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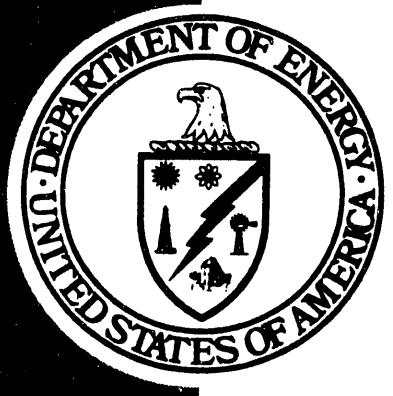

Office of Environmental Management

Office of Technology Development

Rocky Flats Compliance Program

Technology Summary

February 1994

ROCKY FLATS COMPLIANCE PROGRAM

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OFFICE OF TECHNOLOGY DEVELOPMENT
OVERVIEW

The Department of Energy (DOE) established the Office of Technology Development (EM-50) (OTD) as an element of Environmental Restoration and Waste Management (EM) in November, 1989 (see Figure A). The organizational structure of EM-50 is shown in Figure B.

EM manages remediation of all DOE sites, as well as wastes from current operations. The goal of the EM program is to minimize risks to human health, safety and the environment, and to bring all DOE sites into compliance with Federal, state, and local regulations by 2019. EM-50 is charged with developing new technologies that are safer, faster, more effective and less expensive than current methods.

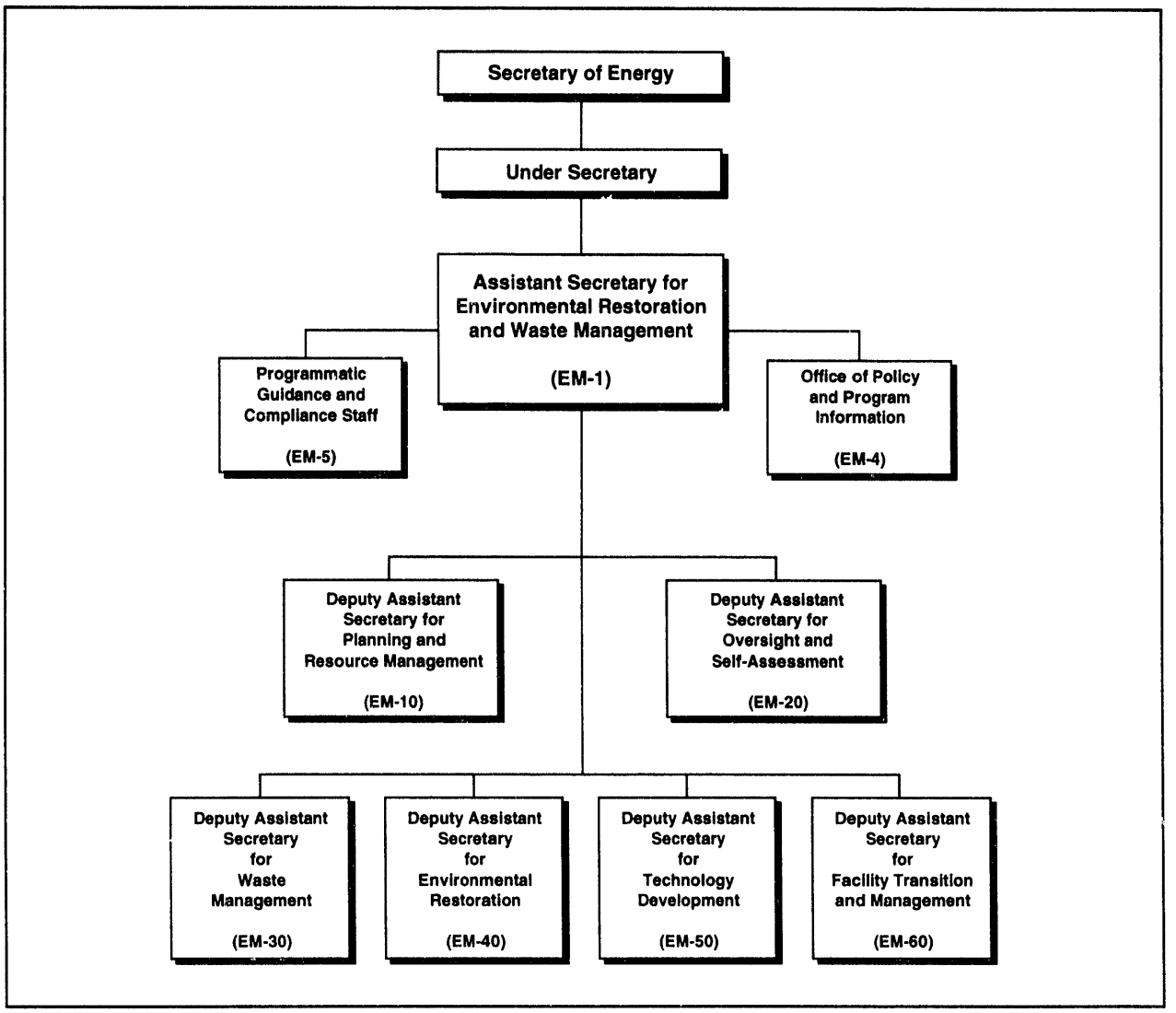

Figure A. DOE Organizational Structure as of June 1993.

In an effort to focus resources and address opportunities, EM-50 has developed **Integrated Programs (IP)** and **Integrated Demonstrations (ID)**. An *Integrated Program* focuses on technologies to solve a specific aspect of a waste management or environmental problem and it can be either unique to a site or common to many sites. An Integrated Program supports applied research to develop innovative technologies in key application areas organized around specific activities required in each stage of the remediation process (e.g., characterization, treatment, and disposal).

The *Integrated Demonstration* is the cost-effective mechanism that assembles a group of related and synergistic technologies to evaluate their performance individually, or as a complete system, in correcting waste management and environmental problems from cradle to grave.

In addition to IDs and IPs, there are programs within EM-50, such as the Rocky Flats Compliance Program, which address site-specific and/or special environmental problems.

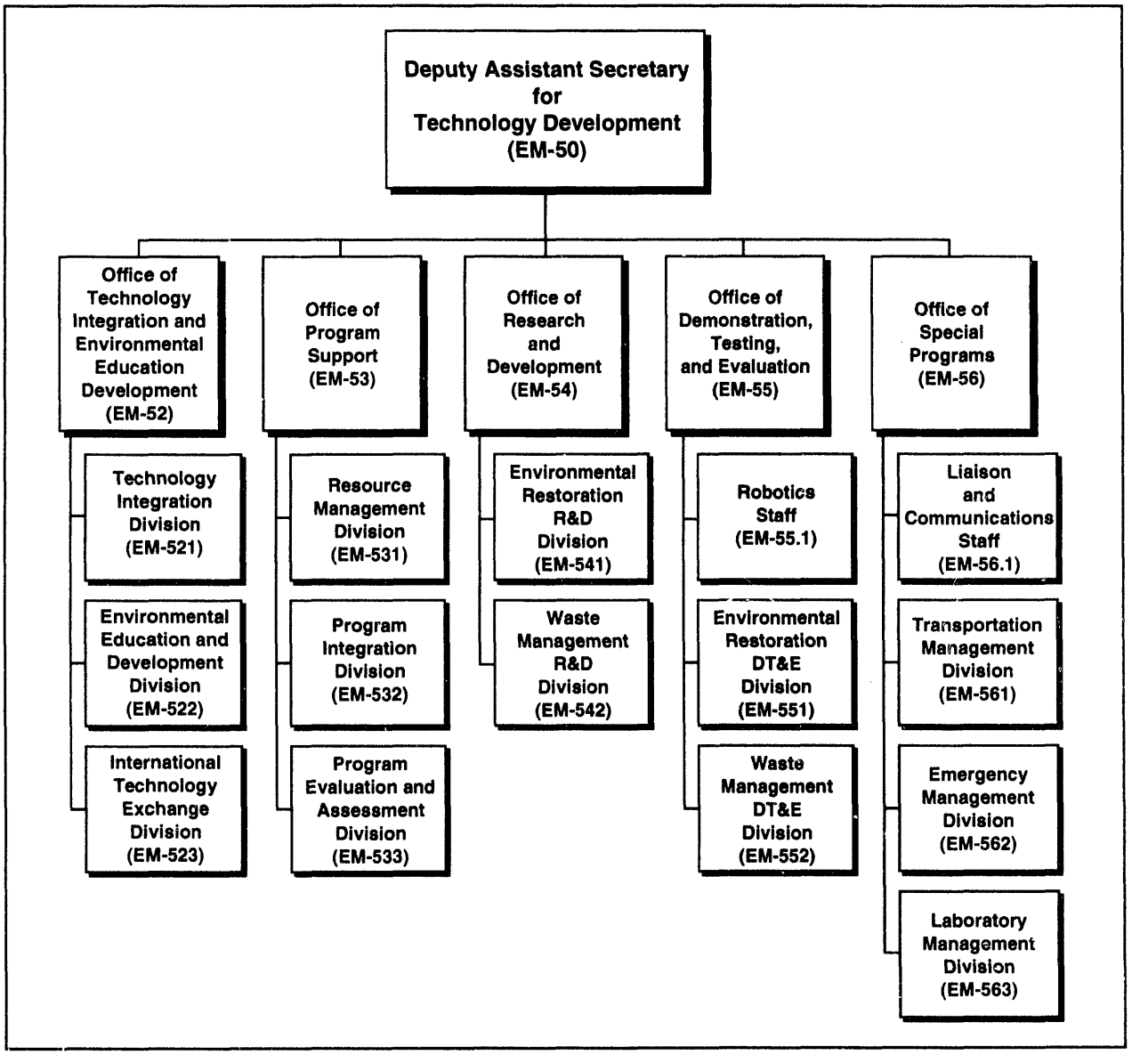

Figure B. Office of Technology Development Organizational Structure as of June 1993.

ROCKY FLATS COMPLIANCE PROGRAM OVERVIEW

PURPOSE, MISSION, AND ORGANIZATION

The primary objective of the Office of Technology Development, Rocky Flats Compliance Program (RFCP), is to develop alternative treatment technologies for mixed low-level waste (wastes containing both hazardous and radioactive components) to use in bringing the Rocky Flats Plant (RFP) into compliance with Federal and state regulations and agreements. Approximately 48,000 cubic feet of untreated low-level mixed waste, for which treatment has not been specified, are stored at the RFP. A summary of the classification of these wastes is shown in Figure C. In addition, newly generated waste from residue elimination, cleanup, and decontamination and decommissioning activities will require treatment and disposal. RFCP also helps to integrate the technology development for the Rocky Flats site with applicable activities in other parts of DOE's EM organization.

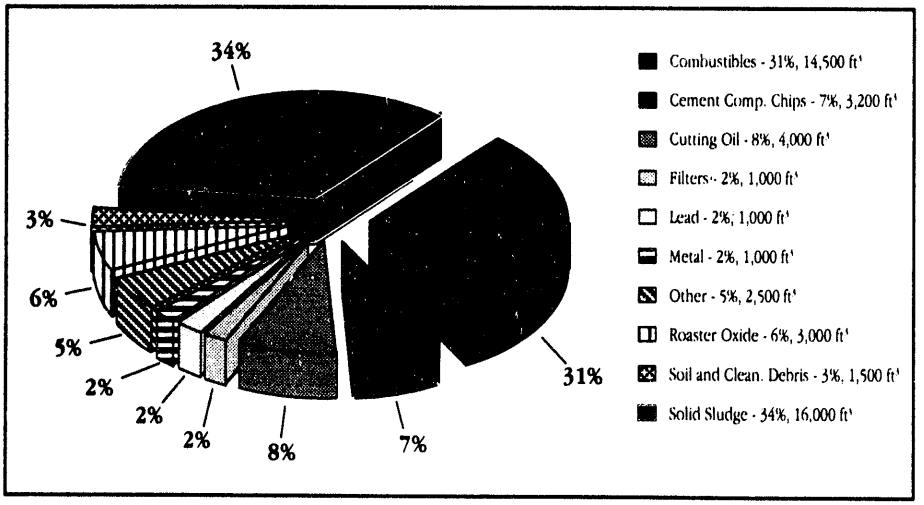

Figure C. Rocky Flats Plant Low-Level Mixed Waste Inventory.

REGULATORY DRIVERS FOR THE ROCKY FLATS COMPLIANCE PROGRAM

The cleanup of the Rocky Flats site is driven by agreements between DOE, the Environmental Protection Agency (EPA), and the Colorado Department of Health (CDH). Under these agreements, a Comprehensive Treatment and Management Plan (CTMP) was drafted to outline the mechanisms by which RFP will achieve compliance with the regulations and agreements. This document describes DOE's strategy to treat low-level mixed waste to meet Land Disposal Restrictions and sets specific milestones related to the regulatory aspects of technology development. These milestones detail schedules for the development of technologies to treat all of the mixed wastes at the RFP. Under the Federal Facilities Compliance Act (FFCA), the CTMP has been incorporated into Rocky Flats Plant Conceptual Site Treatment Plan (CSTP). The CSTP will become the Rocky Flats Plant site Treatment Plan in 1995 and will supersede the CTMP.

TECHNOLOGY NEEDS

The CTMP listed a wide variety of technology options that may be considered for the treatment of the mixed waste at Rocky Flats. Although

technologies, such as incineration and cementation, have been utilized for hazardous waste treatment, investigation of alternative treatments is needed to develop permitable systems, which yield better waste forms, improve process efficiency and achieve cost savings. These alternative technologies are also respondent to regulator and public concerns. Currently, no methods for treating these mixed wastes at RFP have been permitted. Furthermore, no final disposal facility has been identified and approved. In addition to developing treatment technologies, the program is demonstrating, testing, and evaluating systems to reduce the amount of mixed waste requiring disposal.

The technology development activities are organized within the CTMP into a set of systems, each designed to treat a specific waste stream or group of wastes. This Technology Summary describes work focused on the treatment of four waste stream types (Figure D).

- *Solvent Contaminated Wastes (e.g., combustibles)*;
- *Bypass Sludge*;
- *Nitrate Salts; and,*
- *Bulk Lead and Other Bulk Items Surface Contaminated with Organics.*

This comprises the majority of the low-level mixed wastes at Rocky Flats (see Figure D). The efforts in these areas range from laboratory feasibility trials on individual technologies to pilot-scale demonstrations of integrated waste treatment systems. The program provides technologies to support the Office of Waste Operations (EM-30) procurement of Rocky Flats mixed waste treatment capability and capacity as required under the FFCA.

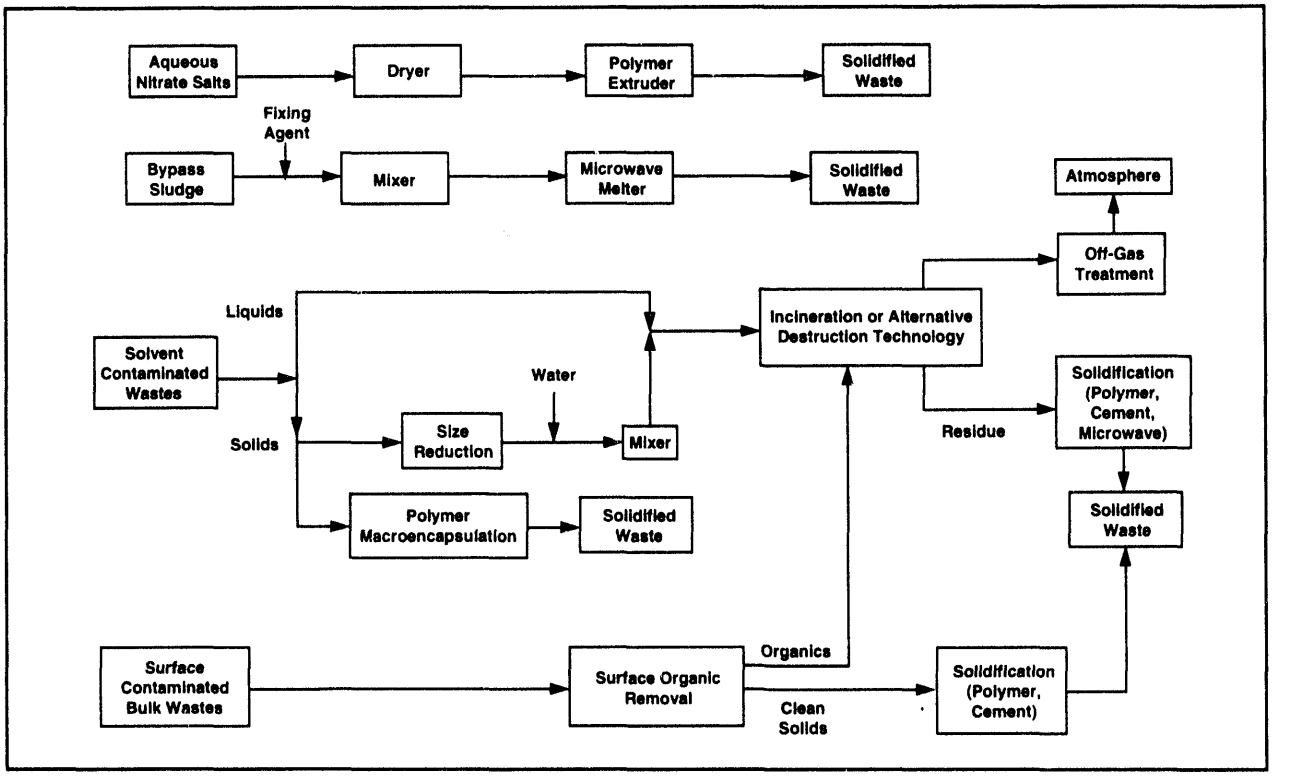

Figure D. Low-Level Mixed Waste Treatment System.

ACCOMPLISHMENTS

Technologies which have been under development by the RFCP for the treatment of Rocky Flats mixed waste include:

- ***Microwave Solidification*** - will provide a method to stabilize inorganic sludges to prevent leaching of hazardous components into the environment. The results of initial laboratory and demonstration-scale tests suggest that stable final wasteforms will be achieved for hydroxide precipitation sludge.

- ***Polymer Solidification*** - another method for stabilization of wastes. This technology would most likely be applied to the nitrate salt, inorganic particulate and debris wastes. Initial laboratory tests with actual waste samples have been successful.

- ***Surface Organic Contaminant Removal*** - these technologies would separate the radioactive and hazardous components and allow separate treatment and disposal. An evaluation of commercially-available volatilization technologies has been conducted and a demonstration program is being initiated.

- ***Alternatives to Incineration*** - these would provide methods to destroy the organic constituents should incineration not be implemented at Rocky Flats. Technologies which would treat the organic contaminants in Rocky Flats' wastes have been identified and laboratory data on destruction efficiencies has been obtained for several key waste streams.

FUTURE DIRECTIONS

Many of the technologies included in the RFCP have been successfully demonstrated at a laboratory or pilot-scale. Scale-up and engineering design issues will be investigated by the technology development teams at Rocky Flats, and the management of the activities will be transitioned to EM's Office of Waste Operations (EM-30), which will be responsible for implementation. Technology development activities within the RFCP will continue to support the development of the technology systems that apply to waste at Rocky Flats and provide potential options for treatment of waste at other DOE sites. A key focus of the program will be the successful integration of National Laboratory, commercial, and university resources into technology development activities directed toward commercialization of RFP technologies.

For more information, please contact:

James Taylor
Program Manager
U. S. Department of Energy
12800 Middlebrook Road
Germantown, MD 20874
(301) 903-7686
(505) 262-8800

Sherri L. Rudolph
Technical Program Officer
Rocky Flats Office
P.O. Box 928
Golden, CO 80402-0928
(303) 966-5788

Microwave Solidification of Mixed Waste

Section 1.0

1.0 MICROWAVE SOLIDIFICATION OF MIXED WASTE

TASK DESCRIPTION

The microwave project is developing a method to immobilize wastes for compliance with Land Disposal Restrictions (LDR) and to minimize the volume of the wastes for storage and disposal. Microwave solidification utilizes microwave energy to melt and glassify waste solids (see Figure 1.0). In this manner, the hazardous components in the waste are immobilized within a stable final wasteform.

This technology is being evaluated as a potential method to treat several mixed wastes, including process sludges, incinerator ash, and miscellaneous wastes, such as crucibles and foundry materials. In contrast to the use of cementation to process these wastes, the microwave approach results in a reduced volume of waste for disposal. In addition, the waste is processed "in-drum", which reduces material handling and generation of another waste stream.

At present, microwave melting for waste solidification is not a commercially-available technology. The basic design of the Rocky Flats microwave technology has been demonstrated with bench-scale tests using actual radioactive wastes. The project has also built a full-scale demonstration system, incorporating potential processes, which has been used for feasibility studies with surrogate wastes.

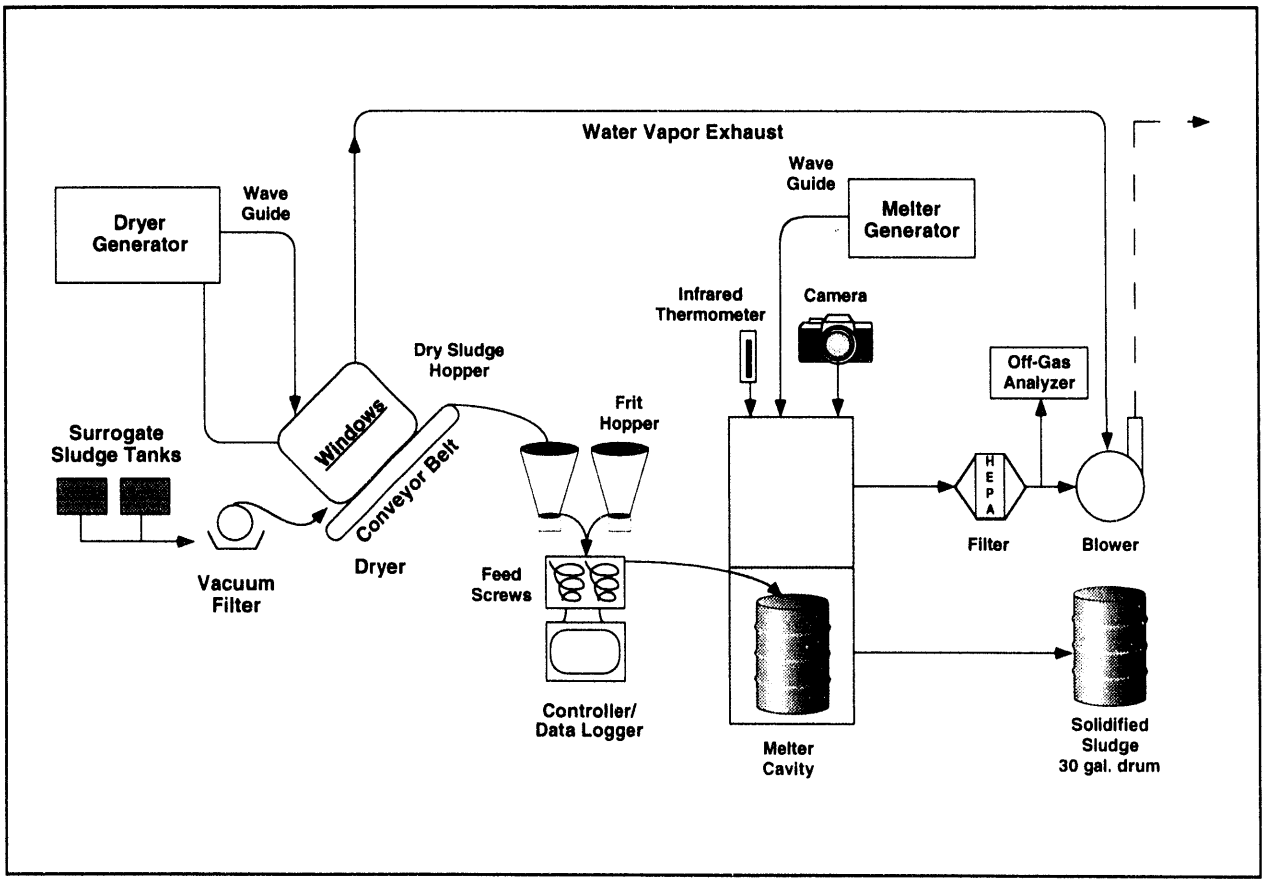

Figure 1.0. Microwave Melter.

TECHNOLOGY NEEDS

The primary focus of the Microwave Solidification project is the completion of the development and evaluation of an integrated microwave production system for implementation at RFP. In FY94, process improvements will be initiated to improve system performance and control. The reliability, accessibility, availability, and maintainability of all systems will be evaluated. Solidification tests using actual radioactive wastes will be completed and analytical tests to confirm the acceptability of the final wasteform will also be conducted.

In addition, the integration of ancillary equipment required for the production microwave system will be performed. Key components include:

- systems for drum opening;
- moving waste drums efficiently in and out of gloveboxes;
- waste pretreatment;
- system control, and
- off-gas monitoring and treatment.

The system under development has been designed to treat a specific process sludge. This sludge is generated at a rate of 1,200 cubic feet per year at RFP. Additional development is necessary to address the Rocky Flats wastes identified above and several waste streams elsewhere in the DOE Complex, which are potentially amenable to microwave treatment.

ACCOMPLISHMENTS

- Completed pilot-scale demonstration on surrogate (non-radioactive) hydroxide precipitation sludge.
- Performed bench-scale tests on actual (radioactive) waste.
- Completed tests (using the Toxic Characteristic Leach Procedure (TCLP)), using surrogate waste, which indicate acceptable leachability of the final wasteform.
- Demonstrated feasibility of using waste raschig rings as glass source for treating sludge waste.

COLLABORATION/TECHNOLOGY TRANSFER

Development of the microwave system at Rocky Flats has been achieved in collaboration with Microdry, Inc. and Rocky Flats Technologies. Investigators at the Oak Ridge National Laboratory and Los Alamos National Laboratory, have also provided input to the microwave project.

The status of work on microwave solidification has been presented at the Second International Mixed Waste Symposium and will be available to designers and engineers of waste management systems. Opportunities for commercialization are also being explored to include solidification of high-level waste at nuclear reactor facilities, soil remediation at Superfund sites and solidification of ash from hazardous waste incinerators.

For further information, please contact:

Gregory S. Sprenger
Principal Investigator
EG&G Rocky Flats
(303) 966-3159

Jerry L. Peterson
Technical Program Manager
EG&G Rocky Flats
(303) 966-5349

Polymer Solidification

Section 2.0

2.0 POLYMER SOLIDIFICATION

TASK DESCRIPTION

Polymer encapsulation of mixed wastes encloses waste products in thermoplastic or thermosetting materials using commercially-available processing technologies (see Figure 2.0). Two primary polymer processes are being tested for RFP wastes.

In one process, thermoplastic polymers, such as polyethylene (a commonly-used plastic that is resistant to chemicals and moisture), are combined with dried waste in a commercially-available extruder, which melts the polyethylene and mixes it with the waste. The waste encapsulated in polyethylene is extruded into a drum, where it solidifies upon cooling. The process operates at a low temperature, requires no off-gas treatment, and generates no secondary waste. Since high loadings of waste may be incorporated into the polymer, a substantial reduction in volume may be possible relative to cementation, which has been used to immobilize wastes at the RFP.

A second process, in which bulk materials (i.e., "debris") are suspended in a drum and encapsulated with molten or liquid plastic, is also being investigated. The solidified polymer surrounds the waste and immobilizes hazardous contaminants. The use of recycled polyethylene is being investigated for this application. Thermosetting plastics (resins combined with hardeners, similar to epoxy) have also been evaluated for encapsulating wastes.

TECHNOLOGY NEEDS

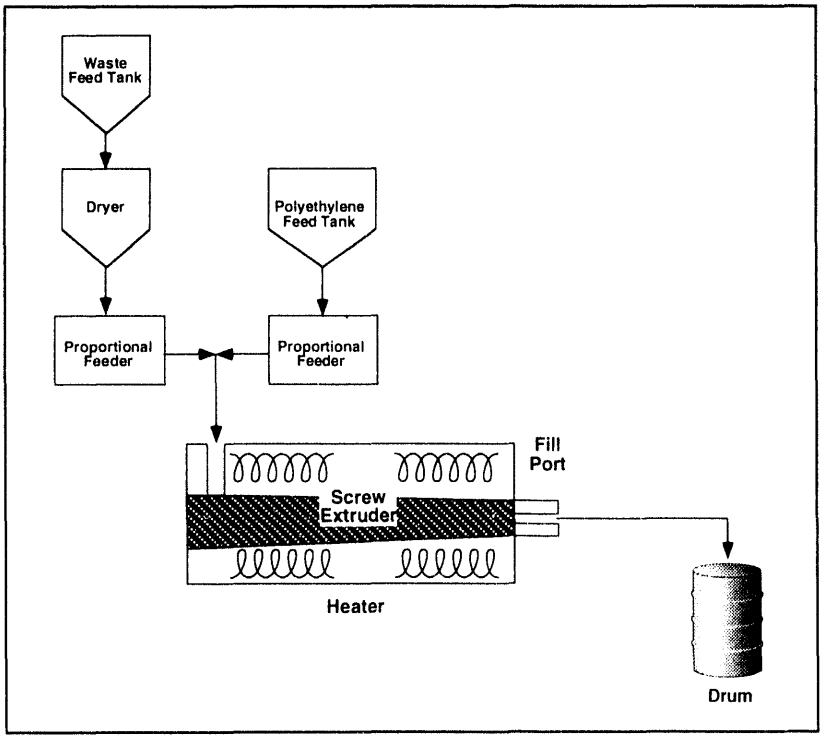

Figure 2.0. Polymer Encapsulation System.

Research efforts focus primarily on the development of a polyethylene extrusion process to stabilize low-level nitrate salt waste, which is one of the largest mixed waste streams at RFP. Pilot-scale studies and an integrated system demonstration are planned to obtain the operational data and design criteria necessary to implement a polymer solidification system for this waste stream. Lab-scale studies have demonstrated the process using actual (radioactive) nitrate salt waste. Treatability studies to evaluate macro and micro encapsulation of other waste streams are also planned.

Scale-up tests using surrogate (non-radioactive) materials are being conducted to identify the optimum method of encapsulating bulk wasteforms, such as lead metal. Tests with actual (radioactive) waste will follow.

ACCOMPLISHMENTS

- Confirmed extrudability of nitrate salts at lab- and pilot-scale.
- Demonstrated acceptable heavy metal leach rates in tests with surrogate and actual nitrate salt waste.
- Initially confirmed radioactive and thermal stability of polyethylene-encapsulated nitrate salt.
- Demonstrated use of recycled plastic for macroencapsulation.

COLLABORATION/TECHNOLOGY TRANSFER

Polymer solidification development at Rocky Flats is being conducted with the collaboration of LCI, Inc. Extrudability studies are also being performed by several equipment vendors. Investigators at Brookhaven National Laboratory are also participating in the development of this technology in conjunction with Pacific Nuclear Services.

Because polymer solidification has been demonstrated for the immobilization of other radioactive wasteforms, (e.g., for nuclear power plants in Japan), data and results will be available to designers and engineers of these waste management systems.

For further information, please contact:

Andrea M. Faucette
Principal Investigator
EG&G Rocky Flats
(303) 966-6420

Jerry L. Peterson
Technical Program Manager
EG&G Rocky Flats
(303) 966-5349

Paul Kalb
Principal Investigator
Brookhaven National Laboratory
(516) 282-7644

Peter Colombo
Technical Program Manager
Brookhaven National Laboratory
(516) 282-3045

Surface Organic Contaminant Removal

Section 3.0

3.0 SURFACE ORGANIC CONTAMINANT REMOVAL

TASK DESCRIPTION

Some of the wastes at the RFP consist of bulk items with contaminated surfaces. Technologies to clean these surfaces would allow the separation of the hazardous and radioactive components for treatment and disposal as land disposal restrictions compliant mixed or hazardous and low-level waste. Such technologies are expected to treat not only debris and solid wastes, but to play significant roles in the decontamination and decommissioning operations. The Surface Organic Contaminant Removal Program consists of two main technology subtasks:

- Volatilization/Low Temperature Thermal Desorption (LTTD), and
- Supercritical Carbon Dioxide Extraction (SCDE) (see Figure 3.0).

LTTD is a volatilization technique that has been a successful treatment for removing organic contamination from soils. Its applicability to combustible mixed wastes remains to be determined. In this process, waste is fed into a heating unit where it is heated to temperatures less than 600°F. The actual heating unit could be a rotary kiln, a calcination unit, or a fluidized bed unit. Heated nitrogen or another inert carrier gas is swept through the heating unit and carries the volatilized organics into a scrubber system. Particulates are separated from the gases and a condenser recovers the organics for disposal or further treatment. No combustion occurs because of the low operating temperatures of the LTTD units, and the resulting waste form is a dry waste.

SCDE is a process that employs a flowing, noncombustible, nontoxic, environmentally-safe fluid as a solvent. This process takes advantage of the enhanced ability of carbon dioxide to dissolve organic contaminants once it has been heated and compressed above 90°F and 1080 psig. In waste cleanup applications, SCDE is used to dissolve the hazardous components and extract them from the substrate material. By lowering the temperature and pressure, the contaminants can be precipitated from the solution to allow separation and recycling of the carbon dioxide. This process would also produce

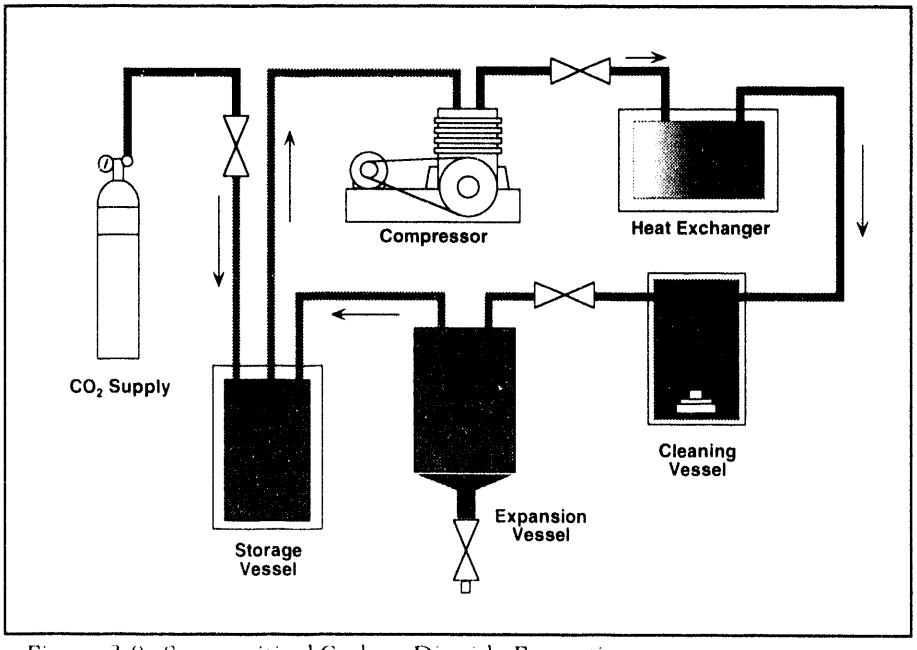

Figure 3.0. Supercritical Carbon Dioxide Extraction.

a dry residual wasteform which can be treated as radioactive, rather than mixed, waste.

TECHNOLOGY NEEDS

Rocky Flats has surveyed a wide variety of volatilization technologies that are available or under development in the commercial sector. While evaluation of these technologies is continuing, treatability studies are being initiated for a LTTD system. Following these tests with non-radioactive waste, one or more technologies will be selected for a demonstration at Rocky Flats.

A laboratory-scale test unit for SCDE has been installed at the University of Colorado. Treatability tests are being completed and tests with surrogate wastes initiated. The need for conducting a pilot-scale demonstration in FY95 will be evaluated based on the results from the laboratory-scale tests and comparison with the thermal desorption results. Additional studies are being conducted with an emphasis on separation of the extracted contaminants from the carbon dioxide stream. Extraction of the hazardous component from combustible waste and partitioning them from the host material is a key pretreatment to incineration alternative processing.

ACCOMPLISHMENTS

- Completed technology status reports for Volatilization and Hot Nitrogen Stripping technologies.
- Demonstrated SCDE cleaning of light oils and solvents from steel and uranium substrates in laboratory tests at Rocky Flats.
- Demonstrated potential for improved SCDE cleaning of complex substrates using ultrasonic cavitation.
- Installed laboratory-scale equipment and initiated surrogate tests.

COLLABORATION/TECHNOLOGY TRANSFER

Studies of Surface Organic Contaminant Removal at Rocky Flats are being conducted in collaboration with the Los Alamos National Laboratory (LANL), the Los Alamos Technology Office (LATO), and the University of Colorado. Substantial industrial participation in studies of selected volatilization technologies is anticipated. A vendor is due to be selected during FY94 to provide a LTTD system for demonstration at RFP.

For further information, please contact:

Peter L. Montez
Principal Investigator (LTTD)
EG&G Rocky Flats
(303) 966-7681

Charles M. Brown
Principal Investigator (SCDE)
EG&G Rocky Flats
(303) 966-5277

Jerry L. Peterson
Technical Program Manager
EG&G Rocky Flats
(303) 966-5349

Alternatives to Incineration

Section 4.0

4.0 ALTERNATIVES TO INCINERATION

Rocky Flats has generated a large quantity of mixed waste consisting of relatively common combustible items, such as rags, coveralls, paper products, shoe covers, and a variety of oils that have been exposed to the production environment. Similar waste streams are prevalent throughout the DOE Complex, as well as in other environments that work with radioactive materials. Although incineration has been identified as the best demonstrated available technology to treat the hazardous components of these mixed wastes and reduce the volume of the combustible materials, RFP agreed to investigate non-thermal alternative technologies in the CTMP.

Work on alternatives to incineration involves several potential technologies which have been shown to destroy organic compounds in hazardous wastes. A series of lab-scale tests using non-radioactive surrogates have shown four technologies that may be appropriate for treatment of the Solvent Contaminated Wastes:

- *Catalytic Wet Chemical Oxidation*;
- *Mediated Electrolytic Oxidation*;
- *Packed Bed Reactor/Silent Discharge Plasma; and*
- *Supercritical Water Oxidation.*

These approaches provide treatment options for liquid and/or solid combustible waste streams in the event that incineration is not performed at RFP.

The RFCP is continuing to evaluate these technologies in order to select a candidate technology for the demonstration of a complete incineration alternative system. Descriptions of the first three technologies are included in this section. The development of the fourth technology is the focus of the Supercritical Water Oxidation (SCWO) Program. This program is described in a separate Technology Summary.

4.1 CATALYTIC WET CHEMICAL OXIDATION

TASK DESCRIPTION

Wet chemical oxidation systems utilize the reaction of oxygen, or an alternate oxidizing agent, to destroy the organic constituents of a waste in an aqueous solution. In Catalytic Wet Chemical Oxidation (CWCO), one or more chemical species are added, which act to increase the rate at which the oxidation reactions proceed (see Figure 4.1).

The CWCO system being developed for Rocky Flats uses both an iron catalyst and a co-catalyst to degrade the organics in a strong acid solution. The system operates at temperatures much below those used in incineration and utilizes moderate pressures (expected operating conditions are approximately 150°F and 70 psig). Both solid and liquid wastes can be treated, and most metals are dissolved and concentrated in the reaction solution.

TECHNOLOGY NEEDS

Delphi Research, Inc., has developed and patented a CWCO system which destroys hazardous organics at practical rates. This DETOX technology has been demonstrated at the bench-scale, with destruction efficiencies of 99.9999% achieved for liquid hydrocarbons (including some chlorinated organics). Due to the strongly acidic nature of the reaction mixture, engineering development is focused on materials of construction, along with scale-up issues. Treatment of the spent reaction solution and system integration will also require study.

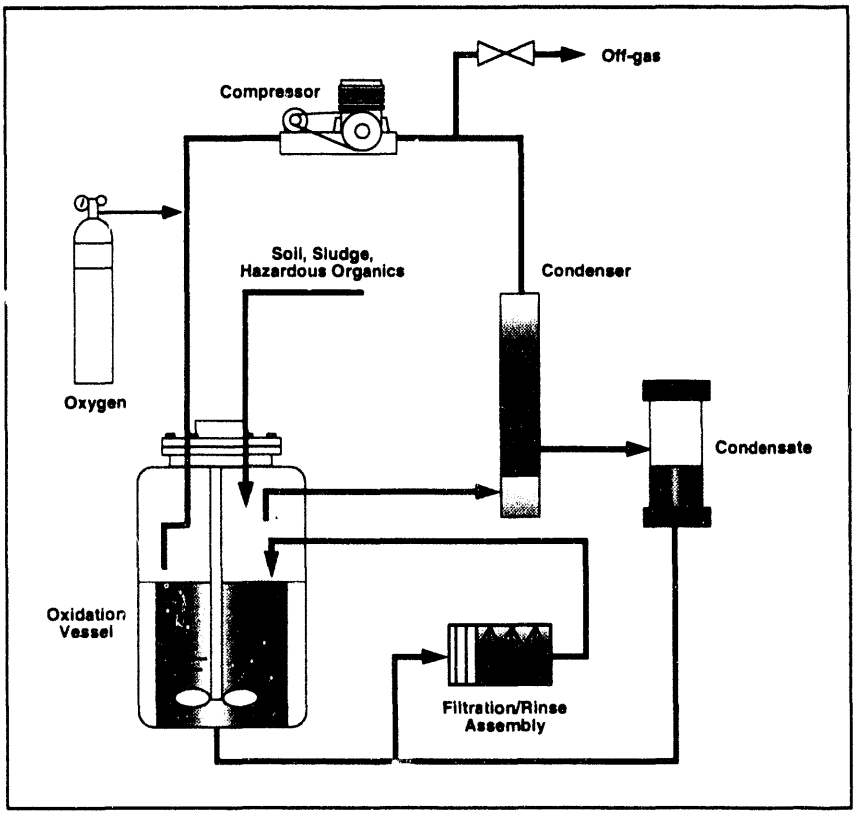

Figure 4.1. Catalytic Wet Chemical Oxidation.

In a DOE project at the Morgantown Energy Technology Center, the application of the DETOX technology to soil remediation is being examined. Additional studies with other surrogates (non-radioactive) for Rocky Flats wastes, including solid combustibles, are also under way. During FY94, Rocky Flats plans to select at least one incineration alternative technology for additional development. A cold (non-radioactive) demonstra-

tion system will be designed and fabricated to allow the effectiveness of the technology to be demonstrated and to provide operational data for the design of a full-scale system.

ACCOMPLISHMENTS

- Completed lab-scale tests and determined destruction efficiencies for surrogate (non-radioactive) FBI oil (liquid chlorinated organics).

- Completed lab-scale tests and determined destruction efficiencies for surrogate solid combustibles (e.g., paper, plastic).

COLLABORATION/TECHNOLOGY TRANSFER

The development of the DETOX process is being conducted by Delphi Research, Inc. Rocky Flats also continues to evaluate published reports and data on other incineration alternative technologies and to follow the development of these technologies throughout the DOE Complex. Development of this technology is expected to provide opportunities for commercial application outside DOE. This work is being coordinated with waste operations at Los Alamos to demonstrate a system by FY96.

For further information, please contact:

Charles M. Brown
Principal Investigator
EG&G Rocky Flats
(303) 966-5277

Jerry L. Peterson
Technical Program Manager
EG&G Rocky Flats
(303) 966-5349

4.2 MEDIATED ELECTROCHEMICAL OXIDATION

TASK DESCRIPTION

In the Mediated Electrochemical Oxidation process, an oxidizing metal ion (such as silver (II), cobalt (III) or cerium) is generated at the anode of an electrochemical cell containing an acidic solution (see Figure 4.2). The oxidizing metal then attacks and destroys the organic components of the waste.

Mediated Electrochemical Oxidation was originally developed to dissolve an insoluble form of plutonium oxide. Later, the ability to achieve high-destruction efficiencies for organic contaminants was demonstrated along with the effective dissolution of metals. The process operates at near-ambient temperatures and pressures using an acidic solution.

TECHNOLOGY NEEDS

This technology has been extensively tested at the bench- and pilot-scale level both in the U.S. and in Europe. Work in DOE has demonstrated feasibility for treating organic liquids and some solids. Development work is focused on demonstration of required ancillary systems and on systems integration.

ACCOMPLISHMENTS

- Completed lab-scale tests and determined destruction efficiencies for surrogate (non-radioactive) FBI oil (liquid chlorinated organics).
- Completed lab-scale tests and determined destruction efficiencies for surrogate solid combustibles (e.g., paper, plastic).
- Completed initial pilot-scale tests for surrogate liquid and solid organic wastes.

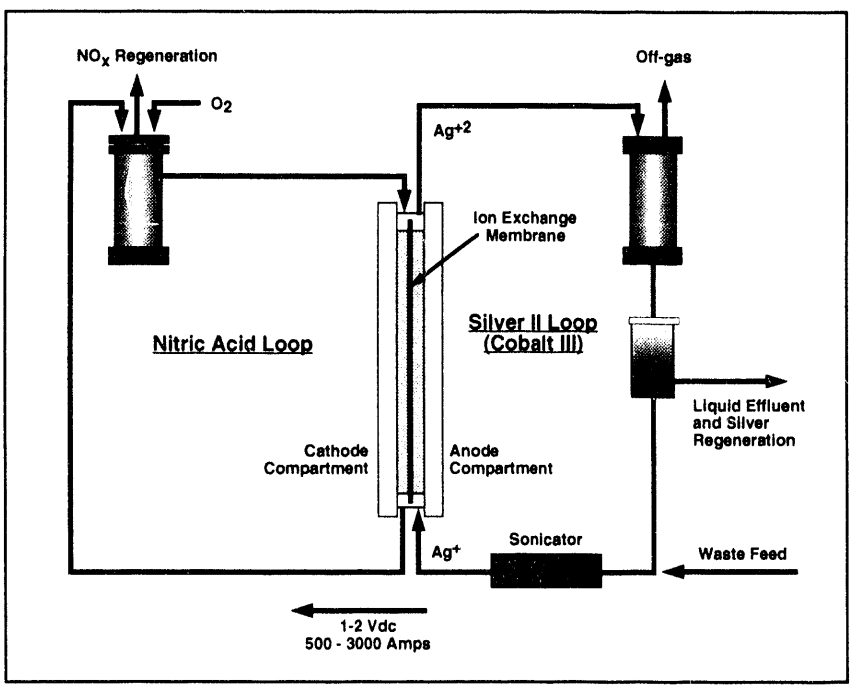

Figure 4.2. Mediated Electrochemical Oxidation.

COLLABORATION/TECHNOLOGY TRANSFER

Evaluation of Mediated Electrochemical Oxidation for Rocky Flats is being conducted at the Lawrence Livermore National Laboratory and by the Pacific Northwest Laboratory.

Rocky Flats also continues to evaluate published reports and data on other incineration alternative technologies and to follow the development of these technologies throughout the DOE Complex.

For further information, please contact:

Charles M. Brown
Principal Investigator
EG&G Rocky Flats
(303) 966-5277

Jerry L. Peterson
Technical Program Manager
EG&G Rocky Flats
(303) 966-5349

Zoher Chiba
Principal Investigator
Livermore National Laboratory
(510) 422-6124

Ann Heywood
Technical Program Manager
Livermore National Laboratory
(510) 422-8203

Jeff Surma
Principal Investigator
Pacific Northwest Laboratory
(509) 376-4905

Steve Slate
Technical Program Manager
Pacific Northwest Laboratory
(509) 375-3903

4.3 PACKED BED REACTOR/SILENT DISCHARGE PLASMA

TASK DESCRIPTION

Silent Discharge Plasma (SDP), or "cold plasma", is a proven technology used extensively in water purification operations (see Figure 4.3). By applying a high-frequency electric field between two plates, short-duration electrical discharges produce a highly reactive substance that attacks gaseous organic molecules present between the plates. SDP is being investigated as an off-gas treatment for existing technologies.

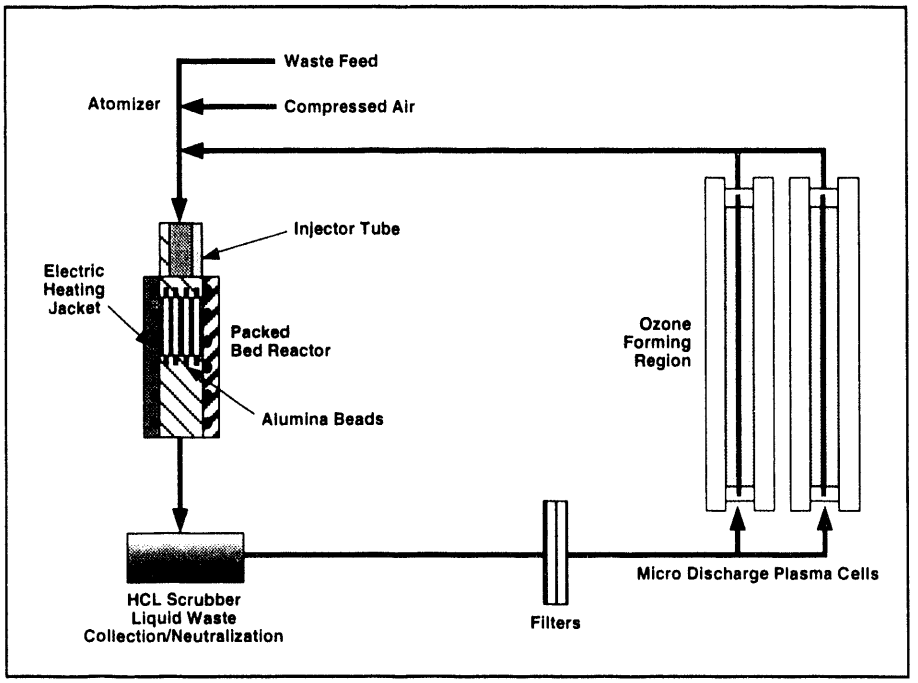

Figure 4.3. Silent Discharge Plasma.

In addition, SDP is being combined with an alumina (aluminum oxide) Packed Bed Reactor (PBR), a new thermal treatment unit, to expand its capabilities to destroy various waste forms. A liquid waste stream is mixed with oxygen and water and oxidized at 1100-2200°F in the PBR. The resulting vapors pass through the SDP cell.

TECHNOLOGY NEEDS

The PBR/SDP technology is being developed at the Los Alamos National Laboratory. High destruction efficiencies of liquid organic wastes have been separately demonstrated with both the PBR and SDP technologies. Although SDP could be used as a primary treatment unit, studies are in progress to evaluate integration of these two units to achieve higher overall destruction efficiencies. Approaches to treating solid wastes are also being explored; treatment of slurries appears promising. Scale-up issues are also being investigated.

SDP is also a candidate technology for off-gas treatment with other technologies serving as the primary treatment unit. Studies will be conducted to assess the ability of SDP to destroy the hazardous components in a variety of off-gas conditions and resolve other integration issues.

ACCOMPLISHMENTS

- Completed lab-scale tests and determined destruction efficiencies for surrogate (non-radioactive) FBI oil (liquid chlorinated organics).

- Completed lab-scale tests and determined destruction efficiencies for surrogate solid combustibles (e.g., paper, plastic).

COLLABORATION/TECHNOLOGY TRANSFER

The development of the PBR/SDP technology for Rocky Flats is being conducted at Los Alamos National Laboratory in collaboration with the Electric Power Research Institute.

Rocky Flats also continues to evaluate published reports and data on other incineration alternative technologies and to follow the development of these technologies throughout the DOE Complex.

Details on the results of these studies will be published in DOE technical reports and outside journal articles.

For further information, please contact:

Charles M. Brown
Principal Investigator
EG&G Rocky Flats
(303) 966-5277

Jerry L. Peterson
Technical Program Manager
EG&G Rocky Flats
(303) 966-5349

Louis Rososcha
Principal Investigator
Los Alamos National Laboratory
(505) 667-8493

Hugh D. Murphy
Technical Program Manager
Los Alamos National Laboratory
(505) 667-8914

How To Get Involved

Section 5.0

5.0 HOW TO GET INVOLVED

WORKING WITH THE DOE OFFICE OF ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT

DOE provides a range of programs and services to assist universities, industry, and other private-sector organizations and individuals interested in developing or applying environmental technologies. Working with DOE Operations Offices and management and operating contractors, EM uses conventional and innovative mechanisms to identify, integrate, develop, and adapt promising emerging technologies. These mechanisms include contracting and collaborative arrangements, procurement provisions, licensing of technology, consulting arrangements, reimbursable work for industry, and special consideration for small business.

Cooperative Research and Development Agreements (CRADAs)

EM will facilitate the development of subcontracts, R&D contracts, and cooperative agreements to work collaboratively with the private sector.

EM uses CRADAs as an incentive for collaborative R&D. CRADAs are agreements between a DOE R&D laboratory and any non-Federal source to conduct cooperative R&D that is consistent with the laboratory's mission. The partner may provide funds, facilities, people, or other resources. DOE provides the CRADA partner access to facilities and expertise; however, no Federal funds are provided to external participants. Rights to inventions and other intellectual property are negotiated between the laboratory and participant, and certain data that are generated may be protected for up to 5 years.

Consortia will also be considered for situations where several companies will be combining their resources to address a common technical problem. Leveraging of funds to implement a consortium can offer a synergism to overall program effectiveness.

Procurement Mechanisms

DOE EM has developed an environmental management technology development acquisition policy and strategy that uses phased procurements to span the RDDT&E continuum from applied R&D concept feasibility through full-scale remediation. DOE EM phased procurements make provisions for unsolicited proposals, but formal solicitations are the preferred responses. The principle contractual mechanisms used by EM for industrial and academic response include Research Opportunity Announcements (ROAs) and Program R&D Announcements (PRDAs).

EM uses the ROA to solicit advanced research and technologies for a broad range of cleanup needs. The ROA supports applied research ranging from concept feasibility through full-scale demonstration. In addition, the ROA is open continuously for a full year following the date of issue and includes a partial procurement set aside for small businesses. Typically, ROAs are published annually in the *Federal Register* and the *Commerce Business Daily*, and multiple awards are made.

PRDAs are program announcements used to solicit a broad mix of R&D and DT&E proposals. Typically, a PRDA is used to solicit proposals for a wide-range of technical solutions to specific EM problem areas. PRDAs may be used to solicit proposals for contracts, grants, or cooperative agreements. Multiple awards, which may have dissimilar approaches or concepts, are generally made. Numerous PRDAs may be issued each year.

In addition to PRDAs and ROAs, EM uses financial assistance awards when the technology is developed for public purpose. Financial assistance awards are solicited through publication in the *Federal Register*. These announcements are called Program Rules. A Program Rule can either be a one-time solicitation or an open-ended, general solicitation with annual or more frequent announcements concerning specific funding availability and desired R&D agreements. The Program Rule can also be used to award both grants and cooperative agreements.

EM awards grants and cooperative agreements if fifty-one percent or more of the overall value of the effort is related to a public interest goal. Such goals include possible non-DOE or other Federal agency participation and use, advancement of present and future U.S. capabilities in domestic and international environmental cleanup markets, technology transfer, advancement of scientific knowledge, and education and training of individuals and business entities to advance U.S. remediation capabilities.

Licensing of Technology

DOE contractor-operated laboratories can license DOE/EM-developed technology and software to which they elect to take title. In other situations where DOE owns title to the resultant inventions, DOE's Office of General Counsel will do the licensing. Licensing activities are done within existing DOE intellectual property provisions.

Technical Personnel Exchange Assignments

Personnel exchanges provide opportunities for industrial and laboratory scientists to work together at various sites on environmental restoration and waste management technical problems of mutual interest. Industry is expected to contribute substantial cost-sharing for these personnel exchanges. To encourage such collaboration, the rights to any resulting patents go to the private sector company. These exchanges, which can last from 3 to 6 months, are opportunities for the laboratories and industry to better understand the differing operating cultures, and are an ideal mechanism for transferring technical skills and knowledge.

Consulting Arrangements

Laboratory scientists and engineers are available to consult in their areas of technical expertise. Most contractors operating laboratories have consulting provisions. Laboratory employees who wish to consult can sign non-disclosure agreements, and are encouraged to do so.

Reimbursable Work for Industry

Laboratory scientists and engineers are available to consult in their areas of technical expertise. Most contractors operating laboratories have consulting provisions. Laboratory employees who wish to consult can sign non-disclosure agreements, and are encouraged to do so.

EM Small Business Technology Integration Program

The EM Small Business Technology Integration Program (SB-TIP) seeks the participation of small businesses in the EM Research, Development, Demonstration, Testing and Evaluation programs. Through workshops and frequent communication, the EM SB-TIP provides information on opportunities for funding and collaborative efforts relative to advancing technologies for DOE environmental restoration and waste management applications.

EM SB-TIP has established a special EM procurement set aside for small firms (500 employees or less) to be used for applied research projects, through its ROA. The program also serves as the EM liaison to the DOE Small Business Innovation Research (SBIR) Program Office, and interfaces with other DOE small business offices, as well.

CONTACT

David W. Geiser, Acting Director
International Technology Exchange Division
EM-523
Environmental Restoration and Waste
Management Technology Development
U.S. Department of Energy
Washington, D.C. 20585
(301) 903-7640

EM Central Point of Contact

The EM Small Business Technology Integration Program (SB-TIP) seeks the participation of small businesses in the EM Research, Development, Demonstration, Testing and Evaluation programs. Through workshops and frequent communication, the EM SB-TIP provides information on opportunities for funding and collaborative efforts relative to advancing technologies for DOE environmental restoration and waste management applications.

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Office of Research and Technology Applications

Office of Research and Technology Applications (ORTAs) serve as technology transfer agents at the Federal laboratories, and provide an internal coordination in the laboratory for technology transfer and an external point of contact for industry and universities. To fulfill this dual purpose, ORTAs license patents and coordinate technology transfer activities for the laboratory's scientific departments. They also facilitate one-on-one interactions between the laboratory's scientific personnel and technology recipients, and provide information on laboratory technologies with potential applications in private industry for state and local governments.

For more information about these programs and services, please contact:

Claire Sink, Director
Technology Integration Division
EM-521
Environmental Restoration and Waste
Management Technology Development
U.S. Department of Energy
Washington, D.C. 20585
(301) 903-7928

Acronyms

Section 6.0

6.0 ACRONYMS

CDH	Colorado Department of Health
CRADA	Cooperative Research and Development Agreement
CSTP	Conceptual Site Treatment Plan
CTMP	Comprehensive Treatment and Management Plan
CWCO	Catalytic Wet Chemical Oxidation
DOE	U. S. Department of Energy
EM	Environmental Restoration and Waste Management
EM-30	Office of Waste Operations
EPA	Environmental Protection Agency
FBI	Fluidized Bed Incinerator
FFC	Federal Facilities Compliance Act
HLW	High-Level waste
ID	Integrated Demonstrations
IP	Integrated Programs
LATO	Los Alamos Technology Office
LDR	Land Disposal Restrictions
LLW	Low-Level waste
LTTD	Low Temperature Thermal Desorption
OTD	Office of Technology Development, EM-50
PBR	Packed Bed Reactor
PNS	Pacific Nuclear Services
PRDA	Program Research and Development Announcement
RDDT&E	Research, Development, Demonstration, Testing and Evaluation
RFCP	Rocky Flats Compliance Program
RFP	Rocky Flats Plant
ROA	Research Opportunity Announcement
SB-TIP	Small Business Technology Integration Program
SCDE	Supercritical Carbon Dioxide Extraction
SCWO	Supercritical Water Oxidation Program
SDP	Silent Discharge Plasma
TCLP	Toxic Characteristic Leach Procedure

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