producing effluent water that meets all permitted discharge standards. Problems have been encountered, however, with iron and manganese oxidizing within the system and clogging the sparger tubes and coating the uv lamp sheaths. The manufacturer is currently working on the system and making modifications to increase the treatment efficiency and the ozone generation capability.

Table II (Continued)

PROJECT TITLE: WASTE ACID DETOXIFICATION AND RECLAMATION (PHASE IV)

LOCATION: Pacific Northwest Laboratory
Richland, Washington

PROJECT OBJECTIVE: To demonstrate processes that reduce the volume, quantity, and toxicity of metal-bearing waste acids generated from metal-finishing operations.

WASTE PROBLEM: Metal-finishing operations at DOE-DP facilities produce quantities of waste acids contaminated with radioactive materials. Detoxification and reclamation of these acids will produce an economic benefit in that the reclaimed acid can be recycled, and the amount of material for disposal is considerably reduced.

TECHNOLOGY: By using distillation, precipitation, and filtration processes, the following goals will be achieved: (1) principal metal ions such as Zr, Cu, and U will be removed from waste acid without reducing acid concentration; (2) the resulting rejuvenated acid will be recycled; (3) anions such as nitrates and fluorides as acid from wastes will be reclaimed by distillation with sulfuric acid; and (4) a residual sulfate waste with low concentrations of nitrates, heavy metals, and radionuclides will be produced.

PROJECT INITIATION: 12/88 PROJECT COMPLETION: 9/91

PROJECT STATUS: This is a new project that will demonstrate technology developed by a HAZWRAP R&D project. Precipitation and distillation were identified as the most feasible processes for reclaiming metals and recycling spent acids. Copper and zirconium were removed from actual spent acid streams with 85% recovery using oxalic acid and sodium fluoride, respectively. Vacuum distillation in a batch packed column demonstrated 80% recovery of acid and a 40% reduction in waste volume from a process stream containing uranium, nitric acid, and sulfuric acid. A 10 gal/h system has been designed, and construction will be completed this year. The system will test simulated spent acid streams from various DOE plants in FY 1990. The equipment will be transferred to an operating facility for on-site demonstration in FY 1991.

Table II (Continued)

PROJECT TITLE: CENTRAL FACILITIES LANDFILL-II REMEDIATION DEMONSTRATION

LOCATION: Idaho National Engineering Laboratory
Idaho Falls, Idaho

PROJECT OBJECTIVE: To demonstrate technology for the nonintrusive locating and monitoring of buried hazardous wastes and to investigate technology for the remediation of localized hazardous waste contamination.

WASTE PROBLEM: The Central Facilities Area (CFA) Landfill-II received various hazardous wastes over the period of operation from 1951 to 1982. The types of waste received include waste solvents contained in drums. The quantities of EPA hazardous waste are fairly well known, but the burial locations are not.

TECHNOLOGY: The objective of this project is to find new methods to identify and control localized contaminated areas rather than to remediate the entire landfill. The project includes three phases: (1) obtain site characterization information, (2) obtain and demonstrate technology for nonintrusive locating and monitoring of localized waste sites, and (3) obtain and demonstrate innovative localized remediation technology. Technology will be sought from the private sector through RFPs.

PROJECT INITIATION: 5/87 PROJECT COMPLETION: 9/90

PROJECT STATUS: The hydrogeological characterization of the site was completed. Six shallow monitoring wells were drilled and instrumented. Drilling problems were encountered in the two deep wells in the form of a heaving sand layer at 628 ft below land surface; completion of these wells was delayed. The RFP to private industry for technology applicable to this project was issued in December 1988 and the contract issued in June 1989. The survey technologies to be used include a variety of geophysical methods combined with a localized soil gas survey. The geophysical methods include magnetometry, electromagnetometry (EM), transient electromagnetometry (TEM), ground-penetrating radar (GPR), and complex resistivity. In addition, a field test of the Ultrasonic Ranging and Data System (USRADS) combined with a magnetometer and an EM31 terrain conductivity meter will be conducted in June 1989 by ORNL. These studies will concentrate on the feasibility and applicability of the various methods to the hydrogeological setting of INEL.

Table II (Continued)

PROJECT TITLE: DESTRUCTION OF VOLATILE ORGANIC CHEMICALS IN GROUNDWATER

LOCATION: Oak Ridge National Laboratory
Oak Ridge, Tennessee

PROJECT OBJECTIVE: To demonstrate several of the most promising treatment methodologies available from the private sector for the removal or destruction of VOCs in groundwater.

WASTE PROBLEM: The presence of trace quantities of VOCs in groundwater at DOE facilities is a common and pervasive problem.

TECHNOLOGY: This project consists of the off-site demonstration, on a pilot scale, of several of the most promising treatment methodologies available from the private sector for the removal or destruction of VOCs in groundwaters from the Oak Ridge Reservation. Results should facilitate the comparison of the performance, capability, and costs of the selected methodologies.

PROJECT INITIATION: 12/88 PROJECT COMPLETION: 9/90

PROJECT STATUS: This is a new demonstration project started in FY 1989. A request for expressions of interest was issued to the private sector; responses were requested by the end of June 1989. A draft Statement of Work was prepared and is under review.

Table II (Continued)

PROJECT TITLE: LOW-LEVEL WASTE CRIB (116-B-6-1) REMEDIATION DEMONSTRATION

LOCATION: Pacific Northwest Laboratory
Richland, Washington

PROJECT OBJECTIVE: To demonstrate the most appropriate technology to "fix" fission products and immobilize or destroy hazardous chemicals in the soil at a mixed hazardous waste site.

WASTE PROBLEM: This low-level waste crib (116-B-6-1) received radioactive wastes from equipment decontamination from 1951 to 1968. In addition to fission products, this crib also contains sodium dichromate, sodium oxalate, and sodium sulfomate. The crib is approximately 14 by 18 ft.

TECHNOLOGY: Based upon preliminary site characterization information, the ISV process appears suitable for treatment and stabilization of this site. The ISV technology involves conversion of contaminated soil into a durable glass and crystalline waste form through melting by joule heating. An electric current is passed between electrodes placed in the soil, creating temperatures sufficient to melt the soil (about 1700°C) and to produce, upon cooling, a vitreous mass of relatively high strength and chemical integrity. The project will include (1) a remedial investigation to locate, identify, and quantify the contaminants present in the crib; (2) verification that the ISV technology is applicable to remediate the site; and (3) a demonstration of the ISV technology at the site.

PROJECT INITIATION: 2/88 PROJECT COMPLETION: 9/91

PROJECT STATUS: A GPR survey was performed to provide a more accurate determination of the location and depth of the crib and surrounding underground structures. Following this survey, boreholes were drilled into and adjacent to the crib to obtain soil samples for chemical and radionuclide characterization. Preliminary data indicate that the major part of the contamination is located just below the crib (at about 14 ft) and decreases to background at a depth of about 25 ft. An engineering scale ISV test was performed to verify that ISV is capable of vitrifying the contaminants, soil, and wooden timbers expected at the crib site; the results confirmed that ISV technology is applicable. Initial preparations are under way at the site, and the ISV system will be moved onsite by late summer.

Table II (Continued)

PROJECT TITLE: GASOLINE SPILL REMEDIATION DEMONSTRATION

LOCATION: Lawrence Livermore National Laboratory
Livermore, California

PROJECT OBJECTIVE: To demonstrate innovative in situ processing technology to remove and process organics (gasoline) from affected soil and groundwater for restoration of the quality of water in the affected water-bearing zones.

WASTE PROBLEM: This demonstration is being conducted on a reasonably well-defined spill of leaded gasoline that leaked from a UST over a period of several months in 1978 to 1979. Gasoline constituents penetrated to a depth of about 130 ft and expanded over a diameter of about 120 ft. Concentrations of the constituents of gasoline in the soil range from a few parts per billion to 80,000 ppb, depending upon depth. Concentrations in the groundwater are in the several-parts-per-billion range.

TECHNOLOGY: The demonstration will include mobilization and removal of gasoline constituents from soil, both water-saturated and water-unsaturated, to depths of 150 ft by use of an induced venting process. This process involves application of a partial vacuum created by a vacuum blower system connected to a venting well. The gas flow containing gasoline vapors, air, and water coming from the venting well will be processed through air strippers, with the organic vapors vented through a thermal oxidizer. To treat the water-saturated zones, the water table will be depressed by use of dewatering pumps at the base of the venting well. Induced venting will operate concurrently with the dewatering operation.

PROJECT INITIATION: 4/87 PROJECT COMPLETION: 9/90

PROJECT STATUS: A multiply completed extraction well was installed, and each of the five individually screened intervals in the unsaturated zone was tested for fuel hydrocarbon concentrations. A vacuum extraction system with thermal oxidizer was put into operation, with monitoring of vapor concentrations at the wellhead and after the oxidizer. Calculations based upon flow rates and hydrocarbon concentrations indicate that about 3300 gal of fuel has been removed through May 1989. This has been accomplished over an accumulated operation time of 1140 hours. These operations demonstrated the effectiveness of vacuum extraction for removing fuel hydrocarbons from the unsaturated zone. Hydrocarbon concentrations in the uppermost zone (20 to 25 ft) declined significantly (from >2600 ppm to <50 ppm). Deeper zones have not shown significant decreases. Consequently, extractions in the recent months have been focused on zones 2 through 5.

Table II (Continued)

PROJECT TITLE: SITE 300 TRICHLOROETHYLENE SPILL REMEDIATION DEMONSTRATION

LOCATION: Lawrence Livermore National Laboratory
Livermore, California

PROJECT OBJECTIVE: To demonstrate the technique of induced vacuum venting for the removal of TCE from soil and perched groundwater.

WASTE PROBLEM: This demonstration is to be conducted on TCE leakage from a process system line that has contaminated a soil interval about 14 ft thick and about 25 ft below the surface. The lateral extent of the contamination covers an area about 300 ft in diameter. The lower portion of the contaminated soil lies in a perched water zone.

TECHNOLOGY: This project will demonstrate a process involving induced venting by applying vacuum to a series of wells completed and screened in the affected soil interval. The induced gas flow through the soil, created by the partial vacuum maintained on the well bore, will cause the trapped TCE to volatilize and move toward the well bore in an areal sweep process. Entrained TCE in the effluent air stream from the wells will be disposed of through surface-mounted processing equipment. The soil will be dewatered to near the bottom of the contaminated soil interval to expose the soil to the venting process.

PROJECT INITIATION: 5/88 PROJECT COMPLETION: 9/90

PROJECT STATUS: Two pilot remediation systems were constructed and installed at the Building 834 Complex. The systems consist of a dual-tank air sparging unit for extraction and treatment of groundwater and an induced vacuum unit for extraction and discharge of TCE vapors from the unsaturated zone. The first system was installed near the southern, downgradient end of the TCE plume. In 6.5 months of operation, about 20,000 gal of water was extracted. TCE concentrations in the extracted water have declined from 19 ppm (by weight) to about 0.2 ppm. TCE concentrations in the extracted vapors have declined from about 6 ppm (by volume) to about 2 ppm. The second system is installed near the center of the 834 Complex in the vicinity of the TCE leaks, where TCE concentrations in water range up to 400 ppm (by weight). About 4300 gal of water containing about 10 pounds of TCE has been extracted. Extracted vapors contain up to 730 ppm (by volume); about 500 pounds of TCE has been removed. Thus far, the project demonstrated that air sparging and induced vacuum extraction are effective methods to remove TCE from groundwater and from sparingly permeable soil and rock.

Table II (Continued)

PROJECT TITLE: GROUNDWATER BIOLOGICAL TREATMENT DEMONSTRATION

LOCATION: Pacific Northwest Laboratory
Richland, Washington

PROJECT OBJECTIVE: To demonstrate a biological process for the destruction of nitrates and organic contaminants in groundwater.

WASTE PROBLEM: Liquid wastes have been generated over the 40 years of Hanford site operations. Some of these liquid wastes that were discharged to the soil contained radioactive and hazardous chemicals as well as nitrates. Groundwater from the U1/U2 crib area contains nitrate in excess of 400 ppm and up to 600 ppb of carbon tetrachloride. This groundwater also contains uranium and other heavy metals.

TECHNOLOGY: This project will demonstrate technology to destroy nitrates and specific organic contaminants in groundwater using facultative anaerobic microorganisms. Laboratory tests have been conducted using microorganisms capable of simultaneous destruction of both nitrates and carbon tetrachloride. Tests will be conducted using a pilot-scale bioreactor system, developed in FY 1988 for another project, first on simulated groundwater and then on actual groundwater at the U1/U2 crib area.

PROJECT INITIATION: 12/88 PROJECT COMPLETION: 3/91

PROJECT STATUS: This is a new technology demonstration project started in FY 1989. Initial tests with simulated groundwater (nonradioactive) are partially complete. Tests are being performed with a pilot-scale bioreactor system consisting of a bioreactor, clarifier, feed tanks, and associated control and monitoring equipment. Denitrification tests were completed in April 1989, and the results demonstrated that the system could be operated at feed rates exceeding design while producing an effluent nitrate concentration below drinking water standards. Carbon tetrachloride destruction tests were initiated in May 1989. These tests using simulated groundwater will continue through FY 1989; tests with groundwater from the U1/U2 crib site will begin in FY 1990.

Table II (Continued)

PROJECT TITLE: C&P AREA BURNING RUBBLE PIT BIORECLAMATION PROJECT

LOCATION: Savannah River Site
Aiken, South Carolina

PROJECT OBJECTIVE: To develop and implement an environmental project for demonstrating/evaluating the potential of in situ bioreclamation for cleanup of shallow subsurface contamination and bioreactor bioreclamation of deep subsurface contamination resulting from disposal of chlorinated hydrocarbons in an unlined waste disposal facility.

WASTE PROBLEM: Disposal of liquid chemical wastes in the past consisted of discharge and/or burning in small, shallow, unlined basins. Over the period from 1956 to 1974, burning rubble pits at the Savannah River Plant were used in this manner. The soil (at a depth of 1.5 ft) has detectable amounts of perchloroethylene (PCE) and TCE at levels of 44.8 and 5.5 micrograms per gram of soil, respectively; the groundwater contains these same contaminants at much lower levels.

TECHNOLOGY: The first subtask is a demonstration of in situ bioreclamation of contaminated soil using microorganisms enhanced by vegetation. Indigenous bacteria have been isolated that aerobically degrade chlorinated alkenes and alkanes to carbon dioxide, hydrochloric acid, and water. These microorganisms will be selectively enhanced in subsurface soils by planting and cultivating certain types of vegetation. The second subtask is a demonstration of bioreclamation of contaminated groundwater using a bioreactor containing indigenous bacteria.

PROJECT INITIATION: 2/88 PROJECT COMPLETION: 9/91

PROJECT STATUS: Soil samples and plants were taken from the site to set up laboratory vegetation microcosm studies. The soil samples were characterized for particle size distribution, nutrient content, and cation exchange capacity. Rhizosphere and edaphosphere soils were collected so that microbial degradation of PCE could be evaluated. Live plants from the site were transferred to greenhouses for study. Laboratory studies are continuing with a new series of bioreactor tests.

Table II (Continued)

PROJECT TITLE: LANDFILL CAP VERIFICATION DEMONSTRATION

LOCATION: Sandia National Laboratories
Albuquerque, New Mexico

PROJECT OBJECTIVE: To investigate the performance of an impermeable composite-cap closure of a chemical waste landfill in the mitigation of contaminant migration in the vadose zone resulting from water infiltration.

WASTE PROBLEM: This demonstration is to be conducted on an unlined landfill used for shallow burial of a variety of wastes. This landfill will be capped for closure with funds from other sources in FY 1990. The landfill is situated in unsaturated alluvium (primarily sand and gravel) about 500 ft above the water table. Hazardous wastes contained at this site include mineral acids, oxidizing and reducing agents, organic compounds, metals, inorganic salts, and chromic acid in concentrations up to several hundred parts per million in near-surface soil. This landfill was in operation from 1962 until 1980.

TECHNOLOGY: The demonstration consists of a field test of the effectiveness of the cap method by direct measurement of water infiltration adjacent to and beneath the cap. Measurements include moisture content, soil moisture tension, and permeability. Complementary laboratory measurements include soil moisture retention and moisture flow experiments.

PROJECT INITIATION: 12/88 PROJECT COMPLETION: 9/90

PROJECT STATUS: This is a new demonstration project started in FY 1989. Primary activities were the collection of all available data on the landfill site and the development of new data on surface sediments and geological features. A laboratory permeameter was constructed and tested for the determination of saturated hydraulic conductivity on samples collected at the site. Neutron probes for in situ moisture determination were acquired, and field testing is under way. Construction of tensiometers and thermocouple psychrometers for in situ determination of capillary pressure head is under way. A location adjacent to the landfill was established as a site for development, field testing, and calibration of instruments.

Table II (Continued)

PROJECT TITLE: ENCAPSULATION DEVELOPMENT - PHASE IV

LOCATION: Brookhaven National Laboratory
Upton, Long Island, New York

PROGRAM OBJECTIVE: To demonstrate the application of encapsulation materials and technology developed in the HAZWRAP R&D Program for the treatment of selected hazardous chemical wastes.

WASTE PROBLEM: Many of the DOE-DP plants and laboratories produce hazardous chemical and mixed waste streams. Disposal of these stored wastes is a problem common to the DOE-DP complex.

TECHNOLOGY: Specific wastes, such as incinerator ash, sludges, and toxic metals, have been selected as potential candidates for application of new or improved encapsulation materials that are not currently being used for the encapsulation of radioactive and/or hazardous waste materials. These encapsulation materials include polyethylene, sulfur cement, and polyester-styrene.

PROJECT INITIATION: 1/89 PROJECT COMPLETION: 9/92

PROJECT STATUS: This is a new project started in FY 1989 to demonstrate technology developed in the HAZWRAP R&D Program. The feasibility of using polyethylene as a solidification agent for nitrate salt wastes has been demonstrated on a bench-scale. High volumetric efficiencies (70 wt%) were obtained using a single screw-type extruder at 120^{0} C. The EPA Extraction Procedure test indicated that the nitrate release from this encapsulated form was an order of magnitude lower than the regulatory limit for drinking water standards. Confirmatory work is currently under way using actual nitrate salt waste from the DOE Rocky Flats Plant. Planning for the demonstration activity is under way.

Table II (Continued)

PROJECT TITLE: IN SITU DETECTION OF ORGANICS - PHASE IV

LOCATION: Lawrence Livermore National Laboratory
Livermore, California

PROJECT OBJECTIVE: To demonstrate the application of a fiber-optic-based system for monitoring contaminant species in groundwater. Development of optrodes (optical chemical sensors) chemistries for detecting TCE and chloroform was carried out in the HAZWRAP R&D Program.

WASTE PROBLEM: The problem of monitoring groundwater at multiple in situ locations for selected hazardous organic compounds with remote instrumentation exists at most DOE-DP sites.

TECHNOLOGY: Optical chemical sensors have been developed that are compatible with optical fiber spectrometers. Optrodes have been developed that are selective for TCE in the presence of chloroform. The instrumental system will be demonstrated under field conditions with actual waste streams and in underground water locations.

PROJECT INITIATION: 1/89 PROJECT COMPLETION: 9/92

PROJECT STATUS: This is a new project started in FY 1989 to demonstrate technology developed in the HAZWRAP R&D Program. Much of the work has involved planning the project, obtaining and modifying equipment for field use, and calibrating optrodes. Several cabled optrodes have been fabricated and are ready for field application. Most of the low-level (below 1 ppm) calibrations are completed, and higher level (above 1 ppm) calibrations have been started.

Table II (Continued)

PROJECT TITLE: FIELD-BASED MEASUREMENT OF RETARDATION FACTORS

LOCATION: Lawrence Livermore National Laboratory
Livermore, California

PROJECT OBJECTIVE: To demonstrate field-based measurement techniques for determining the distribution of solutes between solid and liquid phases in a heterogeneous geological setting. Methods will be developed to incorporate the spatial variability of the field-measured distribution into predictive modeling of the rate of plum movement, extent of site contamination, and the effectiveness of remedial processes.

WASTE PROBLEM: There is a need for improved models for use in predicting plume movement/distribution in geologic formations.

TECHNOLOGY: Analytical data will be derived from the numerous monitoring and extraction wells being installed at LLNL. These data will be used to improve the accuracy of the retardation factors currently used in various models used to predict movement of contaminants in underground geologic formations.

PROJECT INITIATION: 1/89 PROJECT COMPLETION: 9/90

PROJECT STATUS: This is a new technology demonstration project started in FY 1989. An algorithm was developed to calculate the field-based retardation factors. Sensitivity analyses were done involving parameters such as bulk soil density, skeletal density, and distribution coefficient to quantitatively establish the degree of accuracy needed in individual parameters to ensure desired accuracy in the final retardation factors. Comparison of solid structure determinations were performed on LLNL soils to evaluate such methods as wet weight/dry weight analyses, mercury porosimetry, dry gas pycnometry, and fluid volume displacement. Comparisons of VOC extraction techniques used during EPA Method 8010/8020 analysis have begun to identify methods that yield the best estimate of total VOCs in well core samples. Procedures were examined to improve field and laboratory handling of saturated core samples to minimize loss of VOCs.