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Western Governor's Association

***Federal Advisory Committee
To Develop On-Site
Innovative Technologies***

**MIXED WASTE
WORKING GROUP REPORT**

November 9, 1993

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MASTER

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1.0 EXECUTIVE SUMMARY

Mixed Waste - The Problem and the Challenge

The treatment of mixed waste remains one of this country's most vexing environmental problems. Mixed waste is the combination of radioactive waste and hazardous waste, as defined by the Resource Conservation and Recovery Act (RCRA). The Department of Energy (DOE), as the country's largest mixed waste generator, is responsible for 95 percent of the Nation's mixed waste volume, is now required to address a strict set of milestones under the Federal Facility Compliance Act of 1992. DOE's earlier failure to adequately address the storage and treatment issues associated with mixed waste has led to a significant backlog of temporarily stored waste, significant quantities of buried waste, limited permanent disposal options, and inadequate treatment solutions. Dual sets of regulations, incompletely developed and demonstrated forms of treatment, and disagreement among stakeholders as to the best treatment technologies have also contributed to the failure to find permanent and acceptable technological solutions. Mixed waste continues to accumulate at Federal facilities because of a disparity between what the law requires and what conventional technology delivers, and also because of the inability of past regulatory processes to identify and permit technically acceptable solutions.

A New Stakeholder Conversation Adds Value

Between May and November of 1993, the Mixed Waste Working Group brought together stakeholders from around the Nation. Scientists, citizens, entrepreneurs, and bureaucrats convened in a series of forums to chart a course for accelerated testing of innovative mixed waste technologies. For the first time, a wide range of stakeholders were asked to examine new technologies that, if given the chance to be tested and evaluated, offer the prospect for better, safer, cheaper, and faster solutions to the mixed waste problem. In a matter of months, the Working Group has managed to bridge a gap between science and perception, engineer and citizen, and has developed a shared program for testing new technologies.

1994 Phase I Demonstrations - We Can Take Action Today

Literally dozens of promising new technology development projects are being studied and considered at Federal facilities. While the Department of Defense and the Environmental Protection Agency did not have projects mature enough to be demonstrated in 1994, DOE has numerous projects *in the pipeline*. Many of these projects offer promising new approaches and have received funding and attention by the DOE laboratories, but require additional stakeholder review, refinement, and oversight if their demonstration is to result in timely commercialization or full scale permitting at DOE facilities. The Working Group recognizes that numerous other non-DOE technologies deserve special attention, but has decided to focus its immediate attention on projects already

funded within the Federal Government's budget cycle, specifically projects that are at a scale to be tested in 1994. The Mixed Waste Group believes the following nine projects are ready for immediate review by the Federal Advisory Committee to Develop On-Site Innovative Technologies (DOIT Committee). Because none of the technologies have been fully proven, the intention of the demonstrations will be to design a methodical testing and evaluation protocol to determine if the technology in question will in fact be safer and more effective and therefore worthy of future consideration for regulatory permitting or application at other sites.

Mixed Waste Characterization

- Radiological and Hazardous Material Measurement System - Idaho National Engineering Laboratory (INEL)
- Rapid Transuranic Monitoring Laboratory - INEL
- Dig Face Characterizations - INEL

Mixed Waste Treatment

- Fixed Plasma Hearth Treatment - INEL
- Thermal Desorption - Rocky Flats
- Minimum Additive Waste Stabilization - Site To Be Determined
- Microwave Solidification - Rocky Flats
- Two-Stage Advance Oxidation Unit - Los Alamos National Labs

Mixed Waste Disposal

- Advanced Landfill Cover Demonstration Project - Kirtland Air Base

Community Stakeholders will Shape and Guide Technology Demonstrations

Over the next year, several of the above technologies will be tested and evaluated at various DOE facilities in the West. The goals of the demonstration are to improve the quality of the technology testing and evaluation process to ensure full stakeholder participation; improve regulatory mechanisms; and, if successful, result in technical data that will contribute to future permitting, deployment, and commercialization. The Working Group intends to reach beyond traditional, more narrow approaches to technology selection, and instead utilize a range of technical, sociological, community-based and financial technology-evaluation criteria. The broadest range of community stakeholders will be partners in guiding the demonstration projects and overseeing the design, testing, and evaluation of the technology.

Phase II - Encourage New Private Sector Partnerships

In early 1994, the Mixed Waste Group will formally solicit small technology developers, commercial interests, and any others with creative new technological, regulatory or institutional approaches to mixed waste. This national solicitation will seek out a wider range of small technology developers and commercial interests for new technologies to be tested, new approaches to procurement and more inclusive and participatory stakeholder involvement at demonstration sites.

Mixed Waste Working Group Activities - 1994-95

Over the next year, the Mixed Waste Working Group will investigate new ways to improve the technology development and stakeholder input process for DOIT Committee consideration in the following areas:

- Ensuring the transition to site-based stakeholder oversight of demonstrations
- Promoting more flexible and rapid procurement for technology developers
- Developing demonstration implementation plans at each test site
- Developing a standardized technology-evaluation template
- Streamlining regulatory guidelines governing a demonstration
- Identify the mixed waste marketplace to encourage private investment
- Enhance worker training for demonstration testing
- Expedite deployment of successful demonstrations

2.0 MIXED WASTE - THE PROBLEM AND THE CHALLENGE

“State sues DOE over missed deadlines”

“Community claims new incinerator is a health threat”

“Wastes continue to pile up, with no solution in sight”

“Governor closes border to more nuclear waste”

The headlines are all too familiar. The treatment of mixed waste - a combination of RCRA hazardous materials and radioactive waste - remains one of this country's most vexing environmental issues. DOE, as the country's largest mixed waste generator, responsible for 95 percent of the Nation's mixed waste volume, is now required to address a strict set of milestones under the Federal Facility Compliance Act of 1992. DOE's failure to adequately address the storage and treatment issues associated with mixed waste has led to a significant backlog of temporarily stored waste, significant quantities of buried waste, limited permanent disposal options, and inadequate treatment solutions.

Dual sets of regulations, incompletely developed and demonstrated forms of treatment, and technical disagreement among stakeholders as to the best treatment technologies have also contributed to the failure to find permanent and acceptable technological solutions. Mixed waste continues to accumulate at Federal facilities because of a disparity between what the law requires and what conventional technology delivers and also because of the failure of past regulatory processes to identify and permit technically acceptable solutions. The research of the Mixed Waste Working Group reveals the following problems and challenges that lie ahead.

2.1 Congress Mandates Action On Mixed Waste Technology Development

The Federal Facility Compliance Act of 1992 mandated that DOE work directly with the States and the U.S. Environmental Protection Agency to inventory the amount of mixed waste stored and generated at each of its sites around the country and to prepare site specific plans for waste treatment, storage, and handling. To date, DOE has produced a national inventory of its waste and is currently developing site-specific treatment plans for each site. These treatment plans must be approved by the governors of the affected States by October 1995. Assisted by the oversight of the National Governors' Association, the Federal Facility Compliance Act is the primary mixed waste regulatory driver and promises to accelerate DOE's efforts on technology development.

However, legislation and the requirements of the treatment plans alone will not provide solutions to this Nation's mixed waste problem. There are concerns that these plans will be biased towards existing technologies. The Mixed Waste Working Group believes that plans developed under the Federal Facility Compliance Act should include schedules that provide for the testing and development of new technologies. Two of the primary goals of the Working Group are to serve as a complement to the activities under the Act and to provide a mechanism for the development of new technologies, which will provide a bridge between what Federal law requires and what conventional technologies do not achieve.

2.2 Mixed Waste - A National Inventory

The Department of Energy was the primary source of information for this report. Currently DOE is the landlord to roughly 95 percent of all the defense and commercial mixed waste in the Nation. Other generators include the U.S. Department of Defense and the commercial sector, including hospitals, research and academic facilities, and nuclear powerplants. While the information provided by DOE has been useful in assessing the scope of the problem, it continues to undergo scrutiny and refinement. The Working Group will continue to seek out more definitive information from DOE and other Federal agencies.

2.2.1 Mixed Waste - A Definition

By definition, mixed waste contains quantities of hazardous waste as defined by RCRA and radioactive waste as defined by the Atomic Energy Act. Mixed waste can be generally categorized into three forms.

- **High-Level Mixed Waste:** A waste material resulting from the reprocessing of spent nuclear fuel, containing a combination of transuranic waste and fission products in concentrations requiring permanent isolation. Its radiation levels require remote handling.
- **Transuranic Mixed Waste:** Defined as containing hazardous constituents and radioactive material with more than 100 nanocuries of alpha-emitting isotopes with atomic numbers greater than 92 (heavier than Uranium, i.e., Plutonium, Americium) and half-lives greater than 20 years. Some waste releases high levels of radiation from container surfaces and must be "remotely" handled. Permanent isolation or disposal is required.
- **Low-level Mixed Waste:** Waste material that contains small quantities of radioactivity, but in excess of threshold quantities to warrant special handling. Typically, the material can be "contact handled" because of the low levels of radiation released from a container surface. In some cases, permanent isolation is not required when the radioactive decay results in de minimis levels of radiation.

2.2.2 Department of Defense Mixed Waste

The Department of Defense is a generator of mixed waste and has recently begun to categorize the scope of its problem and prepare an inventory. The problems associated with mixed waste management at defense facilities will be complicated by accelerated restoration schedules at closing military bases.

2.2.3 Commercial Low-level Mixed Waste

The volume of commercial low-level mixed waste generated by nuclear power facilities, hospitals, and academic and research facilities utilizing radionuclides accounts for approximately 5 percent of the national inventory. The Working Group has primarily focused its attention on defense facilities, but recognizes that the vast majority of commercial waste is similar in nature to DOE waste streams.

There are accepted practices for volume reduction and/or treatment of mixed waste followed by land burial. However, available disposal capacity is diminishing rapidly, creating a need for improved treatment or significant increases in land disposal capacity.

While Federal law has required States and the private sector to be responsible for treatment and disposal of commercial waste, the Working Group recognizes the advantages of working with host States and their compacts to accelerate innovative technologies for widespread application to both commercial and Federal facilities.

2.2.4 Overview - Total Volume at DOE Facilities

The volume of mixed waste currently stored or buried at DOE facilities is significant and growing. Storage, characterization, and treatment technologies are not keeping pace with regulatory mandates and the expectations of stakeholders. Thousands of drums and tanks and large amounts of buried waste have yet to be characterized because of costly, time consuming, and inadequate analysis technologies.

DOE increased its knowledge about the size, scale, and nature of the problem with the publication of the Mixed Waste Inventory Report in 1993. While the level of information on the scope of the problem has improved, more research and characterization is essential. The information developed by DOE is only a snapshot in time, requiring continual improvement as more waste is identified and located. The information in the following paragraph is a synopsis of the April 1993 publication.

In order to focus its efforts, the Working Group confined its analysis to low-level and transuranic mixed waste, excluding investigation of high-level waste. DOE has identified over 1,400 mixed waste streams currently in storage or expected to be generated in the next 5 years at 50 DOE sites in 22 States. Over 300,000 cubic meters of mixed waste (excluding high-level waste) is in storage, with estimates of almost 300,000 cubic meters to be generated by routine waste management operations over the next 5 years. In addition, over 600,000 cubic meters will be generated from environmental restoration over the next 5 years. Over 90 percent of the volume is located at only six sites - Savannah River, Oak Ridge, Rocky Flats, INEL, Los Alamos and Hanford - four are located in western States.

2.2.5 Uncharacterized Waste

Significant quantities of containerized and buried waste have yet to be characterized or sufficiently analyzed because the technologies are not adequate to protect workers, do not provide timely results at a reasonable cost, or do not provide complete enough data to make treatment or management decisions. For decades, mixed waste storage drums and tanks were filled up without first categorizing or measuring the nature of the material. The process of analyzing the contents of these containers will require improved procedures to ensure worker safety. In addition, experts debate the extent to which *complete* characterization of a waste drum is needed in order to make a disposal or treatment decision.

2.2.6 Volume Precluded by Federal Law from Land Disposal

Land Disposal Restrictions ("LDR") under RCRA preclude certain types of hazardous waste, not treated to LDR standards, from permanent disposal - a technology-forcing mechanism to require treatment. A substantial percentage of DOE mixed waste will be precluded from land disposal *in its present form*. As a result, many DOE facilities are building and maintaining temporary or interim storage facilities. The emphasis of current and future technology development efforts will be to design treatment technologies that separate, reduce, destroy, or consolidate the material into a form acceptable for permanent disposal.

2.2.7 DOE - Low-Level Mixed Waste

Approximately 83 percent of DOE mixed waste in storage (about 250,000 cubic meters) is classified as low-level. Approximately 56,000 cubic meters per year will be generated through routine operations through 1997. Moreover, about 600,000 cubic meters of new mixed low-level waste will be generated between 1993 and 1997 as a result of environmental cleanup and decommissioning and decontamination. In contrast, the amount of transuranic mixed waste that may be generated from these activities is expected to be substantially smaller. DOE currently is seeking permits for mixed low-level waste disposal facilities at four of its facilities.

2.2.8 DOE - Transuranic Mixed Waste

Transuranic waste decays slowly and will require long-term isolation. Transuranic mixed waste accounts for approximately 21 percent of total stored mixed waste. It was predominantly generated by weapons production processes - many of which have now been curtailed in light of recent disarmament agreements. As a result, the generation of transuranic waste will be greatly reduced in the next five years. The Waste Isolation Pilot Plant (WIPP) in New Mexico is expected to accept the majority of transuranic waste currently in long-term storage at eight DOE facilities, but predominantly at Rocky Flats and INEL. In the absence of acceptable land disposal or treatment, many DOE sites are in violation of RCRA and are unable to meet Federal Facility Compliance Agreement objectives.

2.2.9 Environmental Restoration Waste

Future environmental restoration of contaminated soils, buried waste drums, and ground water may ultimately be the largest volume generator of mixed waste. DOE estimates over 600,000 cubic meters will be accumulated through 1997, with more anticipated in the future. It is estimated that the majority of material will be low-level mixed waste. In light of the uncertainty of a future permanent disposal facility, it is also unclear to what extent soils will be removed and stored, removed and treated, or contained and treated in place (in situ).

2.2.10 Future Decommissioning and Decontamination Waste

DOE has focused the majority of its research on waste management and environmental restoration waste. But as the DOE Complex undergoes conversion to nonmilitary uses, a significant number of production buildings will require varying levels of decommissioning. The process of decontamination will likely generate significant quantities of contaminated concrete, piping, and metal, much of which will be classified as low-level mixed waste.

2.2.11 Waste Forms

Waste forms vary widely across the DOE Complex. Approximately 25 percent by volume of stored mixed waste is dry solid waste - either homogeneous or heterogeneous in content. The majority of solid waste is contained in drums or oversized containers. Aqueous and organic liquid waste from routine operations or restoration activities accounts for about 24 percent, typically stored in tanks or drums. Sludges and other wet solids account for about 51 percent, stored in tanks or drums.

2.3 Mixed Waste Technologies - The Challenge

In general, mixed waste treatment capability and capacity are very limited. As a result, the majority of material is being handled primarily in a temporary storage mode, often in violation of RCRA. While DOE continues to pursue permanent disposal solutions for both low-level and transuranic mixed waste, the primary challenge will be to develop characterization and treatment technologies in response to RCRA land disposal restrictions, the Federal Facility Compliance Act, and limited onsite storage space. Mixed waste faces several difficult challenges that require special attention when designing technology demonstration programs:

- **Stakeholder distrust** - this distrust of DOE is a result of a history of agency and contractor secrecy, mismanagement, and misplaced priorities. Efforts to promote new or traditional technologies are met with great skepticism, requiring a higher burden of proof on the part of technology developers.

- **Incineration** - a treatment technology often recommended by DOE, and cited in EPA regulations as Best Demonstrated Available Technology for the purpose of treatment under RCRA Land Disposal Restrictions, is judged to be insufficient by a variety of stakeholder interests. Some stakeholders have serious concerns about the safety of traditional filter systems to control incineration emissions. While many are willing to consider innovative thermal treatment processes, a higher standard of proof is needed, particularly due to community concerns about emissions of organic chemicals, products of incomplete combustion, radioactive particles, and the potential for catastrophic system failure.
- **"Real waste" testing** - use of real waste, rather than surrogate waste, is often preferred from a scientific viewpoint when conducting full-scale demonstrations to obtain the maximum confidence in system performance. But the community must be assured that adequate pretesting and worker safeguards for front-end handling are in place prior to the use of actual waste.
- **Regulatory, procurement and internal DOE rules and procedures** - these rules and procedures governing technology demonstrations at a site result in a significant expenditure of time and resources to conduct demonstrations, often conflicting with the importance of remaining in compliance with FFCA and other regulatory schedules and milestones.

2.3.1 Characterization Technology Challenges

The current regulatory environment places greater demands on the operation of chemical process facilities. Characterization requirements are also driven by treatment process controls as well as by regulatory requirements. DOE chemical or physical processes will be doubly scrutinized due to the nature of the material. New processes need to be optimized to minimize generation of secondary waste streams and limit worker exposure to hazardous and radioactive materials. New processes must also be capable of producing a final waste form for disposal that is both inert and resistant to degradation.

Because of the difficulty of addressing both hazardous and radioactive components of the waste, extraordinary characterization measures must be undertaken that are both time consuming, expensive, and often inadequate. A significant backlog of materials in drums, tanks, and soils remain uncharacterized, creating technical challenges due to the wide variance in waste form, composition, and the geologic conditions of buried waste.

The risks imposed on environmental field personnel when conducting intrusive procedures may present the greatest challenge to technology development. Robotics and nonintrusive instrumenta-

tion will be in high demand and will offer significant commercialization opportunities in other sectors such as military munitions detection. Other technology needs to be addressed include:

- improvements in speed and accuracy of characterization,
- ability to conduct "real-time" testing,
- increased standardization of measurement techniques and comparability of test results,
- improved techniques for characterizing heterogeneous waste streams,
- improved ability to characterize in situ and ex situ,
- improved techniques to ensure worker safety,
- ability to archive inventory after "barrel" characterization, and
- improved techniques for locating buried waste.

Technologies are needed to characterize the waste prior to, during, and after treatment. Real-time instrumentation is needed to provide sufficient information to monitor the performance of treatment systems for contaminants of interest, including a variety of radioactive constituents, toxic metals, organic compounds and potentially corrosive aerosols. Screening techniques are needed for noninvasive characterization of mixed waste in containers to reduce worker exposure and mitigate safety risks. Detection of metal objects, free liquids, and levels of contamination are examples of characterization needs. Also, monitoring devices to support remote sorting, size reduction, and waste segregation operations during feed preparation will be required.

Characterization of waste during processing and treatment is needed to (1) identify chemical and physical components that interfere with the formation of a stable final waste form, (2) optimize/control reagent addition, (3) minimize secondary waste streams, and (4) provide process control based on real-time measurements.

Instrumentation and sensors must be rugged enough to operate in a processing environment and must provide accurate quantitative determinations of the contaminant. Final waste form testing will require techniques and methods for waste acceptance criteria compliance verification and to satisfy Department of Transportation regulations. Acceptance and validation of new characterization techniques and the quality management of data by the EPA and State authorities are critical to their eventual use and application.

Secondary waste stream monitoring needs include real-time measurements of chemical and radioactive constituents in off-gas and liquid effluent streams. Levels of detection must meet or exceed regulatory requirements for release to the environment of "clean" effluent.

Environmental monitoring for contaminants in air, water, and soil will be required at DOE site or facility boundaries for protection of the neighboring public. All DOE facilities and remediation sites will also be required to monitor air quality within the workplace.

2.3.2 Treatment

Treatment capacity for mixed waste currently is limited and inadequate. Innovative treatment processes or systems are being developed to reduce, eliminate, or provide better containment/stabilization of chemical and/or radioactive hazards. A cursory scan of ongoing research indicates a high level of research and development taking place within the national labs, universities and private industry. DOE's Office of Technology Development, the national labs, and others are working on a variety of fronts - including a wide range of thermal, chemical and physical treatment or stabilization technologies. Many new ideas have a multi-year lead time while others are ready for demonstration in 1994. Many in the scientific community have called for an integrated test bed facility for the simultaneous testing of several types of technologies.

Other promising forms of treatment under development include more mobile systems, which some community stakeholders consider appealing due to the temporary nature of a treatment and the ability to deploy a successful process at another site. Mobile treatment does present some unique design and permitting challenges. Given the current regulatory structure, new treatment processes must be optimized to minimize generation of secondary waste streams, limit worker exposure, and produce a final waste form for disposal that is both inert and resistant to degradation in an efficient, controlled manner. The range of views on incineration technology are wide ranging and strongly held. Testing protocols at DOE facilities are often controversial and lengthy. Several areas of special emphasis where technology gaps may exist include:

- technologies that allow for a methodical scale-up;
- technologies that achieve risk reduction through greater volume reduction, promote resource recovery or toxicity reduction, or chemical or physical separation of the hazardous component from the radioactive component;
- methods that put residuals in a safer form;
- increased ability to isolate the radioactive component and produce harmless byproduct material;
- development of closed systems and treatment trains; and
- systems that produce more manageable and legal final waste forms.

2.3.3 Storage or Disposal

Current efforts to develop the WIPP facility for disposal of transuranic waste remain controversial and continue to point out the difficulty in finding a final solution to the mixed waste problem. Several DOE facilities currently conduct surface disposal of low-level mixed waste, and several new facilities are being proposed. As a result, ongoing debate concerning temporary storage sites across the Western United States and transportation through corridor communities will require additional research into improved management of surface storage facilities and safe containment of buried waste until safe permanent disposal or treatment processes are developed.

As the WIPP decision remains in limbo and commercial proposals for disposal facilities remain contentious, stakeholders must also look at innovative ways to contain, consolidate, reduce, and store the current materials with special attention to the significant new volumes of environmental restoration material to be generated over the next 20 years.

Innovative application of traditional technologies, aboveground storage, improved retrievability, containment of migrating ground water, and safer storage of drums will be the focus of the future until permanent disposal solutions are developed. In situ vitrification has received special attention to determine its ability to contain and immobilize contaminated soils and ground water. New techniques for archiving drums after characterization, such as the use of computerized bar-coding, are currently being deployed and will improve waste storage practices.

3.0 SHEDDING LIGHT ON MIXED WASTE - A NEW STAKEHOLDER PARTNERSHIP

Over the last five years, numerous national and site-specific stakeholder initiatives have been organized, increasing the level of understanding and activity surrounding the mixed waste problem. But few forums have been able to tackle the complex concerns surrounding technology development and the difficulties inherent in conducting technology reviews that incorporate multiple and varied stakeholder criteria. The Mixed Waste Working Group is designed as a forum to, provide to the Committee, and help it build a broad-based consensus on the technologies that could address critical technological problems and to conduct focused fact finding on opportunities for technology development. The Working Group was established to promote a higher level of attention to developing new technologies in cooperation with stakeholders.

Thomas Grumbly, DOE's Assistant Secretary for Environmental Restoration and Waste Management, has established many important goals for his office. Mr. Grumbly's management visions parallel the independent efforts of the Mixed Waste Working Group:

- Manage and eliminate the **urgent risk and inherent threats** that exist in our system.
- Provide a **safe workplace** that is free from accidents, injuries and adverse health effects.
- Change the system so that it is **under control** managerially and financially.
- Be more **outcome oriented**.
- Focus the **technology development program** on major obstacles to progress and involve the best talent in the Department of Energy and national science and engineering communities.
- Develop a **stronger partnership** between the Department of Energy and its Stakeholders.

3.1 Community Stakeholders are Concerned and Regulators are Frustrated

The continued buildup of these materials threatens long-term public health, limits the economic opportunities for site reuse, and continues to elevate the levels of mistrust and adversarial communications between Federal officials and State and local stakeholders. Long-term storage and containment, while possible, is not the preferred solution for communities. Traditional treatment technologies previously proposed have encountered significant opposition because communities are unconvinced of their technical merits or safety records. After years of debate and legal actions over DOE's failure to comply with applicable State and Federal laws, State and Federal regulators have designed new and more explicit regulatory compliance agreements and timetables for permitting of stored waste, finally putting in place definitive and enforceable processes under RCRA, tri-party agreements, or the Federal Facility Compliance Act. Yet, as waste continues to accumulate, regulators are forced into an antagonistic relationship with DOE site managers.

3.2 Tribal Stakeholders' Interests are Disregarded

The buildup of mixed waste throughout the country impacts Indian Tribes and threatens their treaty-guaranteed rights. Importantly, such buildup jeopardizes Tribal homelands reserved by treaty. In addition to the obvious potential physical contamination, the Tribes

face an erosion of their spiritual and cultural beliefs and practices. Federal officials often disregard the interests of Indian governments and fail to recognize and adequately consult with the governing Tribal bodies, but, in contrast, seek out input from the State and local communities surrounding Indian reservations. Such Federal action has elevated the mistrust and adversarial situations between Federal officials and Tribes. Despite having issued a Federal Indian Policy, Federal officials do not fully understand the potential adverse effect that the treatment technologies and buildup of waste may have on Tribal cultures, the preservation of their homelands, and their economic futures. Thus, early and open lines of communication and recognition of the unique government-to-government relationship between Tribal and Federal officials improves cooperation and acceptance of new innovative technologies.

3.3 Gridlock Calls for "Shared Risk-Taking" and "Collaborative Conversations"

All stakeholders agree that an aggressive technology development program is needed or the problems are likely to worsen. Under the direction of the DOIT process, the Mixed Waste Working Group was convened in May 1993. Scientists, citizens, environmentalists, public interest groups, entrepreneurs, regulators, engineers, and elected officials from a broad range of perspectives in the West and around the country (see Appendix 7.1) met in a series of forums to design new technology development processes for tackling the mixed waste problem. In an atmosphere of problem solving and shared interest, the group investigated new ways to accelerate the technology development process. With a sense of urgency and bias towards actions, the group aggressively sought out promising technologies on the horizon, avenues for increased private industry participation, Federal sites interested in testing technologies, and new processes for obtaining effective stakeholder input.

3.4 Multiple Stakeholder Views Add Value

Drawing from a wide spectrum of viewpoints, the group applied its special combination of perspectives and talents to answer the following questions - *"How can we accelerate the safe deployment of new and improved technologies for addressing the mixed waste problem? What are the most promising new technologies on the horizon, what demonstrations should occur, and in what manner should such tests occur to ensure their widespread use and commercialization?"*

For years, DOE has struggled with technology development questions almost in isolation, with little confidence by host communi-

ties that the agency could address both the technical performance issues and community concerns about safety and viability. Agency scientists rarely communicated with external groups or the nonscientific community about their technology preferences. The Mixed Waste Working Group asked nonscientists and engineers to come together to review new technologies and design the processes by which these technologies would be demonstrated. DOE opened up for full view its research and development program, obtaining invaluable insights and external guidance.

In a matter of months, the Working Group has managed to bridge a gap between science and perception, and scientist and citizen. The group has developed a shared program for testing new technologies, one which reaches beyond traditional and narrow approaches to technology selection and instead utilizes a range of technical, sociological and financial criteria and nontraditional evaluation methods. The cross pollination of ideas has already borne fruit:

- DOE planners and engineers shared their data on mixed waste volumes and provided a list of technologies currently under consideration in the near future. Never before had a broad-based stakeholder group had access to DOE's internal technology planning process.
- Commercial technology developers proposed specific recommendations regarding procurement reform and financial incentives necessary to motivate them to pursue the development of an innovative technology and to increase their chances of obtaining favorable and expedited acceptance by facility operators.
- University and laboratory scientists provided honest assessments about the technical merits of various research and development projects under consideration by DOE, and engaged in frank debate about the importance of nontraditional and nonquantifiable technology evaluation criteria.
- Environmental and public interest groups and Tribes provided important information on technology preferences and provided guidance to make sure that community-based concerns are the key components of the demonstration design and implementation.
- State and Federal regulators were asked to design demonstration programs that would address the most critical mixed waste problem in their State. State and Federal regulators provided critical insights on the technologies with the highest likelihood of approval from a regulatory viewpoint.

4.0 METHODOLOGY FOR STAKEHOLDER TECHNOLOGY SCREENING

4.1 Expedited review of DOE projects in the Pipeline for Phase I 1994 Demonstrations

Over a seven month period, the Working Group conducted an expedited fact finding and scan of technology proposals under consideration inside the DOE system. The screening was limited to projects already under consideration within the DOE budget process. The Environmental Protection Agency and Department of Defense were asked to submit projects but did not provide any for consideration, in part due to the short timeframe and the general absence of projects ready for demonstration in 1994. Both Federal agencies will be asked to generate projects for post-1994 demonstrations. The Working Group recognized the limitation of the scope of its screening for Phase I. Many in the group were concerned that an examination of only DOE projects limited the review to those proposed by DOE labs or facility Management and Operating contractors. Nevertheless, the group believes this to be the best short-term approach under the circumstances, since numerous promising DOE projects are funded, and therefore stand the best chance of occurring in 1994 and generating immediate and important new technical and stakeholder participation results. Phase II is specifically designed to be a more inclusive and comprehensive solicitation which will attempt to attract non-DOE partners and in particular private sector technology developers.

Overall, the group believes the urgency of the mixed waste problem calls for swift and aggressive technology development activities. But, the group also urges caution as 1994 demonstrations proceed. Environmental and community-based stakeholders must be assured that as the process unfolds, sufficient time and resources are available for methodical stakeholder review of the proposed technologies, particularly characterization, treatment, and disposal/storage technologies that require important community protection safeguards. (See Appendix 7.2 for further discussion.)

The Working Group conducted a preliminary scan of over 80 of the most promising demonstration projects currently under consideration within the DOE system. Many of these projects are ready for full demonstration in 1994, and many offer great promise for 1995 and 1996 demonstrations. In general, the group found the vast majority of the proposed demonstration projects intriguing and potentially useful. The nine technologies described in Section 5.1

offer the best potential for early demonstration. In addition, these nine technologies have the potential for breakthrough innovation, regulatory and host community acceptance, broad deployment and ultimate commercialization, and achievement of the overall goals of the DOIT Committee.

4.2 Eighty Candidate Technologies Submitted

Due to the urgency and size of the mixed waste issue within DOE, the Department provided primary support and guidance to the search process. The Western Governors' Association, with the assistance of Clyde Frank and the DOE Office of Technology Development, conducted a preliminary search for potential projects. Eighty projects were submitted (see Appendix 7.3) from both DOE field sites and headquarters. Submittals briefly described the basic project purpose and approach and applicability to the initiative of the Western Governors' Association.

4.3 Primary Criteria Reveal Twenty-Four Promising Projects

The Mixed Waste Working Group formed three subcommittees (treatment, characterization, and disposal) to review the 80 projects. The subcommittees met in Denver over two days in August and observed that the vast majority of the projects would add some degree of important information to the ongoing search for solutions to the mixed waste problem. However, after engaging in a qualitative and quantitative analysis, 24 projects stood out as the most promising (see Appendix 7.4).

The criteria used to select the projects were derived from the DOIT Committee's General Criteria, but were tailored to the Working Group's particular emphasis on mixed waste and the importance of taking action in 1994. The subcommittees used a focused process of review to identify the projects that exhibited the following key features:

- Does the project address the mixed waste issue?
- Does the project address a problem of significant magnitude?
- Is project funding assured for 1994?
- Will the project be ready for demonstration in 1994?
- Does the project adhere to the general acceptance criteria?
- Is the project located in or locatable to the West?

Less than half of the projects under consideration met these basic requirements. The primary criterion applied was - "Will the project be ready for demonstration in 1994?" The subcommittees then engaged in a qualitative process of scrutinizing the most promising projects from this smaller group. The group again applied the above criteria, further scrutinizing the relative levels of funding, project timing, purpose, and the size of the demonstration. The most promising projects were located by comparing them against the General Acceptance Criteria. In order to meet the special concerns of the Mixed Waste Group, the subcommittee created an additional consolidated set of criteria that included:

- Potential for technology transfer and commercialization
- Public acceptance, permitting and regulatory issues
- Extent of private sector and multi-agency involvement
- Likelihood of successful demonstration
- Total volume reduction
- Final waste forms and secondary waste forms
- Recycling and material recovery potential
- Ease of scale up
- Applicability to multiple DOE or non-DOE sites

Further, each of the subcommittees incorporated considerations unique to treatment, characterization, or disposal projects. Because of the time constraints under which the process operated, some of the analysis lacked complete information as to the actual maturity and specific technical components of projects. The committees have sought out additional information and clarification of key project components. This process is still underway and, as the DOIT Committee begins to make recommendations, more direct contact with the most promising projects and their managers will help identify projects that meet the spirit and intent of the initiative.

4.4 Nine Projects Offer High Prospect for Success in 1994

A new consolidated format for project presentation was developed and DOE was asked to provide the needed information on each of the 24 projects for submittal to the DOIT Committee and for review by the Working Group.

Upon receiving three-page descriptions of each of the 24 technologies, the full Mixed Waste Working Group met again in Denver. Through a process of elimination and a consensus approach, the

group expressed interest in further investigating nine projects (listed in Section 5.1 and Appendix 7.5) for 1994 demonstrations.

Out of the 24 projects, 15 involving mixed waste treatment technology were reviewed. The Working Group identified five technologies (six projects) as being of particular interest. Nine characterization projects from the characterization subcommittee were also reviewed, out of which the Working Group identified three projects of particular interest. In addition, after reviewing three disposal projects, the Working Group identified one for further investigation.

Each of the nine projects identified has unique and special features that heightened the group's interest. Several projects possess exceptional prospects for wide applicability in other industries. Several projects offer the potential to treat a wide variety of mixed waste. Additionally, several offer promising alternatives to continuing concerns about off-gases from thermal combustion. Others offer significant potential for cost savings in the waste characterization and handling process.

4.5 Continuous Stakeholder Input Sought

Throughout the process, national and site-based stakeholders have been consulted. Future stakeholder input will continue to shape and redirect the nature and types of technologies under consideration. The Working Group has designed a process to ensure that new comments are taken immediately into consideration. For instance, some stakeholders have called for additional scrutiny of each project to ensure that the most advanced pollution or emissions control technologies are also used during the demonstration.

The Working Group is continuing its research into these projects. In the coming weeks, the group will seek the input of the many national and site-based stakeholders who must ultimately support the decision to proceed with a technology demonstration. The process of review is ongoing and iterative, and no project is considered locked in stone. Conversely, promising projects not included in the first screening are still open to consideration by the DOIT Committee. The Working Group continues to learn about promising new projects, and stakeholders continue to provide the needed guidance.

The Working Group has mailed the comprehensive list of technologies to over 200 site-based stakeholders in the West for their review. In addition, the descriptions of the short-list of 24 projects were also distributed for review. Committee members have briefed the National Governors' Association and sought comments on key technology gaps. In addition, a stakeholder outreach team will begin the transition from a regional to a site-based stakeholder process. While the process to date has ensured widespread and diverse participation, the implementation of demonstration projects must now be centered around key stakeholders at project sites.

As the DOIT Committee moves into the site demonstration phase, the Working Group will ensure that site-based stakeholder education, involvement, and participation is initiated and supported at those sites under considerations and is conducted in a fashion sensitive to and compatible with existing site-based advisory groups, regulatory processes, and agreements. The Working Group also believes that resources are needed to enhance the ability of community stakeholders to monitor the demonstration-in-progress and to sustain their participation throughout the project. Representatives of the States and the four Federal agencies expect to be on the demonstration planning and oversight stakeholder teams to help ensure broad acceptability and deployability of the demonstration results to other sites or users.

5.0 FINDINGS FOR DOIT COMMITTEE REVIEW

The *Technology Gap* Requires Two Tracks - Phase I 1994 Demonstrations and Phase II Private Sector Participation.

- **Phase I** (described in 5.1) will seek out demonstrations that can occur immediately in 1994 and will attempt to *piggy-back* onto and enhance those projects already funded and ready to go at selected DOE sites.
- **Phase II** (described in 5.2) will promote a broader process for involvement of the private sector, small business, and other stakeholders offering creative new technology or institutional approaches to demonstrations at Federal facilities. Phase II will consist of a national solicitation for commercial and stakeholders demonstration partnerships. Phase II will also begin in 1994, but have a longer development timeframe than Phase I.

The Working Group seeks further guidance from the DOIT Committee on both Phase I and Phase II, described in the following sections.

5.1 Support and Fund Phase I Demonstration Projects in 1994

The Mixed Waste Working Group has discovered that significant technology development activities are already underway within the DOE system. Many new technologies offer great hope for new and safer forms of characterization and treatment. Many of these

projects are ready for demonstration in 1994 at selected sites. With the assistance of the DOIT Committee, the Mixed Waste Group has endorsed a series of Phase I demonstrations of technologies fully funded by the U.S. Government and in the DOE pipeline. Each project is being proposed for a specific DOE facility in the West. While each of the nine technologies have applicability at many DOE and commercial facilities, each technology demonstration is associated with a specific site and under the guidance of the site's DOE or contractor technology developer staff.

The Working Group conducted a preliminary scan of over 80 of the most promising demonstration projects currently under consideration within the DOE system. Many of these projects are ready for full demonstration in 1994, and many offer great promise for 1995 and 1996 demonstrations. In general the group found the vast majority of the projects intriguing and potentially useful. The nine technologies listed below offer great promise for early demonstration, the potential for breakthrough innovation, and the achievement of the overall goals of the DOIT Committee. The Working Group believes further support and attention by the committee to these projects will ensure enhanced consideration by DOE and increased stakeholder involvement.

The Working Group is continuing its research into these projects. The group recognizes the flaws inherent in an expedited solicitation and screening and for this reason acknowledges that the projects identified warrant ongoing review. Moreover, the group acknowledges that other projects not included in the first screening may warrant special consideration. Because of the nature of the review, the nine identified technologies are primarily sponsored by the large Management and Operating contractors or DOE laboratories. Some stakeholders remain concerned that overreliance on traditional DOE contractors may foster the promotion of traditional technologies. Nevertheless, the technologies described in the following sections are considered promising and have been highlighted by the group because of their innovative features.

The Working Group cannot prioritize the following nine projects, but does recognize the importance of characterization technology development as a precursor to successful treatment technology. In addition, characterization technology is likely to be supported by site-based stakeholders because it lacks some of the risks that may be associated with treatment demonstrations using "real waste." These nine projects at this stage in the process are considered unproven. In fact, a successful demonstration of their technical viability may possibly result in their failure - i.e., new cost, performance, and safety data demonstrating the ineffectiveness of the technology. Such is the primary purpose of the demonstration - for regulators and stakeholders to evaluate whether a technology is worth being considered for actual application, permitting, or commercialization.

5.1.1 Characterization Technologies (3 Projects)

Radiological and Hazardous Material Measurement System (RHMMMS)

The Idaho National Engineering Lab proposes a comprehensive and nonintrusive way to determine the content of containerized waste. Use of a series of high-energy neutron and gamma ray based analytical measurements will precisely characterize mixed waste without opening containers. Under the direction of EG&G, the project is expected to demonstrate the potential for significant cost savings and decreases in worker exposure, with applicability at all DOE sites and useful for buried waste analysis as well.

Rapid Transuranic Monitoring Laboratory

The Idaho National Engineering Lab proposes a fundamental change to the way mixed waste samples are collected and tested. A mobile laboratory demonstration will test the ability to conduct all radioactive air, soil, filter, and swipe sample analysis directly onsite during remediation, with results available in less than one-half hour. The mobile laboratory consists of a compact set of five different analytical instruments and safety systems. The project team, led by EG&G, believes the technology has wide application inside contaminated buildings, adjacent to buried waste sites, and during actual treatment and storage activities.

Dig Face Characterization

The Idaho National Engineering Lab proposes to test the deployment of multiple geophysical sensors on a continuous basis at buried waste sites. This would allow remediation engineers to obtain accurate "real-time" knowledge of the level and nature of contaminants physical properties and anomalous conditions in the waste and interstitial soils as a project proceeds. The array of nonintrusive sensors will continuously update the low resolution characterization data acquired from the ground surface, resulting in effective and safe control of cleanup operation. The project team, led by EG&G believes the technology has significant applicability throughout DOE sites and mining and hazardous waste sites.

5.1.2 Treatment Technologies (5 Projects)

Fixed Plasma Hearth Treatment

The Idaho National Engineering Lab proposes to test a new high temperature thermal treatment that has the potential to process the majority of solid mixed waste forms, with particular applicability to traditionally difficult-to-treat heterogeneous waste. The process will test a plasma arc torch (currently a commonly used technology in commercial industry) in a fixed hearth chamber to destroy organics and create stabilized residuals in a nonleaching, vitrified form. Uniquely, intact drums of waste can be placed in the plasma chamber, minimizing risky waste handling. The team, consisting of SAIC, Argonne National Laboratory-West, and EG&G Idaho, also hopes to demonstrate that the highly vitrified waste slag will be in a signifi-

cantly safer form for disposal. The separate metal waste is a candidate for possible metal reuse.

Thermal Desorption

The Rocky Flats Plant, or another western DOE site, proposes to test a patented process for thermal treatment of a wide variety of soils and debris. The technology uses a form of volatilization - thermal desorption - to remove organic contaminants. Hazardous contaminants are separated from mixed waste by heating material in a nitrogen atmosphere. This volatilizes the material and then captures and condenses the contaminants in the off-gas. The process is an alternative to traditional high temperature treatments and is potentially applicable to sludges, low-level and transuranic waste, and a variety of hazardous waste. EG&G, the Los Alamos Technology Office, Rust Remedial Services, and the Clemson Technical Center are also investigating other commercial vendors of thermal desorption technology for potential demonstration at Rocky Flats.

Minimum Additive Waste Stabilization (MAWS)

A group of industrial partners, including GTS Duratek, Lockheed, and Argonne National Laboratories propose an interesting new process to be tested on a variety of waste streams and contaminated soils at a to-be-determined western site. MAWS will test the concept of whether the chemical compounds already existing in the waste and soil can be manipulated and processed into a vitrified waste form without the introduction of new materials or additives. By recycling secondary treatment streams back into the waste, the MAWS system hopes to generate more stable vitrified waste and enhanced waste minimization. The technology is currently being studied at Fernald and will be further demonstrated at a site to be selected in the western States.

Microwave Solidification

The Rocky Flats Plant proposes to microwave inorganic liquids, ashes, sludges, or solids contaminated with heavy metals and/or radioactivity. Microwave technology, already used in commercial industry, will be used for the first time in the United States to treat mixed waste. Waste is mixed with a silica source and melted using microwave energy. The material is then cooled and solidified into a stable, robust waste form amenable to land disposal. EG&G at Rocky Flats and other industrial partners hope to demonstrate the technology's applicability to radioactive waste.

Two-Stage Advanced Oxidation Unit

Los Alamos National Laboratory, in partnership with the Electric Power Research Institute, the Idaho National Engineering Laboratory/U.S. Bureau of Mines, EG&G Mound Applied Technologies, the National Nuclear Institute of Mexico, and others, proposes to treat a wide variety of mixed and/or hazardous waste using an

innovative two-stage process. The first stage, the thermal packed-bed reactor, will treat organic liquids or solids in slurries. Off-gases from the first stage are fed into a second stage, the nonthermal plasma reactor, where entrained toxic compounds are further destroyed. The second stage is capable of simultaneously removing hazardous organics, oxides of sulfur, and oxides of nitrogen. The two-stage technology offers the prospect of creating simple, economical, and safe closed-loop waste treatment systems. The American utility industry, as well as Japanese and European industry, also envision application of the nonthermal plasma stage to off-gases from sulfur-emitting powerplants, auto exhaust, and other air toxics.

The need for off-gas treatment is pervasive throughout the DOE cleanup effort. The second stage of this technology has strong potential applications for off-gas treatment for three other technologies presently under consideration by the Western Governors' Association Mixed Waste Working Group (Fixed Plasma Hearth Treatment, Thermal Desorption, and Microwave Solidification).

5.1.3 Disposal Technologies (1 Project)

Advanced Landfill Cover Demonstration Project

Sandia National Laboratories proposes to test a new form of in situ landfill cover at its facility on Kirkland Air Force Base in New Mexico. Sandia will simultaneously test three different landfill cover technologies to determine which one holds the most promise for widespread use at existing or new landfills. In cooperation with the Environmental Protection Agency, Sandia will test the conventional clay barrier, a new and innovative "bio-engineered" barrier emphasizing site-specific vegetation, and the "dry barrier" system utilizing air flow to evaporate moisture from the cover.

5.2 Phase II - National Solicitation (RFI) for Commercial and Small Business Technology Developers and Stakeholder Partnerships

Because Phase I demonstrations have been limited only to internal Federal agency projects that are funded in 1994, the Working Group believes that additional opportunities to test innovative stakeholder processes and new forms of private sector commercialization partnerships should be promoted through a specially designed long-term DOIT Committee solicitation. While the 1994 projects will generate immediate results, the projects under consideration were limited to established DOE contractors and national laboratories. This fact generated spirited discussion within the Working Group to aggressively broaden private sector outreach.

The Working Group therefore is investigating a more inclusive process for seeking out all new ideas - many in their infancy - for innovative approaches to mixed waste. Numerous untested institutional,

regulatory, and technical issues will require a process that builds from the grass roots up and tests new ways of doing business between multiple stakeholders.

The Working Group is considering a **Request for Information** (see Appendix 7.6) be sent out from the Department of Energy under the auspices of the DOIT Committee to generate interest and to encourage a range of creative public, private, regulatory, and technological solutions. The emphasis will be to attract private sector technology partners who may not have had the ability to work through traditional procurement or Management and Operating contractor processes, or have not had sufficient incentives to invest time or resources in mixed waste technologies. Smaller technology developers will be encouraged to participate. National labs will be encouraged to participate, but only if they ensure that a commercial partner is in a lead position in the proposal.

The Working Group is further refining the scope and focus of the solicitation and is investigating the best way to locate proposals that address critical technology gaps. The Working Group is looking toward a publication of the solicitation in December 1994 through a Federal agency announcement or an independent DOIT Committee solicitation.

6.0 MIXED WASTE WORKING GROUP ACTION PLAN, 1993-1995

At its last meeting in October 1993, the Working Group endorsed proceeding with the two tracks - Phase I Demonstrations and Phase II Private Sector solicitation. The 1994 demonstration will set the stage for long-term or Phase II activities by the Working Group. In cooperation with the DOIT Committee, the Working Group will also pursue additional research and activities on the eight issues discussed in the following sections. These activities will, in part, focus on assisting and providing support to successful Phase I demonstrations, but will also help prepare for demonstrations to occur in 1995 and beyond. With limited time and resources at its disposal and because of the volunteer nature of the committee, the activities will be carried out only with the assistance of the Western Governors' Association or Federal agency staff.

6.1 Stakeholder Outreach Team - Making the Transition to Site-Based Demonstrations

The Working Group has involved a variety of site-based and national stakeholders in its deliberations. As the DOIT Committee moves into the demonstration phase, it is important to make a smooth and coordinated transition from a regional-based stakeholder process to one which is centered around site-based stakeholder processes. A stakeholder outreach team will develop a program for ensuring site-based stakeholder participation in the consideration, design, and evaluation of demonstrations at the four sites now under consideration in the West. The team will help ensure that site managers and stakeholders closely coordinate with one another and are clear about each other's decisionmaking role and authority. The stakeholder team will investigate the development of a funding mechanism for stakeholder participation.

The Working Group will give special attention to communication with the site specific advisory boards currently in existence or being formed at DOE facilities. In addition, all DOE sites have ongoing stakeholder participation forums that are considered the focal point for community discussion of DOE related issues. The DOIT process does not intend to supersede or replace such processes, particularly given the already difficult meeting demands placed on community stakeholders. Instead, the DOIT process will seek permission to utilize existing forums to discuss its efforts.

6.2 Demonstration Implementation - Defining Roles/Responsibilities/Actions

The goals of the Phase I demonstration effort will drive design of implementation programs, including the roles, responsibilities, and actions required to achieve success. Many of the issues and considerations have been addressed in a white paper developed by the Working Group (see Appendix 7.7). The Working Group has established a Demonstration Implementation Team to design the nuts of bolts of how to conduct the demonstration and to determine who will manage the effort.

In Phase I, where existing projects are leveraged by adding a proactive stakeholder process, it is envisioned that the lead agency (in this case DOE) would directly fund the effort. Additional funding may be required for the demonstration to support the active stakeholder involvement effort. The Western Governors' Association Working Group would monitor the overall effort and serve as a resource to the site-based team.

It is expected that the Point of Contact (POC) for stakeholder involvement would be selected from the region hosting the demonstration

and provide support to stakeholders as they provide input to the design and implementation of the demonstration. The POC, coordinating with DOE Field Office(s) and the Western Governors' Association Working Group, would coordinate program activities and handle the administrative and scheduling matters for the stakeholder process, including close coordination with the existing Headquarter's Program Manager.

Consistent with the goals of the efforts, the stakeholders will have significant input to the direction and structure of the project. To accomplish this, the stakeholders will be briefed on the technology and their concerns and information needs will be identified. This information will be communicated to the technical team and factored into the demonstration design to assure the required information is collected and analyzed. The stakeholder group will be provided opportunities to observe demonstration efforts. Throughout the demonstration, the stakeholders will be briefed on results and be requested to provide input on acceptability and/or remaining concerns and issues as well as potential mitigative measures if appropriate. The results of the stakeholder input will be factored into the decision process, and demonstration processes will be altered accordingly or shutdown to reflect stakeholder concerns.

The team will also develop management practices for such issues as shared liability, procurement processes, data quality assurance, and other mechanisms to ensure the maximum applicability of test results to other sites.

6.3 Regulatory Barriers

In Phase I demonstrations, the Working Group will assist site-based stakeholders in designing demonstrations that attempt to overcome the primary barriers to innovative technologies - with primary emphasis on shortening the time needed to conduct the demonstration.

Recognizing the importance of improved technology evaluation data, the Working Group will assist the DOIT Committee in designing a standardized technology evaluation template for use on Phase I demonstrations.

The Working Group hopes to incorporate the findings of the October 23, 1993, Regulatory Barriers Workshop, sponsored by the DOIT Committee and held in San Francisco, into the design of the mixed waste demonstrations. It will give special attention to the following barriers:

- Ways to streamline the approach to Research, Development and Demonstration permits as well as permitting accepted technologies.

- Development of broadly accepted, uniform permit processes.
- Development of process for validation/acceptance of monitoring characterization technologies and subsequent data.
- Review of the process of delisting RCRA-listed waste streams under Land Disposal Restriction requirements.
- Streamlining internal DOE Order and regulatory review processes.
- Ways to increase independent emission monitoring of demonstration processes by community stakeholders.
- Methods for ensuring more effective joint and concurrent stakeholder and agency review of technical and regulatory decisions.
- Increasing funding and support to sustain stakeholder participation

Finally, the Working Group will research the limitations of State/Federal authority over "strictly radioactive" materials. Throughout the Working Group meetings, stakeholders remain concerned about DOE's self-regulation of strictly radioactive materials under the Atomic Energy Act. While great progress has been made under the leadership of the National Governors' Association and States Attorney Generals to clarify State authority to regulate mixed waste, the Working Group recognizes that new technologies that eliminate or destroy only the hazardous waste component will generate a strictly radioactive residual that therefore exempts DOE from the State or Federal regulatory authority. While the group does not believe that this should impede or slow down technology development, it will investigate the policy implications to maintaining appropriate levels of independent oversight of DOE waste.

6.4 "Reinventing Procurement"

While DOE has extensive internal experience and the infrastructure for procurement processes, the group believe that more flexible, adaptive, and speedier procurement mechanisms that will hasten technology deployment at Federal sites. A preliminary white paper on procurement policy was developed by the group outlining the multiple mechanisms available to Federal agencies. Additional research is needed, particularly in light of the recent recommendations of the National Performance Review conducted by Vice President Gore.

The group has formed a subcommittee to research ways to improve procurement mechanisms and will work with the DOIT Committee to design and test new procurement mechanisms for use on Phase I demonstrations and for Phase II projects.

6.5 Commercialization - Defining the Marketplace For Small and Large Business

Mixed waste presents some unique challenges to the industrial sector. Because of its special features, efforts to encourage industrial partnerships must be focused and specialized, but sensitive to the wider application of technologies to other environmental problems. The Working Group has had excellent participation from the private sector, many of whom are owners or vendors of innovative mixed waste treatment technologies. The Working Group will investigate ways to attract more industrial participation, particularly startup technology development companies who have limited resources to invest in joint ventures on demonstration projects. Demonstration projects in 1994 will be asked to develop a detailed commercialization plan, including potential technology buyers and market opportunities.

In addition, dissemination of DOE's waste inventory report will increase interest from the technology development community, still leery about the broad applicability or marketplace for specific technologies. The potential for centralized, privatized, or transportable treatment facilities will also be further explored. In addition, further cooperation with commercial waste generators and vendors will be explored.

6.6 Measuring and Evaluating Success - Improve and Standardize Technology Screening, Performance, and Evaluation Protocols

Throughout its deliberations, the Working Group has discovered multiple and at times conflicting methods of describing the features and merits of new technologies. In addition, Federal and State protocols for evaluating and measuring the success of a technology demonstration have proven instructive but inadequate to the increasing demands of the regulatory community and technology users. The burden of proof of an innovative technology is high, and test results must be clear, understandable, validated, and comparable to years of data supporting more conventional technologies.

Critical to the success of any technology demonstration process is a clear up-front understanding of the potential merits and attributes of a technology, followed by the ability to rigorously measure an array of evaluation criteria. Nationally, various technology cost and performance formats are in use. This makes it very difficult for a broader range of stakeholders to conduct educated evaluations and comparisons of the merits of alternative technolo-

gies. The SITE program within EPA and other technology evaluation programs have helped shed light on the type of data and evaluation protocols essential to demonstration processes and the measurement of success or failure of those processes. Pacific Northwest Laboratories has developed a stakeholder involvement process that draws evaluation criteria directly from the stakeholders. Through a user-friendly computer tool, stakeholders can learn about technology performance and make technology comparisons. The Nuclear Regulatory Commission has also developed a technology profile formula.

More work needs to be done, however. The Working Group has established a team to develop a standardized evaluation formula or template for use on the Phase I demonstrations. The team will consolidate its efforts with those underway among participants in the regulatory workshop and the key western State representatives. The team will also conduct further research into better ways to conduct third party validations that incorporate not only the technical merits but the social science features of a technology, including financial viability, market potential, and community concerns.

6.7 Work Force Education and Training

Over the next 10 years, the weapons production mission of many DOE facilities will be downsized as the environmental restoration and decommissioning and decontamination mission will be enlarged. Enhanced worker safety and training protocols on mixed waste characterization technologies will be critical as DOE scales up its level of intrusion into drums and buried waste. The level of manpower needed to manage mixed waste storage facilities and manage treatment programs will grow exponentially.

The Working Group will research and monitor new processes for waste handling that will decrease the risks associated with radioactive waste management as new technologies are tested and containers are opened for the first time. Efforts to ensure safe management of the radioactive components must be enhanced. In order for community stakeholders to embrace testing of new technologies, a higher level of excellence and quality assurance will be expected. The Working Group, with the help of key labor and training experts, will investigate ways to increase the understanding and promotion of quality assurance and the highest level of worker training and retraining for this growing field and throughout the demonstration projects. The Working Group expects to expand its outreach to emerging work force institutions, i.e., universities, technical colleges and training programs, within those communities that will be addressing mixed waste in future years.

6.8 Promote Institutional and Peer Communication

Because of the technical complexities of mixed waste and the high visibility of the issue in site communities, efforts must be expanded to increase the level of interaction and education occurring between Federal agencies, commercial mixed waste generators, private sector technology developers, scientific experts, community-based groups, and the regulatory communities across western States and throughout the country. Information exchange systems within DOE and between Federal agencies has improved substantially, but additional attention is needed. The Working Group will investigate ways to enhance increased cooperation and information exchange on technology needs and stakeholder processes.

The group will provide updated information to the National Governors' Association Working Group, the Federal Technology Roundtable, the Low-Level Radioactive Waste Forum, the Waste Management Education & Research Consortium, and other initiatives. The videoconferencing capability of the Waste Management Education and Research Consortium and its discussions on mixed waste should be part of the Working Group's activities.

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7.0 APPENDICES

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Please note that the findings of the Mixed Waste Working Group do not necessarily reflect the views of every member of the working group. Some members were not able to participate in the development of the report, nor were the able to fully review its contents. The report does not represent the official view of any federal agency or department, state, or other group.

7.2 Mixed Waste Technologies

CHARACTERIZATION OF MIXED WASTE

Increased public awareness of safety, health, and environmental concerns has generated a regulatory environment that places greater demands on the operation of chemical process facilities. The DOE complex waste clean-up efforts will require facilities that are operating chemical processes, which make them a target for even more stringent regulations because of the nature of the waste materials requiring processing. Considering the present and future regulatory climate, the processes must be optimized to minimize generation of secondary waste streams, limit worker exposure to hazardous and radioactive materials, and be capable of producing a final waste form for disposal that is both inert and resistant to degradation in an efficient, controlled manner. One method for achieving process optimization is to develop operating methods with process control based on real-time chemical analyses. Achieving better control requires increased knowledge of the chemical and radiological parameters that affect the process operations.

Mixed wastes will be processed by thermal and/or chemical methods to destroy, react, or stabilize contaminants. Technologies are needed to characterize the wastes prior to, during, and after treatment. Real-time instrumentation is needed for screening level and decision-quality data for contaminants of interest including transuranics, heavy metals, volatile and semi-volatile organic compounds, uranium, and fission and activation products. Waste matrices include aqueous streams (solutions and slurries), liquid organic streams (spent solvents, scintillation cocktails and slurries), solids (sludges, resins, cement sludges), and gases (stack off-gas).

Screening techniques are needed for non-invasive characterization of mixed waste in containers to reduce worker exposure and mitigate safety risks. Detection of metal objects, free liquids, and level of radionuclide contamination are examples of characterization needs. Also monitoring devices to support remote sorting, size reduction, and waste segregation operations during feed preparation will be required.

Characterization of waste during processing and treatment is needed to (1) identify chemical and physical components that interfere with the formation of a stable final waste form, (2) optimize/control reagent addition, (3) minimize secondary waste streams, and (4) provide process control based on real-time measurements. Instrumentation and sensors must be rugged enough to operate in a processing environment and must provide accurate quantitative determinations of contaminants at levels of interest in a usable time frame for process control purposes.

Final waste form testing will require techniques and methods for waste acceptance criteria compliance verification and to satisfy Department of Transportation regulations. Procedures to replace the current labor intensive analysis techniques (such as the Toxic Characteristic Leaching Procedure) are highly desirable, although they will require regulatory acceptance.

Secondary waste stream monitoring needs include real-time measurements of hazardous and radiolytic constituents in off-gas and liquid effluent streams. Levels of detection must meet or exceed regulatory requirements for release to the environment of "clean" effluents.

Ambient air and groundwater monitoring will be required at DOE site or facility boundaries for protection of the neighboring public. All DOE facilities and remediation sites will also be required to monitor air quality within the workplace. Existing technologies that measure air quality in real-time need to be improved to satisfy regulatory requirements.

Mixed Waste Subcommittee Methodology For Analysis of Potential or On-going Demonstration Projects

The Mixed Waste Working Group conducted an expedited solicitation of federal agencies with innovative mixed waste technology demonstration projects which are currently under development or "in the pipeline". The working group sought to locate projects to which it could lend its support and resources in order to increase the potential for early and successful deployment of new technologies.

The U.S. DOE provided primary support and guidance to the search process due to the urgency and size of the mixed waste issue within the agency. Other federal agencies did not provide a list of candidates. The group understands that while the other federal agencies may have mixed waste projects for future consideration, the DOE's mixed waste technology development efforts are the most mature and thus more compatible with the wishes of the Working Group.

As a result, the U.S. DOE and the WGA conducted a preliminary search for potential projects. Over 80 projects were submitted from both DOE field sites and headquarters. Submittals briefly described the basic project purpose and approach and applicability to the WGA initiative.

The Mixed Waste Working Group formed three subcommittees to review the 80 projects. Meeting in Denver over two days in August, the group generally observed that the vast majority of the projects would add some degree of important information to the ongoing search of solutions to the mixed waste problem. But, after engaging in a qualitative and quantitative analysis, a smaller number of projects stood out as the most promising.

Taking its direction from the Mixed Waste Working Group, the subcommittees used a process of review which located those projects exhibiting the following key features:

- * Does the project address the mixed waste issue?
- * Does the project address a problem of significant magnitude?
- * Is project funding relatively assured for 1994?
- * Will the project be ready for demonstration in 1994?
- * Does the project adhere to the general acceptance criteria?
- * Is the project located or locatable to the West?

Because of the time constraints under which the process operated, some of the analysis lacked complete information as to the actual maturity and specific technical components of the projects. The committees have sought out additional information and clarification of key project components. This process is still underway and, as the DOIT committee begins to make recommendations, more direct contact with the most promising projects and their managers will help identify projects which meet the spirit and intent of the initiative.

The Mixed Waste Working Group subcommittee formed to review submitted characterization projects determined that nine of the projects met the criteria and addressed the characterization needs for mixed waste. These projects were discussed at the September 9th meeting of the Mixed Waste Working Group. The full working groups selected three of the most promising projects, and they are described in detail. The other six projects are also included in this report in the form in which they were submitted.

PROJECT TITLE: Radiological and Hazardous Material Measurement System (RHMS)
CONTRACTOR: EG&G Idaho, Inc.
CONTACT: Tim Roney, Phone: 208-526-9712, Fax: 208-526-6249

DESCRIPTION

Scope: To minimize sampling and handling of mixed waste prior to treatment, nonintrusive measurement techniques will be used to analyze and categorize containerized mixed waste. RHMS has been conceived and developed as an integrated, nondestructive, multiple measurement system for characterization of low level, mixed, and TRU waste. The system includes a passive gamma screen for initial activity levels and coarse spatial distribution of radioactive isotopes, passive gamma analysis for high-energy resolution gamma ray spectroscopy of radioactive isotopes (TRU and nonTRU), passive and active neutron for TRU, and thermal neutron induced gamma ray emission spectroscopy for neutron absorbers and hazardous elements. An increase of resolution, accuracy, and confidence in nonintrusive characterization data of containerized waste will be achieved by integrating all available information, as well as improving individual measurement specifications.

Technology: Technology includes high-energy resolution gamma ray spectroscopy, high output neutron source for active neutron interrogation of fissile and hazardous metals, and capability for integration of multiple measurements. Significant improvements in individual measurements in both passive gamma assay (PGA) and passive/active neutron (PAN) will be made. PGA improvements stem from advanced data integrity techniques while the active neutron measurement will be greatly enhanced by the addition of a high-flux neutron generation subsystem. The neutron generator is based on the ${}^7\text{Li}(p,n){}^6\text{Be}$ interaction and will produce an interrogating neutron flux one thousand to ten thousand times conventional neutron sources. For active neutron interrogation, substantial improvements in sensitivity, especially for low level wastes, will result from the use of this neutron generator.

APPLICATION

Containerized waste will require characterization information during retrieval, pre-treatment, post-treatment, shipping, and final disposal. Assays must be sufficiently quantitative to meet the requirements of the various controlling agencies. For example, the Waste Acceptance Criteria (WAC) of the Waste Isolation Pilot Plant (WIPP) specifies that a contact-handled 55-gallon drum contain no more than 200 grams total fissile gram equivalents. Waste that can be classified as low level, i.e., containing less than 100nCi/g of fissile material, need not be stored at WIPP. The ability to separate TRU from nonTRU waste will result in substantial cost savings for disposal. This technology can also be adapted for characterization of soils.

DOE Applications/Waste Streams: The applicable sites are INEL, Rocky Flats, and other DOE sites that have buried or stored containerized wastes. The waste streams include transuranic, low level, hazardous, and mixed waste categories.

Non-DOE Applications/Waste Streams: This technology can also be used to characterize commercial hazardous, low level, transuranic and mixed waste.

Size of Problem: Over a million containers of mixed waste are in storage at DOE sites in addition to a substantial amount of buried waste containers.

Direct Leverage with Other DOE Sites: A collaborative effort has been initiated with Lawrence Livermore National Laboratory to develop a simulated waste package, coordinate algorithm development for passive gamma assay and gamma ray tomography, and for development of the data integration system.

INVOLVEMENT OF OTHER GOVERNMENT AGENCIES
None.

INDUSTRY PARTICIPATION

The principal investigator has been tasked by the DOE program office to explore private industry and/or university participation by March 31, 1994. A successful working relationship has been developed with the Idaho State University Physics Department.

Commercialization Prospects: Industry has expressed interest in the neutron interrogation and gamma spectroscopy subsystems. It is expected that the technology will be transferred to industry to build the production systems.

Technology Transfer: The Principal Investigator will focus on identifying a commercial partner in 1994. There have been several expressions of interest from industry with regards to developing cooperative research and development agreements (CRADAs) in response to announcements in Commerce Business Daily and presentations at meetings. Discussions with one vendor have been initiated for transferring the active neutron interrogation technology.

DEMONSTRATION

The major goal for FY-94 through FY-96 is to develop and demonstrate the integrated system approach to containerized waste characterization. The emphasis will be on integration of measurement data from several assay programs and assay systems currently under development including Combined Thermal Epithermal Neutron (CTEN), Active and Passive Computed Tomography (A&PCT), Associated Particle Imaging (API), Digital Radiography and Computed Tomography (DRCT), and other industrial and DOE systems under development. The passive gamma assay measurement will be demonstrated in FY-94 on a 3/4-scale rectangular waste package. System integration will be demonstrated in FY-95 at the INEL.

Nature of material-Surrogate/Real: Tests will be conducted on real TRU waste packages.

Performing Organization: INEL

PROPOSED SCHEDULE AND BUDGET:

Characterize linac for neutron production	09-30-93
Deliver status report	10-31-93
Thermal neutron capture investigation and demonstration	01-01-94
Initiate system integration task	09-30-94

Current FY-93 Funding: The funding for 1993 was \$535K.

Budget: The anticipated funding for FY-94 is \$716K and the proposed funding for FY-95 is \$535K.

	FY-94	FY-95
FTE	3.25	3.25
Labor	500K	500K
Non-Labor	100K	35K
Subcontracts	56K	0
Capital Equipment	60K	0
Total	716K	535K

REGULATORY ISSUES

This technology development is driven by the regulations covering the remediation tasks of retrieval, treatment, transportation, and storage. Successful implementation of RHMMS and its component measurement cells will provide, in a noninvasive manner, the accurate information required by the regulations.

INNOVATION

A tremendous savings in remediation and storage costs is possible when waste is accurately characterized and handled according to the appropriate regulations. Tons of overburden will simply be returned to the earth rather than stored if it can be shown that the material is below regulatory concern. RHMMS may ultimately pay for itself by the savings incurred when barrels can be placed correctly in low-cost storage as opposed to high-cost storage.

Existing assay equipment is inadequate and unusable for waste characterization tasks involving unknown package constituents. Individual measurements need to be optimized for the unique waste remediation and characterization problems and multiple measurement integration is required to insure confidence in the quantitative results. This project will demonstrate these needed improvements.

PROJECT TITLE: Rapid Transuranic Monitoring Unit
CONTRACTOR: EG&G Idaho
CONTACT: Guy G. Loomis, Phone: 208-526-9208

DESCRIPTION

Scope: The Rapid Transuranic Monitoring Unit is a mobile counting laboratory for air, soil, filter, and smear samples for isotopic identification and quantification of alpha and gamma emitting radionuclides. Sample analysis time is on the order of one-half hour with lower levels of detection for isotopic identification in the tens of pCi/g. The system will be upgraded and demonstrated for beta measurement capabilities.

Technology: Analysis systems and software codes include: (1) an air monitoring system consisting of four remotely operated alpha CAMs and associated alpha spectrum analysis software that will have a sensitivity for airborne TRU isotopes that is superior to the sensitivity of 8 DAC-hr required by DOE order 5480.11, (2) an alpha spectrometer system consisting of three large-area ionization chambers that will analyze soil samples in 30 minutes or less with a lower limit of detection of 50 pCi/g for TRU isotopes, (3) an X-ray/gamma-ray spectrometer capable of analyzing soil samples in 30 minutes or less with a lower limit of detection of 50 pCi/g for plutonium, 1 pCi/g Am-241, and 4 pCi/g for gamma emitting radionuclides such as Co-60 and Cs-137, (4) a beta spectrometer capable of analyzing Sr-90 with a lower limit of detection of 50 pCi/g, and (5) software codes for storing, retrieving, and displaying analysis results.

APPLICATION

The Rapid Transuranic Monitoring Unit can be used during any transuranic waste handling operation, but was specifically designed for buried waste retrieval and processing. Simultaneously, the unit can analyze the entire gamma spectrum from 15 keV to 2 MeV. The unit can presently analyze both alpha and gamma emitting radioisotopes; in FY-94 the capability will be expanded to include beta emitting radioisotopes.

DOE Applications/Waste Streams: The mobile unit will analyze air, soil, filter, and smear samples in the field for alpha, gamma, and beta emitting radionuclides. It is applicable to retrieval of buried waste and during deactivation and decommissioning of facilities.

Non-DOE Applications/Waste Streams: The mobile unit would be useful for any field screening tasks that require measurements of alpha, gamma, and beta emitting radionuclides including the deactivation and decommissioning of commercial nuclear power plants.

Size of Problem: Numerous DOE sites have a need for a rapid screening of samples in the field for alpha, gamma, and beta emitting radionuclides. There are also numerous sites in other countries that could benefit from this technology.

INVOLVEMENT OF OTHER GOVERNMENT AGENCIES
None.

INDUSTRY PARTICIPATION

Commercialization Prospects: The Principal Investigator has been tasked to identify a commercial partner in 1994.

Technology Transfer: HASCO of Ohio built the sample preparation trailer, and Ordella of Oak Ridge built the large area ionization chambers.

DEMONSTRATION

The Rapid Monitoring Unit was demonstrated in field conditions during the summer of 1993. During the demonstration, both cold and spiked "hot" samples were processed by the unit. The unit was shown to meet expectations of 100 samples per day at levels of detection approaching fixed laboratory capability. This unit will be made available to ER/WM during FY-94, and the instrumentation and capabilities could be demonstrated during the year.

PROPOSED SCHEDULE AND BUDGET

Draft Technology Preparedness and Status Report	11-01-93
Draft FY-94 Test Plan	12/15/93
Initiate Testing of Beta Spectrometer	01/01/94
Complete Testing of Alpha Spectrum Analysis Codes	03/20/94
Complete Testing of Beta Spectrometer	07/01/94
Complete Testing of LXRAY code	07/01/94
Update Operating Manuals for ER/WM use	08/30/94

FUNDING BASE/SOURCES

FY-93 funding is \$1279K from DOE Office of Technology Development. Anticipated funding for FY-94 is \$696K from DOE Office of Technology Development.

	FY-94
FTE	3.6
Labor	620K
Non-Labor	39K
Subcontracts	0
Capital Equipment	40K
Total	699K (3K discrepancy needs to be reconciled)

REGULATORY ISSUES

The state of Idaho must be notified prior to using the sample preparation trailer HEPA filtered hood. During the summer 1993 demonstration, the state gave permission to operate the unit.

INNOVATION

The Rapid Transuranic Monitoring Unit is innovative because it offers a 10 to 1 cost savings and a 10 to 1 time savings for evaluating air, soil, filter, and smear samples compared to fixed laboratories. The levels of detection are approaching those found in the fixed laboratory. The large area ionization

chambers for alpha counting are serial model 1 and 2 built to INEL specifications and the thin window sample holders for X-ray and gamma counting allow examining the entire spectrum from 15 kev to 2 Mev.

PROJECT TITLE: Dig Face Characterization
CONTRACTOR: EG&G Idaho
CONTACT: Dick Callow, Phone: 208-526-2042

DESCRIPTION

Scope: The dig face characterization project is an integrated demonstration of multiple sensors that can be used as part of a retrieval effort. The dig face characterization technology will continuously monitor the site being remediated. In contrast to techniques that perform all site characterization prior to initiating remediation, the dig face characterization technique is intended to be integrated into the remediation process itself. This has the advantage of improving sensor resolution since the sensors will be brought closer to the targets as remediation proceeds. In addition, the fact that the sensed targets are eventually retrieved allows for the potential to improve sensor data interpretation skills by comparing interpreted data images with the actual target retrieved.

Geophysical, chemical, and radiological sensors will be deployed in a robotic type system (currently envisioned as a gantry crane). The sensors will scan over the surface to be remediated. As retrieval of the waste proceeds, the sensors will continuously characterize the waste.

Technology: Sensors are being investigated for detection of volatile organic compounds (VOCs), hazardous chemicals, toxic metals, and radioactive materials. The technology is intended to be adaptable as required for a specific site.

APPLICATION

The dig face characterization approach is applicable to any waste site undergoing retrieval operations. Approximately 2 million cubic feet of buried waste exists within the DOE complex that could ultimately require retrieval and processing. The concept can also be applied to non-DOE hazardous waste sites undergoing retrieval and remediation.

DOE Applications/Waste Streams: The dig face characterization approach is applicable to any waste site that requires retrieval of buried waste.

Non-DOE Applications/Waste Streams: Hazardous waste sites that require retrieval of buried waste could benefit from the dig face characterization approach, for example, mine tailings sites and munitions dumps.

Size of Problem: Approximately 2 million cubic feet of buried waste exists within the DOE complex that could ultimately require retrieval and processing. Applications to the mining industry and DoD munitions sites may significantly increase the size of problems this technology addresses.

Direct Leverage with Other DOE sites: Current collaborative work is underway with other DOE laboratories including Sandia and Grand Junction.

INVOLVEMENT OF OTHER GOVERNMENT AGENCIES

*United States Geological Survey (USGS)

INDUSTRY PARTICIPATION

The dig face concept is in initial development and there are currently no industrial partnerships. However, the potential for commercialization is significant due to the flexibility of the concept to adapt to specific site needs. Areas for potential commercialization and technology transfer include: technology transfer of prototype sensors under development, and technology transfer of robotic deployment techniques and equipment. Universities and companies current involved in related activities include Colorado School of Mines, Deneb Robotics Systems, and Ecology International.

DEMONSTRATION

During FY-93 the concept feasibility was demonstrated. This demonstration includes field testing of integrated sensor use, pilot-scale demonstration of a robotic system deployment of multiple sensors, and laboratory development of three prototype sensors for future use. The FY-94 demonstration will expand and incorporate improvements in the system.

Field Testing: A field test will be conducted of deployment of several sensors at a test trench constructed at the INEL. The sensors deployed will be: magnetometer, electromagnetic sensor, and a volatile organic compound (VOC) sensor (all are commercial sensors). The test trench is constructed of full-scale and small-scale simulated, nonhazardous waste. Testing objectives are focussed on obtaining dense data sets as overburden and waste is removed as would happen during retrieval. The data will be used to demonstrate sufficient target resolution ability that could be supportive of retrieval operations. The data will also be available for use in developing new interpretation and data display methods.

Pilot-Scale Demonstration of Robotic Deployment: This testing will be conducted at the INEL robotics laboratory. Multiple sensors will be deployed over simple targets (metal objects, nonhazardous chemicals) buried in a soilbox. Sensors will include magnetometers, metal detectors, and VOC sensor. Issues such as interference effects, optimum scan rates, and control capabilities will be identified.

Prototype Sensor Development: Several sensors are being developed and tested for feasibility in dig face characterization. A dielectric permittivity sensor will be demonstrated at lab-scale at the USGS test facility in Denver and a prototype EM Induction sensor will be demonstrated at the Geotech laboratory facility in Grand Junction. A prototype gamma spectrometer will be tested at the INEL.

PROPOSED SCHEDULE AND BUDGET

Technology preparedness and Status Report	11-29-93
Draft Gantry Experiment Test Plan	04-29-94
Complete Design and Assembly of Sensors	05-02-94
Draft Trench Test Plan	06-24-94
Draft Demonstration Evaluation Report	08-30-94
Final Demonstration Evaluation Report	09-30-94

FUNDING BASE/SOURCES

FY-93 funding is \$1556K from DOE Office of Technology Development.
Anticipated FY-94 funding is \$1100K from DOE Office of Technology Development.

	FY-94	FY-95
FTE	4	
Labor	840K	1000K
Non-Labor	30K	
Subcontracts	190K	
Capital Equipment	40K	100K
Total	1100K	1100K

REGULATORY ISSUES

Because the dig face concept is based on nonintrusive waste characterization, there are no anticipated regulatory issues directly governing the use of the technology. However, the technology is designed to be used as an integral part of a retrieval process, and that process will have regulatory issues. This technology may assist in addressing those issues.

INNOVATION

Dig face characterization is a new concept which is being developed for use as an integral part of retrieval of buried waste. Specific areas of innovation are:

1. The integration of the characterization with the retrieval allows for improved resolution from geophysical sensors as compared to current techniques of pre-characterization from the ground surface where overburden soil separates the target waste from the sensors.
2. The use of a robotic positioning system allows data to be obtained on a tight grid which can improve the resolution when compared to most current surface mapping grids. Reducing the region of interest to that which will be immediately retrieved may allow sensor modifications that further improve resolution when compared to surface mapping techniques where overlying waste can hide signals and reduce knowledge of underlying waste.
3. The ability to learn from experience may allow a wider range of data interpretation techniques since the interpreted data can continually be compared with the "true answer" as the waste is retrieved.

**Mixed Waste Working Group Demonstration
Treatment and Disposal Projects
Identified for Submittal to the DOIT Committee
(revised 10/27/93)**

Summary List

Treatment and Disposal

Treatment Projects

- Vac *Trax thermal Desorption Process
- Two Stage Advanced Oxidation/Reduction Unit for Mixed Waste Treatment
- Microwave Solidification
- Plasma Hearth Process Development for Mixed Waste Treatment
- Minimum Additive Waste Stabilization (MAWS)

Disposal/Storage Projects

- Advanced Landfill Cover Demonstration Project

See attached project descriptions

PROJECT TITLE: VAC*TRAX - Mobile Vacuum/Thermal Desorption Process Treatment System

CONTRACTOR: EG&G Rocky Flats, Chemical Waste Management, Inc., Rust Remedial Services (RRS), Clemson Technical Center (CTC)

CONTACT: Peter L. Montez, EG&G Rocky Flats, (303) 966-7681, Dr. Charles Reece, Clemson Technical Center, (803) 646-2413

DESCRIPTION

Scope: This proposal combines DOE efforts through the Morgantown Office, which has entered into contract with Clemson Technical Center (CTC) for the testing of the VAC*TRAX, and Rocky Flats Plant (RFP) which is proposing demonstration of the VAC*TRAX at RFP. The objective of this project is to develop, through full-scale application, an economical, thermal separation process for treating organically contaminated soils from relatively small sites (200 to 2,000 cubic meters of waste). Additionally, RFP waste identified as potential treatment candidates for volatilization technologies includes: combustibles, glass and ceramics, metals, and leaded materials. The planned siting of the VAC*TRAX demonstration at RFP is intended to treat soils and debris. RFP is planning to utilize this demonstration to conduct actual waste treatment studies.

The RFP Federal Facilities Compliance Agreement (FFCA) Treatment Plans I and II and the Comprehensive Treatment and Management plan (CTMP) proposed several cleaning technologies to remove organic contaminants from Landfill Disposal Restricted (LDR) waste streams. RFP has large quantities of hazardous non-radioactive waste, and low-level mixed (LLM) and transuranic mixed (TRM) waste. Most of this waste is hazardous as a result of low levels of RCRA-listed organic solvents. This technology has potential use for environmental remediation of contaminated soils and sludges, and, use in the waste management of stored and generated waste at RFP as well as other DOE facilities. Combined efforts among three agencies (EG&G, METC, LATO) increase the likelihood of a demonstration at RFP in FY94 or early FY95. The project is proposed to proceed as follows:

1. Treatability studies at selected vendor facilities
2. Cold/Hot Pilot Demonstrations at RFP
3. Full-scale Implementation at RFP

The plan includes Rust Remedial Services (RRS) and/or similar Low Temperature Thermal Desorption (LTTD) systems as needed or contracted.

Technology: VAC*TRAX is a technology uncovered in the initial volatilization technology survey of the Surface Organic Contaminant Removal Project. The VAC*TRAX is a low temperature thermal desorption process, enhanced with both vacuum and nitrogen atmospheres, which was developed as an economical means of treating smaller volumes of organically contaminated soils, sludges and sediments. Future demonstrations are planned for both environmental restoration and waste management. The system is composed of a reactor chamber where the matrices are agitated and the volatilized constituents are condensed and collected in an off gas treatment stage prior to disposal. Development of this treatment system is being funded under a Programmatic Research and Development Arrangement (PRDA) out of Morgantown Energy and Technology Center (METC). The PRDA plans for treatability studies, pilot and full-scale systems development, and pilot and full-scale demonstrations.

Rust Remedial Services' (RRS) VAC*TRAX process is an economical, method for treating organically contaminated soils, sediments, and sludges at sites with small waste volumes. Most of the existing thermal separation systems require large mobilization and demobilization costs which significantly impact the processing costs for sites with smaller feed quantities. The VAC*TRAX system is small, mobile, and requires minimal mobilization and demobilization activities.

In mixed waste applications, the VAC*TRAX process generates product streams that are amenable to further treatment and/or disposal via conventional methods. In the VAC*TRAX system, the use of a vacuum environment reduces the operating temperature of the process relative to conventional thermal separation systems, providing a reduction in the solids heating time. VAC*TRAX is designed to operate as a batch process because batch process vacuum dryers effectively used in many industries, are readily available, and are reasonably priced.

APPLICATION

VAC*TRAX is a thermal separation process for separating organic contamination from soils, with applicability to both hazardous and mixed (hazardous and radioactive) waste streams. Rocky Flats Plant (RFP) waste identified by the CTMP as potential treatment candidates for volatilization technologies includes: combustibles, glass and ceramics, metals, and leaded materials. The planned siting of the VAC*TRAX demonstration at RFP is intended to treat soils and debris. RFP is planning to utilize this demonstration to conduct actual waste treatment studies.

DOE Applications/Waste Streams: The applicable waste streams include low-level mixed (LLM) and transuranic mixed (TRM) waste, organic contaminated soils and sludges and decommissioning and decontamination (D&D) generated wastes.

Non-DOE Applications/Waste Streams: Many hazardous waste streams at Federal facilities in the West are also potential targets for this process. In addition, numerous industrial sites in the West hold possible applications, such as industrial petroleum spills, paint manufacturers' waste treatment needs, and pulp-mill organically contaminated sludges.

Size of Problem: Targeted waste streams account for a large volume of stored waste at RFP, and other DOE sites.

Direct Leverage with Other DOE Sites: The premise shared by EG&G and LATO is that "debris" type waste lends itself to the treatment by low-temperature thermal-desorption processing and, as such, application of this treatment technology may significantly reduce the targeted volumes of waste requiring further treatment. This demonstration is targeted at Rocky Flats. Numerous other DOE sites contain wastes readily treated by this technology, providing the opportunity for quick wins at several Complex sites.

INVOLVEMENT OF OTHER GOVERNMENT AGENCIES

DOE facilities involved in this effort include Morgantown Office, which has entered into contract With Clemson Technical Center for the testing of the VAC*TRAX, EG&G Rocky Flats (EG&G/RF) who is proposing demonstration at RFP, and Los Alamos Technology Office at Rocky Flats (LATO/RF) which is joining the treatability studies effort on low temperature thermal desorption technologies. In implementation, interactions are anticipated with Federal, State, and local regulatory agencies as appropriate.

INDUSTRY PARTICIPATION

Commercialization Prospects/Technology Transfer: Large scale thermal desorption system have been used extensively in environmental restoration as part of EPA's Best Demonstrated Available Technology (BDAT) and Innovative Technologies Program. Chemical Waste Management, Rust RS-Clemson Technical Center has participated with it's X*TRAX system in the past. It is anticipated that the opportunities for commercialization and technology transfer are good since the VAC*TRAX system is small, mobile, and requires minimal mobilization and demobilization activities.

DEMONSTRATION

For RFP, the following project phases are proposed:

1. A coordinated treatability phase
2. A coordinated demonstration phase
3. A coordinated implementation and treatment phase

For the Programmatic Research and Development Arrangement (PRDA) out of Morgantown Energy and Technology Center (METC), the Clemson Technical Center project management plan provides for phases described as follows. A logical sequence of developmental phases will take the technology from its current level to the point where a viable full-scale mobile VAC*TRAX treatment system would be available for use in remediations at DOE sites. These phases are as follows:

- I. Pilot System Design/Assembly Completion and Qualification Testing (Surrogate Wastes).
- II. Pilot Testing Using Mixed Wastes.
- III. Full-Scale VAC*TRAX System Design.
- IV. Full-Scale VAC*TRAX System Construction and Demonstration.

The PRDA demonstration activities include the following key elements:

- The first phase demonstration will be pilot scale. A full scale system will be developed during an optional third phase for demonstration testing at the selected DOE facility.
- The probable site(s) for demonstration are Rocky Flats or Oak Ridge.
- The demonstration will use surrogates and actual soils containing mixed waste from the selected DOE site.
- The performing organization for the demonstration will be Rust Remedial Services and Rocky Flats or Oak Ridge site personnel

Size/Scale:

1. Treatability studies will be done at vendor facilities on bench-scale system, or, pilot scale system if available.
2. Demonstrations will run on pilot-scale units (50 kg charge RRS VAC*TRAX system).
3. The final treatment facility will be a full-scale system (30-50 tons/day RRS VAC*TRAX system).

Size and scale are dependent on systems sourced by the vendor.

Locations:

1. Under the PRDA, pilot through demonstration units will be built, tested, and prepared for field demonstration at Rust Remedial Services and/or Clemson Technical Center facilities. A demonstration will be sited at a selected DOE facility that can define an appropriate niche for this technology.
2. Additionally, RFP treatability studies and evaluations are planned to be performed with EG&G or subcontractor facilities under the direction of EG&G or LATO. For this proposal, EG&G proposes RFP for the field demonstration.
3. Demonstrations resulting from the LATO efforts can be at RFP or any other DOE site.

Nature of Material-Surrogate/Real: Under the PRDA, surrogates of soils are currently being run or have been treated. RFP has shipped an actual "cold" RCRA sample (55-gallon drum) to CTC for testing in October, 1993. Treatability studies, contracted by LATO on various matrices and various contaminants, are in progress at WASTE TECH in Golden, Colorado. EG&G will contract similar surrogate studies as necessary to establish a system baseline and to determine system extraction efficiencies. Information gleaned will be used to develop treatment and demonstration plans and will be carefully coordinated between EG&G, LATO, and CTC to avoid duplication of effort.

Performing Organization: Under the PRDA, pilot through demonstration units will be built, tested, and prepared for field demonstration using Rust Remedial Services and/or Clemson Technical Center facilities. For this proposal, RFP is proposed for the field demonstration. For the RFP application, the bulk of the work is to be performed under EG&G's Surface Organic Contaminant Removal Project, DOE TTP RF121204. The RFP EG&G project's principal investigator will coordinate between the agencies involved to insure completion of objectives and the free flow of data between partners. The principal partners in this investigation are: RUST-Remedial Services, Clemson Technical Center, DOE Morgantown Energy and Technology Center (METC), EG&G Rocky Flats, LATO (RFP), and DOE-RFO.

**PROPOSED SCHEDULE AND BUDGET:
FUNDING BASE/SOURCES**

Morgantown Office: Clemson Technical Center

Budget Request for FY94 and Future:

Budget Summary (Dollars in Thousands)		
	FY94	FY95
Total	TBD	TBD

Note: Details not available. Total Estimated Value: \$2,388,000.

Task/Milestone Summary		
Activity or Milestone	Start Date	End Date
PHASE I START	09/30/92	
PHASE II START	03/01/94	
PHASE III START	03/01/94	
CONTRACT END	-	04/01/95

NOTE: PHASE I START: 09/30/92; PHASE II START: 03/01/94; PHASE III START: 03/01/94; CONTRACT END: 04/01/95.

Rocky Flats Plant

Current FY93 Funding: RFP EG&G/RF efforts are presently funded for related technology development under TTP RF121204, Surface Organic Contaminant Removal, for \$50k. The TTP is expected to be funded in FY94.

Budget Request for FY94 and Future:

Budget Summary (Dollars in Thousands)

	FY94	FY95
Total	750	750

Other Sources: LATO for \$30K (Treatability Studies), and Morgantown PRDA as noted separately

Task/Milestone Summary

Activity or Milestone	Start Date	End Date
Treatability Studies	1993	
Further Studies: Cold/Hot Studies	1994	
Demonstrations: (PRDA, EG&G Expedited, LATO)		
Cold /Hot Pilot Scale	1995	

REGULATORY ISSUES

• RCRA-LDR, FFCA II, and CTMP. RFP is in violation of the RCRA-LDR provisions and must develop and implement treatment technologies to address the backlogged hazardous and radioactive mixed wastes. Surface Organic Contaminant Removal technologies represent a pathway to achieve compliance and are identified in the CTMP. At a minimum, a Treatability Study Exemption (TSE) and probably an RD&D Permit will be necessary to treat targeted wastes.

Other regulatory drivers include:

- NTS and WIPP waste acceptance criteria (WAC)
- Agreement in Principle (AIP) and Inter-Agency Agreement (IAG)
- DOT regulations for shipment of hazardous and radioactive wastes
- DOE Regulations 5820.2a, 4700.1, and 5700.6c concerning radioactive waste management, project management, and quality assurance

INNOVATION

The VAC*TRAX process is designed as an economical, mobile method for treating organically contaminated soils, sediments, and sludges at sites with small contaminated soil volumes (200 to 2000 cubic meters). By utilizing a vacuum, the VAC*TRAX system requires lower operating temperatures and retention times than traditional thermal treatment

systems. The VAC*TRAX system is small, mobile, and requires minimal mobilization and demobilization activities, thus resulting in substantial cost savings compared to previous thermal treatment systems. VAC*TRAX developers view this thermal desorption system as capable of fulfilling a definite niche in both private industry and government facilities. EG&G considers this technology a possible means to resolve specific waste issues at ROCKY Flats.

PROJECT TITLE: Two-Stage Advanced Oxidation/Reduction Unit for Mixed Waste Treatment

CONTRACTOR: LANL

CONTACT: Louis Rosocha, Phone: 505-667-8493, Fax: 505-665-2840

DESCRIPTION

Scope: In collaboration with our industrial partners, we propose a project to design, construct, laboratory test, and field demonstrate a mobile two-stage mixed waste treatment unit at a selected Western site on wastes that are characteristic of several Federal sites. The unit can be used for waste treatment (stored or process-generated wastes) or environmental remediation (compounds extracted from soils or groundwater). Mixed liquid organic wastes, sludges, and combustible solids (particularly those containing hazardous compounds regulated by RCRA and TSCA) comprise a substantial part of the inventory of DOE and other Federal facility mixed wastes. This technology shows favorable economics, effective removal of RCRA and TSCA components from these types of mixed wastes, and the potential for timely fielding and permitting, which are key needs of the WGA/DOIT demonstrations. We are proposing a three-phase project with the following key elements:

1. Design, construction, and testing of a field-scale, mobile two-stage unit (ready for field demonstration at the end of FY94);
2. Cold (non-rad) field demonstration at a selected Western site by mid-FY95;
3. Hot (rad) field demonstration at a selected Western site in early FY96 (late FY95, if permit schedule allows).

Technology: Under presently-funded projects for the treatment of mixed wastes, LANL has developed an innovative thermal packed bed reactor (PBR) - which effectively destroys hazardous organic liquids and slurried solids - and a non-thermal plasma (NTP) reactor - which destroys air toxics or off-gases. A RCRA permit has been submitted to the state of New Mexico for this unit. Because of existing development, Western site compliance needs can be addressed in a timely, cost-effective manner. The technology has demonstrated extremely good combustion efficiency and DREs for hazardous organics and slurried solids. The two-stage process has several distinct advantages:

The PBR/NTP units are simple, rugged, have few moving parts, and are inexpensive

The system is modular and can be mobile

Glovebox operation for mixed wastes is easily incorporated

Simultaneous removal of NO_x, SO_x and hazardous organics is accomplished in the NTP stage

Added fuel is not required, which reduces secondary waste

The system can easily be implemented in closed-loop mode, reducing risk of emissions and preparing for the advent of even more stringent pollution regulations

The system is easily adaptable to feedback for variable waste stream composition/upsets

The unit is low in capital and operating costs

EPRI study has shown e-beam driven NTP already less expensive preferred option for power plant de-SO_x/NO_x scrubber retrofits; electrical-discharge driven NTP expected to be less expensive.

Japanese Ministry of International Trade and Industry study concluded NTP should be developed as next-generation technology and is 25% lower in cost than best existing technology.

Attachment 1 summarizes the performance of our two-stage unit to date. Please note that development is now at pilot scale for many applications (i.e., kg/hr throughput for many representative wastes).

APPLICATION

Our main targets are Western Federal-Site mixed wastes comprised of low-level radionuclides plus organic liquids (including RCRA hazardous compounds), nitrate-, nitrite-, ferrocyanide-containing aqueous liquids and sludges, organic solids that can be introduced as slurries, and potential mixed-waste off-gases emitted from primary treatment units. The respective treatability groups are: Organic Liquids, Aqueous Liquids and Organic Sludges (with Toxic Organics and Metals, with and without mercury).

DOE Applications/Waste Streams: The applicable sites are LANL (hazardous organic liquids and sludges, off-gases, and vacuum-extracted VOCs); Rocky Flats (machining-oil wastes, PCB oils, and the combustibles paper, Tyvek, polyethylene, vinyl, and rubber); INEL/EG&G Idaho (waste waters with up to 20% solids containing radionuclides, toxic metals, and organics).

Non-DOE Applications/Waste Streams: Naval Facilities Engineering Command (NAVFAC), Western Division (low-level radionuclides and solvents, oils, PCBs, and pesticides); and Hanford (sludges/liquid mixed wastes with ferrocyanides and/or organics). In addition to these mixed waste streams, many hazardous waste streams at Federal facilities in the West are also potential targets for this process. Hazardous organics, Napalm, solvents, and nerve agents at sites such as NAVFAC Southwestern Division, Brooks Air Force Base (AFB), Mather AFB, Hill AFB, Rocky Mountain Arsenal, the Pueblo Army Depot, and the Tooele Army Depot. In addition to these Federal sites, numerous industrial sites in the West hold possible applications. In collaboration with industrial partners, we have concentrated on industrial sources of air toxics in the South Coast Air Quality Management District of California (although many other sites exist in several Western states).

Size of Problem: For DOE sites, Attachment 2 gives a table of representative wastes, their classification, and amount. For non-DOE Federal sites, applicable waste streams range from small quantities (10's of barrels) to amounts even larger than the DOE sites (e.g., 10 million gallons of toxic sludge at the Rocky Mountain Arsenal). Industrial sites of concern have tons to hundreds of tons per year in toxic air emissions.

Direct Leverage with Other DOE Sites: EG&G Mound has determined that the LANL two-stage PBR/SDP unit is a match to its tritium-kerosene-PCB stored wastes. Considerable synergism would exist if the Mound and WGA/DOIT applications were simultaneously pursued. Numerous other DOE sites contain small to medium-sized volumes of wastes readily treated by this technology, providing the opportunity for quick wins at several Complex sites.

INVOLVEMENT OF OTHER GOVERNMENT AGENCIES

- New Mexico Environmental Division (RCRA permit)
- US EPA, Ohio (TSCA permit)
- US Bureau of Mines (collaborative project on hazardous off-gas with INEL & LANL)
- Memo of Understanding (MOU) with National Nuclear Institute of Mexico for technical collaboration; presently working with Mexican scientists on deploying a two-stage system in Mexico if funds can be found (widespread applications and benefits for NAFTA).

INDUSTRY PARTICIPATION

Commercialization Prospects: A collaborative agreement with a small business is in place to evaluate their pulsed power modulators for driving our plasma cells. If the evaluation is successful, they are interested in further commercialization. We have also established a collaboration with the Electric Power Research Institute, EPRI (CRADA on a two-year industrial air-toxics demonstration being signed, funds-in to LANL starting September 1993) which contains a requirement to identify an industrial commercialization partner in the first year.

Technology Transfer:

Electric Power Research Institute, EPRI (CRADA on a two-year industrial air-toxics demonstration being signed, funds-in to LANL starting September 1993). This CRADA will represent the transfer of this technology to a large fraction of US utilities, of which many customers have considerable need and economic incentives to implement advanced pollution control technologies.

Integrated Applied Physics, IAP (collaborative research and tech-transfer agreement on VOC treatment in place).

DEMONSTRATION

We are proposing a three-phase project with the following key elements:

1. Design, construction, and testing of a field-scale mobile unit (ready for field demonstration at the end of FY94);
2. Cold (non-rad) field demonstration at a selected Western site by mid-FY95;
3. Hot (rad) field demonstration at a selected Western site in early FY96 (late FY95, if permit schedule allows).

Size/Scale: All units will be full scale (e.g., 100+ kg/day treatment capacity).

Locations: The cold demonstration unit will be built, tested, and prepared for field demonstration at LANL. The Applications section above lists several possible candidate sites for the field demonstration; we would work with DOE, WGA, and other agencies to select an appropriate site.

Nature of Material-Surrogate/Real: In FY94, surrogate materials will first be employed; when the RCRA R&D permit is in place, real cold wastes will be used. For the FY95 field demo, cold real wastes will be employed. In FY96 (or late FY95), real mixed wastes will be treated.

Performing Organization: The bulk of FY94 work will be performed by LANL, but a key goal is to team with a host organization. In FY95 and FY96, a team consisting of LANL, the host site organization, and a waste management contractor/private firm will perform the demonstrations. In addition, our academic partner, the University of Illinois, will participate in lab shakedown tests and preparations for the field demonstration.

PROPOSED SCHEDULE AND BUDGET: TWO-STAGE ADVANCED OXIDATION/REDUCTION UNIT

FUNDING BASE/SOURCES

Current FY93 Funding: Presently funded for related technology development under two major TTPs (AL121215 & AL121104) for \$959k. Both TTPs are expected to be funded in FY94, but reduced. Guidance has been given for an additional TTP with INEL/BWID for nonthermal plasma off-gas/metal vapor treatment in FY94 (\$240k). However, dedicated funds will be needed for this hardware-intensive proposal, even

though considerable leverage with other efforts is available to accelerate progress and assure success.

Budget Request for FY94 and Future:

Budget Summary (Dollars in Thousands)			
	FY94	FY95	FY96
OP	690	340	390
CE	45	30	40
LI	0	0	0
GPP	0	0	0
Total	735	370	430

Private Sources: Electric Power Research Institute, EPRI (CRADA on a two-year industrial air-toxics demonstration being signed, \$200k funds-in to LANL starting September 1993).

Task/Milestone Summary			
Activity or Milestone		Start Date	End Date
A1	Test surrogate air emissions w/NTP reactors..	10/01/93	01/31/94
A2	Test hazardous waste surrogates w/PBR.	10/15/93	01/31/94
M1	Decision point for mobile unit design.	02/01/94	02/15/94
A3	Design mobile unit & conduct DVT's.	02/15/94	05/30/94
A4	Construct & lab-test mobile unit.	04/01/94	09/25/94
M2	Unit ready for field demonstration	09/25/94	09/30/94
M3	Complete field demo; issue performance report.	10/01/94	03/31/95

REGULATORY ISSUES

Permits will be required to treat real wastes (R&D, RCRA, TSCA, and radioactive), both at LANL and at the field-demo site. Considerable progress in permitting has been made: RCRA R&D permit submitted to state of New Mexico; using RCRA permit as a model for a TSCA permit (which we plan to pursue in FY94). No permitting issues are envisioned for this technology. Also, two positive features are envisioned: the two-stage unit is flameless and falls under regulations for thermal treatment units established in 40 CFR of March 1991; and the unit can be operated in a closed-loop mode, thereby drastically limiting emissions and being less affected by public perceptions concerning mixed waste treatment.

INNOVATION

This two-stage hazardous waste destruction process is a major advance in environmental technology. It combines engineering simplicity with the subtlety of effectively directing electrical energy into chemical processing via a non-thermal plasma ("cold combustion"). This marriage of a robust thermal technology with an innovative plasma technology has lead to the development of a waste treatment technology characterized by improved effectiveness, increased energy efficiency, reduced emissions, modularity, a broad spectrum of waste treatment applicability, and an inherent closed-loop architecture.

Attachment 1

LANL PBR/SDP DEMONSTRATED DESTRUCTION MATRIX

In many of the runs listed below, the hazardous waste concentrations were reduced below our detection limits. For example, we are unable to quantify [TCE] or [PCE] below 50 ppb.

COMPOUND	EPA Waste #	FORM	PBR ONLY	SDP ONLY	PBR/SDP	MEASURED DRE
trichloroethylene (TCE)	U228, F001	up to 10% in oil up to 10% in oil 1000 ppm in air	X	X	X	>99.99 >99.99+ 99.99
trichloroethane (TCA)	U227, F002	up to 10% in oil >100 ppm in air	X	X		>95 99
perchloroethylene (PCE)	U210, F002	>2000 ppm in air		X		>99.9
dichlorobenzene (PCB surrogate)	U070, F001	17% in kerosene 10 ppm in air PCBs (estimated)	X	X	X	>99.9996 99.4 >99.999998
CFCs (Freon 113)	F001	>1000 ppm in air up to 20% in oil	X	X		>90 >95
scintillation fluids (p-cumene)	U055	up to 100% liquid in water	X		X	>95 >95
toluene	U220, F005	up to 20% in oil 100% liquid	X		X	>90 >95
carbon tetrachloride	U211, F002	3% liquid in oil >100 ppm in air	X	X		>95 >99
hydrocarbons		in air			X	>99

For the tests listed below, with oil or slurry feeds, combustion efficiency is the more instructive parameter.

COMPOUND	FLOW RATE cc/min.	FORM	PBR	Combustion Efficiency $100 * [CO_2] / ([CO_2] + [CO])$
hydrocarbon oil	10	liquid	X	>99.95
chlorinated oils (TRIMSOL)	6	5% in water to 100% liquid	X	>99.9
nitrates	2.5	3M NaNO ₃ in water	X	>99.9
polyethylene	>20	>10% wt. slurry	X	>99.9
rubber	>100	>10% wt. slurry	X	99.8
vinyl	>40	20% wt. slurry	X	99.9
Tyvek overalls	>40	>6 % wt slurry	X	>99.9
cellulose	>10	15% wt slurry	X	>99.9

For more information contact John Coogan (505-665-0186) or Louis Rosocha (505-667-8493).

Attachment 2

Representative Waste Forms for Treatment by Two-Stage Unit (Contact-Handled, Non-Alpha plus Pu-Alpha, Non-PCB); Sums from Hanford, INEL, LANL, Lawrence Berkeley, LLNL, and Rocky Flats

Waste Matrix	Toxic Organics		Toxic Organic & Metals w/ Hg		Toxic Organic & Metals w/o Hg	
Organic Liquids	15	344	5	122	5	51
Aqueous Liquids	5	3	2	75		
Organic Sludges	4	20	3	11	2	2

Key: Left number is number of waste streams; right number is amount of waste in cubic meters (stored plus projected 5-year generation).

PROJECT TITLE: Microwave Solidification for Mixed Waste

CONTRACTOR: EG&G Rocky Flats, Inc.

CONTACT: G. S. Sprenger, phone: (303) 966-3159, fax: (303) 966-7096

DESCRIPTION

Scope: In conjunction with the WGA, local and federal environmental regulators, private sector consultants, and other interested stakeholders, EG&G proposes that a series of tests be conducted to demonstrate the applicability of the microwave solidification technology on various environmental remediation waste forms. The demonstrations will be conducted in the full-scale, non-radioactive, pilot plant currently in operation at the Rocky Flats Plant in Golden Colorado. Characteristic surrogates will be prepared based on information provided to the RFP Project team by the WGA DOIT sponsors. Performance of the microwave solidification technology will be evaluated based on criteria agreed upon by the demonstration participants. The amenability of this system has been proven on hydroxide sludges, incinerator ashes, high nitrate salt streams, and soil materials. Thus, the proposed DOIT technology demonstration will benefit directly from the background experience already available through the RFP project. Additionally, the regulatory issues addressed through the RFP project will strengthen the proposed WGA DOIT program.

Technology: The process being developed at the Rocky Flats Plant is an in-drum melting system designed to isolate the molten waste in the shipping container during processing. This processing system offers advantages over other thermal processes. Because the material does not have to flow, viscosities of the melt can be higher than glasses, allowing much higher waste loadings thereby reducing waste volumes. Greater energy transfer efficiency is achieved due to direct coupling between the microwave energy and the waste. Since the waste is being directly heated, energy control is instantaneous. Synthetic minerals also offer a each resistant, stable matrix especially suited for hazardous and radioactive wastes. The high temperatures also ensure destruction of soluble materials such as nitrates. The process equipment is also more easily maintained because the heat is contained in the disposable drum which is insulated from the rest of the process equipment.

There are three primary mechanisms involved in heating with microwave energy. Type I is characterized as the vigorous vibration of a dipole molecule due to the oscillation of the electromagnetic field. The vibration causes frictional heat to build up between the molecules which elevates the temperature of the material. The simulated and actual sludge used in these tests contain metal oxides which are normally electrically neutral; however, when placed in an electromagnetic field they become dipolar. Type II heating involves substances that are magnetic in nature and couple with the magnetic component of the microwave field. The oscillation of the magnetic component of the field results in hysteresis loss within the material which generates heat. Type III heating takes place when an electrically conductive material, such as carbon black, is a component of the material being heated. A current is generated throughout the material by the electric component of the microwave field. The material is heated by the current flow through the material.

The process for microwave solidification treatment involves drying the waste, mixing with a silica source and a matrix modifier, transferring the material to a processing container, subjecting the mixture to microwave energy to melt the material, and allowing the processed waste material to cool and solidify. As the process takes place at elevated temperatures, nitrates, sulfates, and residual organics are driven from the molten material. Thus, off-gas containment and treatment systems are required. The resulting waste form is a glass-like mineral that does not contain free liquid, it has limited releasable particulates, and is highly leach resistant due to its vitreous nature.

At the heart of the proposed production system is a 60 kW, 915 MHz microwave generator which is connected to a 40 inch cubic applicator cavity by a WR975 waveguide. Other features of the facility include 1) feed characterization and preparation systems, 2) a frit preparation and transfer system, 3) a waste pelletizer and dryer to produce a particle which can be handled in the system with minimal dust generation, 4) an integrated hoist and bagless posting system to transfer items into and out of the glovebox facility, and 5) associated off-gas treatment systems to remove dust and regulated emissions.

During operation of the system, the waste material is introduced into the glovebox as is appropriate for the physical form of the waste material. The waste is then comminuted to meet material handling requirements of the down-stream equipment. A silica source/matrix modifier (composed of diatomaceous earth and borax in a two to one ratio) is added to the material to produce a waste loading of approximately 60 to 70%. The mixture is pelletized using an extrusion pelletizer to create a robust particle which will not produce dust during subsequent transfer operations and is dried using a multiple-tray, direct dryer. The dried material is transferred to a surge hopper where it is accumulated prior to the melting process.

To initiate microwave melting, a 30 gallon stainless steel drum is connected to the applicator cavity by placing it in an insulation cage and compressing it against a rotary choke mechanism using a lifting turntable. An initial ten kilogram charge of waste material is added to the drum while the turntable oscillates continuously to assure an even distribution of the waste in the drum. Microwave energy is transmitted to the 30 gallon drum thereby raising the temperature of the material to approximately 1000 degrees centigrade causing it to melt. After the initial charge becomes molten, waste material is continuously transferred from the surge hopper to the 30 gallon drum through a vibrating feeder which penetrates the wall of the applicator cavity.

Effluent gases generated during the melting process are removed by ventilating the cavity using a down-stream blower system. Suspended particulates are removed from the effluent gas by passing the stream through a high efficiency cyclone and a sintered metal filter. Oxides of nitrogen and sulfur are treated using a catalytic reduction apparatus. The temperature of the effluent gas is reduced by means of a spray quencher and demister system. Finally, the clean effluent is passed through a roughing filter before entering the building filter plenum system where it is polished through several stages of HEPA filtration.

The process continues until 200 kilograms of processed waste material have accumulated in the 30 gallon drum. At this time, the process is momentarily interrupted while the drum is removed from the melting cavity and transferred to a cool-down/inspection station and an empty drum is loaded into the melting system. While still molten, the contents of the processed drum are sampled for analytical characterization and certification. The drum is allowed to cool and is then transferred to the bagless posting system for removal from the glovebox.

Rocky Flats has a full-scale demonstration system for treating non-radioactive surrogate waste. The technology is applicable to both mixed waste management issues and to environmental restoration activities.

APPLICATION

Microwave solidification technology is an ex-situ treatment process applicable to homogeneous, wet or dry, inorganic solids.

DOE Applications/Waste Streams: Several waste streams at RFP and other DOE facilities in the Complex have been identified as potential candidates for microwave solidification. The RFP streams include fluid bed incinerator ash, nitrate salts, sand, slags, crucibles, and remediation soils. The target contaminants for the technology are heavy metal and radionuclides. Other DOE applications for microwave technology include the nitrate salts buried at Idaho National Engineering Laboratory, the by-pass sludge from TA-50 at Los Alamos, and use in the Waste Handling and Packaging Plant (WHPP) at Oak Ridge. Additional wastes forms may be identified in the future as microwave application investigations continue.

The RFP Microwave Solidification Project has application potential to the Mixed Waste Treatment Project and the Mixed Waste Integrated Program. The technical areas being addressed by microwave solidification include (1) Waste Destruction and Stabilization, (2) Final Waste Form, and (3) Front-end Waste Handling and Feed Preparation. Due to the maturity of the development project at RFP, microwave solidification could be easily incorporated into the MWTP or MWIP demonstration programs. This would provide an immediate opportunity to investigate a treatment option under consideration for implementation in the future DOE complex. Not only would this benefit MWTP and MWIP, but it would accelerate the design and construction of COMPLEX 21.

Non-DOE Applications/Waste Streams: This technology is also applicable to a variety of industrial waste treatment needs. For example, it can be used for (1) high level waste solidification at nuclear reactor facilities, (2) hydroxide sludge solidification from steel manufacturing, (3) soils remediation at Superfund sites, (4) solidification of ash from hazardous waste incinerators, and (5) solidification of ash from commercial power plants.

Size of Problem: The generation rate of 1,200 cubic feet per year coupled with an existing backlog of 18,000 cubic feet makes precipitation sludge one of the largest waste problems by volume at RFP. Current treatment of this waste stream is accomplished by cementation, which results in large waste volume increases. Due to LDR, this waste form is not acceptable for land disposal. The improved waste form produced by microwave solidification offers significant waste volume reductions up to 80% as compared to the present immobilization process. Additionally, microwave solidification of precipitation sludge removes water (the source of ground water mobilization and hydrogen generation), while immobilizing radionuclides and heavy metals and eliminating releasable particulates. Thus, a waste form can be produced that is suitable for land disposal.

Direct Leverage with Other DOE Sites: The hydroxide coprecipitation sludge, which has been the focus of this development activity to date, is not unique at the Rocky Flats Plant. Any facility that processes a liquid waste stream generating a sludge or that is involved with soils remediation will be a candidate for application of this technology. Specifically, Los Alamos National Laboratory's facility TA-50 is nearly identical to Rocky Flats Plant's B374. The possibility of coordinating with TA-50 up-grade efforts have been discussed with LANL representatives. Additionally, joint studies on environmental remediation opportunities have been discussed with engineers from the Idaho National Engineering Laboratory. A collaborative effort in either of these efforts will benefit this program through the leverage advantage of joint participation.

INVOLVEMENT OF OTHER GOVERNMENT AGENCIES

This development program is jointly funded through EM-30 and EM-50. As such, the program has employed an integrated approach to developing the technology. Expertise

from throughout the DOE complex has been utilized at various stages during the program, specifically, Los Alamos National Laboratory, Los Alamos Technology Office, Lawrence Livermore National Laboratory, Oak Ridge National Laboratory, Idaho National Engineering Laboratory, Savannah River Site, and the Westinghouse Hanford Corporation.

Information concerning the project has been presented to regulatory and environmental organizations through several forums. Additionally, representatives from the federal and states regulatory agencies have toured the demonstration facility on several occasions. These groups are considered stakeholders in the implementation of the technology for the solution of RFP waste management issues. As such, these organizations will be heavily involved in peripheral activities associated with technology selection, permitting, and implementation.

INDUSTRY PARTICIPATION

Commercialization Prospects: Microwave technology has been used in the food and chemical industries since early 1970, with the majority of the work concentrated in the areas of drying and the vulcanization of rubber. High temperature technology has been developed by the Japanese for converting plutonium nitrate to plutonium oxide for nuclear fuel production and for solidifying of waste incinerator ash. Laboratory scale vitrification of calcined high-level nuclear wastes using microwave energy was done by the Idaho National Engineering Laboratory, in 1979. Significant work with solidification of inorganic wastes has been performed at the Rocky Flats Plant since 1985. Wastes successfully processed include precipitation sludge, incinerator ashes, nitrate salts, and soils. The incinerator ashes included fluidized bed catalyst ash, and ash from shredded HEPA filters. Both types were mixed with fluxing agents and a silica source, and heated using microwave energy. Nitrate salts were heated to their melting points to form a salt cake. Oak Ridge National Laboratory has performed additional salt solidification work with outstanding results.

Throughout the development program, several industrial partnerships have been developed through contract services to supply requisite expertise in hardware/system design, fabrication, and installation. A partial list of past and present industrial participants includes, Microdry Corporation, RF Technologies, Coors Fabrication, Coors Analytical Services, Environmental Engineering and Technology, Cha and Associates, Bend Research Corporation. Independent consultants include, A.J. Johnson, W. Vaughn, C. Buffler.

Technology Transfer: Because the technology is already heavily used in U.S. industry, the transition of the microwave solidification technology into the commercial waste treatment industry will be smooth and amicable. RFP has identified this potential and is pursuing technology transfer as appropriate. Rocky Flats is also preparing to pursue industrial CRADAs with appropriate partners.

DEMONSTRATION

Industrial Status: At present, microwave melting for waste solidification is not a commercially available technology. Although a similar technology, which could potentially be used for solidification of bypass sludge, is available at Japan's Tokai Works, appropriate operating parameters would have to be defined as the existing system is used for processing incinerator ash. Also, ORNL has developed a pilot-scale salt drier utilizing

microwave technology. However, the ORNL technology does not immobilize LDR components.

RFP Status: The Microwave Solidification Project was initiated at Rocky Flats in 1986 at the request of the Waste Operations organization. Since that time, laboratory-scale tests have been performed on actual and surrogate wastes and pilot-scale tests have been performed on surrogate materials. The basic design of the Rocky Flats microwave technology has been demonstrated with bench-scale tests on actual waste. Test results indicate that volume reductions of up to 80% are achievable by the continuous feeding of dried sludge into a waste container while applying microwave energy.

Size/Scale/Location: Currently, a full-scale, cold demonstration system is available and has been operational since March 1991. To date, sixteen tests have been performed on the full-scale system. The demonstration system, which is a successful scale-up of 30X from the bench-scale system, is sized and designed for specific application to RFP wastes, and certain components of the design have been patented by RFP engineers. Preliminary NO_x off-gas treatment systems have been identified and documented. RFP has also assisted ORNL in the development of a microwave process to treat nitrate salts for the WHPP facility at Y-12. A preliminary economic evaluation was completed for RFP's system. NEPA documentation has been completed for the demonstration phase of the RFP project.

Nature of Material-Surrogate/Real: Laboratory-scale tests have been performed on actual and surrogate wastes and pilot-scale tests have been performed on surrogate materials.

Performing Organization: EG&G Rocky Flats, Inc. will be the performing organization for the demonstration and implementation of this technology.

PROPOSED SCHEDULE AND BUDGET:

FUNDING BASE/SOURCES

Currently, the Research and Development portion of the Microwave Solidification Project at Rocky Flats is jointly funded by DOE EM-30 and EM-50. It is anticipated that this dual-funding profile will continue throughout the projected future of the project. The projected annual funding breakdown for this activity is as follows.

Dollars in Millions			
	EM-30	EM-50	Total
1993 Actual	1.001	1.316	2.317
1994 Approved	0.542	2.100	2.642
1995 Requested			2.750
1996 Requested			1.275
1997 Requested			1.402

The above costs cover the development of a system for treating hydroxide sludge at RFP. Minimal additional funds may be required to support the WGA DOIT program.

The life-cycle costs through implementation of the technology into operations at RFP have been estimated as follows.

Demonstration Test	\$8.3M
Regulatory/Permitting	1.8
Conceptual Design	0.7
Title I	1.2
Title II	2.3
Equipment Procurement	8.1
Equipment Installation	0.8
Preoperational Testing	0.3
Total	23.5

The following gross level schedule for implementing the technology into operations at RFP is included for informational purposes.

FY'94 to FY'96 -- Complete demonstration testing.
 FY'94 to FY'98 -- Regulatory and permitting activities.
 FY'94 -- Conceptual Design
 FY'96 -- Title I Design
 FY'96 to FY'97 -- Title II Design
 FY'97 -- Equipment procurement
 FY'98 -- Equipment installation
 FY'99 -- Start-up operation

REGULATORY ISSUES

Rocky Flats Plant is out of compliance with the Resource Conservation and Recovery Act (RCRA) regulations because many of its wastes are prohibited from land disposal and they have been stored at RFP in violation of the law's storage prohibition. The Federal Facility Compliance Agreement (FFCA) is an agreement that allows RFP to continue operations under the condition that means would be developed to treat its LDR wastes by pursuing suitable treatment technologies.

A Treatability Study Exemption is in place for evaluations using actual hydroxide coprecipitation sludge from the B774/374 Liquid Waste Treatment Facility at RFP. The project is entering the capital project funding phase, thus operating permits will be pursued in the near future.

INNOVATION

The microwave solidification system under development at RFP is unique throughout US industry. To date this is the only system that uses microwave energy to treat mixed waste. The system is being designed to be broadly applicable to a variety of inorganic wastes that occur in large volumes throughout the DOE complex and US industry. Microwave solidification produces an excellent (exceeds the waste acceptance criteria) robust waste form that is relatively unaffected by feed variability or process up-set conditions.

PROJECT TITLE: Plasma Hearth Process Development for Mixed Waste Treatment

CONTRACTOR: Science Applications International Corporation (SAIC) through subcontracts with DOE-ID and a variety of DOE contractors, including MSE/Butte, Martin Marietta Energy Systems, Inc., EG&G Idaho, Inc., and Argonne National Laboratory-West

CONTACT: Milo Larsen, SAIC, (208) 528-2109
Grant McClellan, ANL-W, (208) 533-7257
William Scott, DOE-ID/EG&G Idaho, (208) 526-8189

DESCRIPTION

Scope: This project is demonstrating the applicability of the plasma hearth process (PHP), an innovative technology derived from the specialty metals industry, to the treatment of DOE solid mixed wastes. The PHP technology will be developed into a production system through a sequence of tests on several test units. These tests can be divided into two categories; non-radioactive and radioactive. Figure 1 shows the five different systems that will be used in the development program.

Non-Radioactive

Figure 1. Plasma Hearth Process Technology Development Plan

The Demonstration Unit has been constructed at Retech's facility in Ukiah, CA and the final testing is in the process of being completed. The Demonstration Unit was constructed to conduct the original "proof-of-principle" tests. These tests have been completed and have shown that the technology is feasible, has the potential to meet or exceed regulatory requirements, produces an excellent final waste form, and is capable of processing a very wide range of waste materials.

The Pilot Scale System will replace the Demonstration Unit for testing of a refined PHP unit with all required subsystems. The advanced pilot-scale system will lend itself to rapid, economical evaluation of the primary process chamber and offgas pollution control system performance. This capability will result in the timely implementation of a reliable pollution control system for the Full-Scale Prototype System, thereby expediting the permitting process for the full scale prototype. The pilot-scale system will also be used to evaluate long-term operation on non-hazardous materials. These tests will greatly reduce the risks and costs associated with radioactive waste treatment process development. Testing will also include "blind" tests to simulate treatment of waste materials with limited pre-

characterization. These tests will be extremely helpful in defining the pre-characterization requirements and defending this level of characterization during the permitting process.

Concurrent with the construction of the pilot-scale System, a Bench-Scale System will be constructed and installed at Argonne National Laboratory (West) to perform radioactive materials studies. An important program element is to construct and test a PHP system at a facility that will allow testing on actual radioactive materials to determine the behavior and partitioning of specific radioisotopes, particularly those that are alpha emitting. The Bench-Scale testing will focus on determining the quantity of each radionuclide that is retained in the glass phase, the quantity that is partitioned to the metal phase, and the quantity that is volatilized or otherwise transported to the offgas.

Based on the bench-scale radioactive testing and the non-radioactive testing at Ukiah, California, a full-scale radioactive system will be designed and built to demonstrate full-scale processing of actual mixed waste. This major program element will serve as the first step to transfer the PHP technology to the end user. For this demonstration, a specific waste treatment application will be selected for a site-specific waste treatment need. A PHP pilot-scale prototype system will then be designed and built for demonstration testing on that waste stream(s). Current plans are for this system to be built and tested at an existing facility to be designated at the ANL-W complex for demonstration on an actual EM-30 mixed waste stream, for example drums of heterogeneous reclassified TRU stored at the INEL. This system may then be converted for production operations or a new Production facility will be built for waste treatment operations.

Technology: The PHP is a high temperature thermal treatment process using a plasma arc torch in a refractory lined chamber that destroys organics and stabilizes the residuals in a nonleaching, vitrified waste form. The PHP also addresses "front end waste handling and feed preparation" in that little to none is required. Whole drums may be fed into the process chamber, which minimizes pretreatment handling. The PHP also addresses the requirements of "final waste form", in that the residual from the PHP provides a very stable vitrified final product of high integrity, often without the need for glass formers. The chemistry can be controlled, if necessary (through additives), to condition the slag to optimize properties.

Arc plasma is not a new technology; rather this project involves the adaptation of an existing, well understood, and commercially available technology. Industry has been using plasma arc torches in various applications for many years. Some of the commercial applications of plasma currently used around the world include:

- metal and ceramic powder production,
- composites production (e.g. metal on metal, metal on ceramic, etc.)
- titanium dioxide pigment production,
- chemical production (acetylene, ethylene, etc.),
- metal ore smelting,
- metal and refractory recycling,
- metal refining,
- metal cutting and welding.

The goal of the PHP project is to demonstrate a potentially robust process for treatment of mixed waste. This project is structured to ensure that the plasma technology can be employed in radioactive service, and that surrogate radioactive studies on larger scale nonradioactive units properly model the behavior of radionuclides during treatment. Regulators and waste management personnel will be involved closely in the project

throughout the various phases and subtasks to ensure that all requirements will be met.

APPLICATION

This technology is applicable to any solid or sludge waste category for which a stabilized byproduct is required for disposal, such as medical, hazardous, or radioactive waste. The technology is ideally suited for heterogeneous wastes of any category which are difficult to treat by conventional thermal technologies.

DOE Applications/Waste Streams: The application for which it is currently being developed is DOE solid mixed wastes, both low level and TRU. While the DOE mixed waste volumes are not large, they represent a significant problem because of their nature. These wastes are found at most DOE sites and many of the waste streams have no identified treatment option. Most of the DOE sites with the largest volumes of these waste types are located in the western states and include: the Hanford Reservation; the Idaho National Engineering Laboratory; and the Rocky Flats Plant.

Non-DOE Applications/Waste Streams: Several demonstration tests using the PHP concept have been conducted in the U.S. and Canada in the area of municipal waste treatment. Research in this area is stalled since municipal waste treatment is not currently required. However, these tests have demonstrated the ability of PHP to accept a heterogeneous solid waste feed stream, burn the bulk organics, and melt the residual materials into a slag that solidifies into a high integrity residual material. Applications for which these characteristics are desirable include medical waste and hazardous waste.

INVOLVEMENT OF OTHER GOVERNMENT AGENCIES

To date, no other government entities have been involved in this technology development project. Various state regulatory agencies will become involved as permit applications and related communications are conducted for the program elements.

- State of California, Cal/EPA
- State of Idaho, Department of Health and Welfare, Division of Environmental Quality
- EPA Region 10

INDUSTRY PARTICIPATION

Commercialization Prospects: This technology is being developed for DOE by a private company, SAIC, and its primary partner/vendor, Retech, Inc. Patent rights are being investigated and both entities are interested in commercialization of the technology as appropriate based on test results.

Technology Transfer: Technology transfer will occur naturally through the participation of the private companies.

DEMONSTRATION

As detailed under DESCRIPTION, the project consists of five elements, as follows:

1. A Demonstration unit, nearing completion
2. A pilot-scale nonradioactive test unit at the Retech facility in California, in the design phase
3. A bench-scale radioactive test unit at ANL-W, in the design phase

4. A full-scale Prototype radioactive test unit at ANL-W, based on 2 and 3 results
5. A Production unit will be made operational, either by converting the Prototype, or by building a new unit

Size/Scale: The bench-scale unit will be approximately 1/6 scale, the remainder will be full-scale (e.g. nominally 1 drum per hour).

Nature of Material-Surrogate/Real: Surrogate materials will be employed for the nonradioactive tests at Retech. Surrogates, spiked radionuclides in surrogate wastes, and actual mixed waste will be employed for the bench-scale tests. Actual mixed wastes will be treated in the Prototype and Production units.

Performing Organization: Science Applications International Corporation will be responsible for the PHP unit and subsystems for all tests. Retech will conduct operations on the nonradioactive tests, and EG&G Idaho will manage funding for these tests. ANL-W will conduct operations for the radioactive tests.

PROPOSED SCHEDULE AND BUDGET:

FUNDING BASE/SOURCES

Current Funding: Two activities are currently funded: 1) the near-full-scale pilot demonstration unit at Retech, Inc.'s plant in Ukiah, California for demonstration on nonradioactive and surrogate wastes for EM-54, and 2) the bench-scale radioactive test unit being designed for installation at an ANL-W facility to be determined shortly, also for EM-54.

	<u>Pilot Scale</u>	<u>Bench Scale</u>
Current FY-93:	EM-54, \$1,500K SAIC, \$120K Retech, \$300K	EM-54, \$500K
Proposed FY-94:	EM-54, \$2,250K	EM-54, \$1,000K
Private Sources:		
SAIC, Retech		

Demonstration Schedule:

Initiate Pilot-scale operations	4th Quarter FY-94
Initiate Bench-Scale operations	1st Quarter FY-95
Initiate Full-scale Prototype operations	1st Quarter FY-97

REGULATORY ISSUES

Permits will be required to treat real wastes. No permitting issues are anticipated for this technology. The plasma arc technologies are classified as incinerators by the EPA and, as such, would normally face all of the permit requirements of an incinerator. The Mixed

Waste Integrated Program, which is funding this technology, is developing a strategy to convince the regulators that less stringent characterization of wastes is required of this type of technology due to its versatile operational characteristics. Adoption of this position would significantly simplify the permitting process, since identification and refinement of waste acceptance criteria is one of the major activities in the permitting process. Reduction of characterization requirements would also result in lower personnel exposures. This technology produces a stabilized final waste form that will meet most disposal requirements without requiring additional treatment.

INNOVATIVE TECHNOLOGY CHARACTERISTICS

The elements of this technology that make it innovative include: 1) extremely high temperature operation that completely destroys organics while stabilizing inorganics; 2) the ability to accept a very wide range of waste types without pretreatment; 3) the ability to treat waste without removing it from the container; 4) generation of separate slag and metallic phases, allowing segregation and possible reuse of the metal; and 5) the preference of many radionuclides (especially the actinides) to migrate to the stable slag phase.

PROJECT TITLE: Minimum Additive Waste Stabilization (MAWS)

CONTRACTOR: GTS-Duratek/Catholic University/Lockheed Environmental Service/Argonne National Laboratory (ANL)

CONTACT: Minimum Additive Waste Stabilization (GS21)
Grace Ordaz, EM-54 Program Manager (301)-903-7440

DESCRIPTION

Scope: The MAWS concept is currently being investigated for application to a variety of wastes including: tank wastes, contaminated soils, sludges, ashes, asbestos/transite, and miscellaneous buried waste to expand the compositional envelope and demonstrate the flexibility of this approach. The objective of a MAWS demonstration at a Western site to be determined will be to develop technology systems that are essentially closed-loop, with secondary wastes being minimized through recycle to the melter unit. Waste forms are expected to pass EPA TCLP leachability test, and various other leachability and durability tests (discussed in the following sections), and off-gas is expected to meet release requirements. The end result will be long lasting quality waste form, minimization of waste volume, and reduction in treatment/disposal cost. These objectives have already been achieved in lab-scale demonstrations of the MAWS concepts for Fernald wastes, and an on-site demonstration at Fernald has been initiated.

Tank wastes and soils are available at many sites. Treatment alternatives for these tank wastes are presently under review. If required the process selected will likely involve separation of the wastes into high-activity and low-activity streams with vitrification of the former. Treatment of the large volume, low-activity stream is less certain, however. A recent study ("Tank Waste Technical Options Report", WHC-EP-0616, March 1993) of life-cycle costs concluded that the least expensive cementation (grout) option would be about 50% more expensive than vitrification (cost difference about \$5B), and would produce a considerably inferior waste form in terms of leach resistance.

With the MAWS approach, the low activity sodium streams from tank waste separation processes could be combined with soil-washing concentrates to produce a durable and leach-resistant glass waste forms, while significantly minimizing the quantity of final waste for disposal. Very substantial cost savings could be realized by blending waste streams in this way to produce a superior waste form.

A demonstration at a selected Western site would progress in a phased approach similar to that used at Fernald, which is comprised of compositional glass formula development at the crucible stage, followed by bench-scale and pilot-scale testing. The experience gained during the demonstration at Fernald will be leveraged to other sites.

Technology: In the MAWS concept, waste streams are viewed as resources for vitrification, since they contain the basic chemical components from which a glass waste form can be made. The challenge is to combine these resources in such a way that minimizes the use of non-waste additives, yet yields a processable and durable final waste form for disposal. Major benefits of this approach are that waste loading is maximized, and therefore, the volume of the final waste form is minimized since little or no additives are used. The vitrification process itself results in significant volume reduction through evaporation of water, combustion of organics, and compaction of the solids into a non-porous glass. This implies a significant reduction in disposal costs due to volume reduction alone, and minimizes future risks/costs due to the long-term durability and leach resistance of glass.

A treatability study, using the MAWS integrated technology system, to determine the feasibility of remediating multiple waste streams at Fernald was initiated in late FY-92. The integrated system included a joule heated melter complete with off-gas system, a soil washing system, and a waste water treatment system. The study was conducted using a systems approach where mixed waste sludge contaminated with U and RCRA metals, soil contaminated with U, and waste water contaminated with U from soil washing are the inputs to the treatment system, and durable glass, clean soil, clean water, and clean off-gas are released from the system. Laboratory crucible studies achieved high waste loading (up to 90% on a wet basis) while producing quality glass, i.e. passes TCLP and compares favorably to the high level waste glass PCT test standards. A radioactive continuous bench scale melter test was successfully completed (10 kg/day and 100 kg/day glass production rate) which produced similar quality glass and acceptable off-gas. The pilot scale system which includes a 300 kg/day glass production melter, a 0.25 ton/day soil washing system, and a 100 GPM ion exchange waste water treatment system, for radioactive testing is currently on site at Fernald, and testing was initiated in September, 1993. Preliminary analyses indicate an estimated total life-cycle cost saving of \$720M for the 8 pit wastes at Fernald when comparing the MAWS vitrification approach to cementation.

APPLICATION

In FY-93, MAWS development activities for application at other DOE sites were initiated. Additional developmental work will be built upon the knowledge already acquired from the Fernald treatability study, and will be the focus of FY-94 activities. Crucible studies using actual waste from various DOE sites will be initiated in November 1993 to provide information regarding waste loading and quality of the glass produced. In addition, higher temperature melter technologies will be developed for wastes that may have different processing requirements. These activities are all funded by the MAWS FY-94 Program.

DOE Applications/Waste Streams: To date, Hanford, INEL, Rocky Flat, and Oak Ridge have been contacted in regards to MAWS applicability. Since vitrification is a versatile technology that is amenable to a wide range of waste streams, almost all DOE sites as well as other federal agencies and private industries have wastes that can utilize this technology. Examples of these wastes are: various kinds of sludges, contaminated soils, ion exchange resin from ground water clean up, sludges with chunks of metals, pondcrete, saltcrete, incinerator ashes, fly ashes and debris from burn pits, asbestos, transite, Raschig rings, etc.

Non-DOE Applications/Waste Streams: As discussed above, the range of waste streams that is amenable to the MAWS technology is broad, and therefore, MAWS concepts should apply outside of DOE. A good example is asbestos from either industry or other federal agencies. The principal investigators working on MAWS have recently completed testing in which bags of asbestos (non-radioactive) were melted into glass frit that can be recycled for industrial use, and have provided data that indicated no asbestos carry through in either the off-gas or product glass.

Size of Problem: Waste problems are large, and vitrification is a versatile technology that is amenable to a wide range of waste streams. Almost all DOE sites, as well as other federal agencies and private industries, have wastes that can utilize this technology.

Direct Leverage with Other DOE Sites: The currently funded activity under the MAWS Program, to conduct crucible studies on actual wastes and soil concentrates from soil washing, provides a good starting point for a future demonstration at a selected site. The existing radioactive bench scale continuous melter system complete with a two-stage off-gas scrubber system, which was used for the Fernald study, is available for testing to

provide necessary data prior to on-site demonstration. Existing data from the Fernald lab/bench scale study and new data, as it becomes available from the Fernald on-site demonstration in early FY-94, will all provide valuable groundwork information, and help expedite the future demonstration at a selected site. The experience gained during the demonstration at Fernald will be leveraged to other future sites wherever possible.

INVOLVEMENT OF OTHER GOVERNMENT AGENCIES

The initial OTD demonstration at Fernald OU-1 is being done in collaboration with CERCLA Remedial Investigation/Feasibility Studies and in close coordination with EPA region III, who approved all the work plans for demonstration on site. At a future demonstration site, involved parties would include: DOE-HQ, DOE-field offices and their contractors (from both the Offices of Waste Management and Environmental Restoration), local EPA and USEPA, as well as the public and other stakeholders.

INDUSTRY PARTICIPATION

Commercialization Prospects: The contractors participating in this demonstration would include GTS Duratek Inc. (to conduct equipment design, fabrication, and testing), Catholic University of America (to conduct crucible studies, bench scale testing, and the demonstration), Lockheed Environmental Services (to design, fabricate and test soil washing equipment), Argonne National Laboratory (to perform long term glass durability study and contracting services), and possibly other private industries in collaboration with DOE and site contractors (to provide the test bed). GTS-Duratek is actively involved in commercialization of the technology which is developed.

Technology Transfer: The data collected from the Fernald demonstration will be factored into the OU-1 ROD due November 1994. With other sites also becoming interested in this technology, the potential of technology transfer to other users is extremely high.

DEMONSTRATION

A future demonstration would progress in a phased approach similar to that used at Fernald, which is comprised of compositional glass formula development at the crucible stage, followed by bench-scale and pilot-scale testing (both non-radioactive and radioactive).

Prior to on site demonstration, crucible study information will be crucial and necessary. The objective of the crucible melt studies is to develop processable formulations using actual wastes which will produce high waste loading and quality final waste forms. Crucible studies are geared toward arriving at glass formulations that will enable waste forms to pass the TCLP leach test and compare favorably with the Product Consistency Test (extended leach tests ranging from 7 to 180+ days) results for high-level glass standards. These tests would also indicate levels of radioactive constituent leaching which is expected to be lower than site determined cleanup levels. Additional tests would be conducted to provide information on the long-term waste form durability and stability of secondary phases that form on the leached glass surface.

Size/Scale: Bench-scale melter systems (10 kg/day and 100 kg/day) are currently available, and will be used for testing the formulas developed during the crucible melt stage. These systems will provide preliminary process information, including off-gas data.

to assess quality and ability to meet clean up requirements. They will also be used for specification of the site pilot-scale unit.

A pilot MAWS technology system will be designed, fabricated and delivered for demonstration at the selected site. The capacity and configuration of the site demonstration system will be dependent upon the specific treatability needs and site requirements. For each phase of this work, it is expected that knowledge and lessons learned during the Fernald demonstration will expedite development and implementation of the pilot unit.

Locations: Laboratory information, both from the crucible melts and laboratory-scale melters, will be obtained on actual radioactive wastes and can be conducted at the CUA VSL facility. A pilot MAWS technology system will be designed, fabricated and delivered for on site demonstration.

Nature of Material-Surrogate/Real: Both non-radioactive and radioactive testing will be conducted to maximize the information obtained with the funding provided.

Performing Organization: GTS Duratek Inc. will conduct equipment design, fabrication, and testing. Catholic University of America will conduct crucible study, bench scale testing, and the demonstration. Lockheed Environmental Services will design, fabricate and testing of soil washing equipment. Argonne National Laboratory will provide long term glass durability study and contracting. DOE and site contractors will provide the test bed for the demonstration, possibly with the involvement of other private industries.

PROPOSED SCHEDULE AND BUDGET:

FUNDING BASE/SOURCES

Limited crucible studies are currently funded for FY94 through the MAWS Program, Office of Technology Development (OTD). Estimated funding for crucible melts with waste streams from several sites is roughly \$1.2M. Additional funding will be required for laboratory bench and site pilot scale equipment development/ demonstration. A rough estimate of cost for the complete crucible study, bench scale testing, and delivery of an on-site demonstration system is \$6M. This does not include the cost for the site test bed preparation, or the demonstration itself.

Budget Request for FY94 and Future:

Budget Summary (Dollars in Thousands)			
	FY94	FY95	FY96
OP	1500	2400	TBD
	2000		
	217		
	see (1)		
CE	500	600	TBD
LI	0	0	TBD
GPP	0	0	TBD
Total	4217	3000	TBD
		see (2)	

Notes:

1. The FY-94 budget shown here reflects the glass compositional envelope study (which will conduct limited crucible study on waste from various DOE sites), and the initiation of high temperature melter development other than the Joule heated melter. It includes \$2000K from EM-40, and \$217K from EM-50 for Fernald. The FY-95 funding shown here reflects the continuation of the melter developmental work initiated in FY-94 from bench scale to pilot scale.
2. An additional funding of \$1.6M is budgeted in FY-95 for a demonstration. This funding could be used toward the demonstration requirement in FY-95.

Task/Milestone Summary		
Activity or Milestone	Start Date	End Date
A1 Develop Future Site Work Plan	10/01/93	12/01/93
A2 Procure and Characterize Candidate Wastes	10/01/93	12/15/93
A3 Vitrification (crucible melts)	12/01/94	06/01/94
M1 Complete Crucible Melt Studies	05/15/94	06/01/94
A4 Bench Scale Testing (10 & 100 kg/day runs)	02/01/94	05/01/94
A5 Procure Long Lead Items	11/01/93	05/01/94
A6 System Design	11/01/93	04/15/94
M2 Complete System Design	04/15/94	05/01/94
M3 Complete Lab Testing and Waste Characterization	06/15/94	07/01/94
A7 Order Off-gas System	04/01/94	07/01/94
A8 Fabricate, Ship, and Install Melter	05/01/94	08/01/94
A9 Install Off-gas System	07/01/94	08/01/94
M4 System Complete and Installed	08/01/94	08/15/94
A10 Prepare Procedures	04/01/94	08/01/94
A11 Test and Train	08/01/94	08/15/94
A12 Bake-out and Cold Run	08/15/94	09/01/94
A13 Operational Readiness Review	09/01/94	09/15/94
M5 System Approved for Hot Runs	09/01/94	09/15/94
A14 Hot Runs & Testing	09/15/94	01/01/95

REGULATORY ISSUES

Catholic University of America VSL has all the required permits to conduct testing on low level real wastes (R&D, RCRA, TSCA, and radioactive).

INNOVATION

The MAWS concept is innovative in that it takes an integrated systems approach to waste treatment. Secondary waste treatment streams are recycled back into the vitrification unit to become part of the glass product, and the view of combining wastes as resources to minimize additives results in substantially lower costs for such a vitrification process because waste loading is maximized and the volume for disposal reduced over other technologies such as cementation. Furthermore, the superior leach resistance of the waste form provides strong support for possible delisting applications which have the potential for further substantial savings in disposal costs for RCRA listed wastes.

Disposal/Storage Projects

PROJECT TITLE: Advanced Landfill Cover Demonstration Project

CONTRACTOR: Sandia National Laboratories and others

CONTACT: John Stormont

Environmental Restoration Technologies Dept.

Sandia National Laboratories

P.O. Box 5800

Albuquerque, NM 87185

Phone: (505) 845-9347 Fax: (505) 844-0543

DESCRIPTION

Scope: This demonstration project involves the construction, testing and evaluation of a number of intermediate scale (<1 acre) landfill cover designs. One of the cover designs will be the present conventional design as governed by EPA guidance. Three alternatives will be tested for comparison to the conventional design: the EPA advanced composite cover, the Los Alamos bio-engineered cover, and the Sandia dry barrier design. The test design will emphasize measurement of the water balance for each design option, consisting of data for runoff, erosion, movement through the cover, lateral drainage, change in water storage, and evapotranspiration. The demonstration will use a new landfill cover design methodology to optimize designs. Success is defined as demonstrating that the advanced designs address shortcomings of the conventional design in the western US (e.g., desiccation of clay layers). Collection of data from the field demonstration can begin well within a year of funding, and the project has a scheduled duration of 5 years total.

The alternative designs to be demonstrated have both performance and cost advantages. The conventional approach of using clay layers is problematic in arid/semi-arid environments because of desiccation cracking before and after installation. Geosynthetic clay liners are being suggested as a replacement for compacted clay liners. The bio-engineered cover designs emphasize capillary barriers and utilize site-specific vegetation schemes. The dry barrier uses air flow to evaporate and remove moisture from the cover system to enhance its performance.

Technology: The use of landfills to manage sanitary, hazardous and radioactive wastes has existed as a baseline management method because of the need to dispose of large quantities of industrial wastes. However, the long term migration of hazardous materials from uncontained landfills to surrounding soils, groundwater, and the atmosphere has caused potential health threats and a degradation of the environment. Classical methods of fill and cover operations for landfills have lead to the final landfill cover concept, whereby a soil cover over the last waste fill layer is used to prevent surface erosion and prevent the infiltration of rain and snow that might leach hazardous materials out of the landfill. For hazardous and radioactive waste landfills, the final cover has evolved into a complex, multilayered containment structure designed to minimize the leaching and migration of the much more dangerous wastes found in these landfills.

Since the promulgation of regulations pursuant to the RCRA, all hazardous waste landfills must be closed with such a final cover. However, every five years the regulatory guidance has been reissued to eliminate design flaws that were not anticipated. The designs for these final covers are based on geotechnical and civil engineering practices for the management of

water infiltration, erosion, and waste subsidence. For less arid conditions in the eastern United States, the EPA RCRA landfill cover design has been shown to be successful in most installations. However, the use of clay as a hydraulic barrier in arid/semi-arid installations of the western United States has been problematic because of desiccation cracking during and after installation. Since the EPA RCRA landfill cover design basis did not include the dry water balance conditions of arid/semi-arid environments, a transition of the design basis from eastern climates to western climates is necessary. Recent design innovations indicate that new components and systems could become extremely effective for western landfill sites. For example, site-specific non-conventional designs which emphasize vegetation and capillary barriers are being demonstrated at LANL and PNL. Geosynthetic clay liners are being suggested as a replacement for compacted clay layers in cover systems by researchers at the University of Texas. This demonstration will fill a critical void in the state-of-the-art: a field scale evaluation of cover components and systems in an arid/semi-arid environment which are explicitly benchmarked to the EPA RCRA landfill cover design.

Replacement and/or retrofit costs for engineering failures are the direct consequence of inadequate validations of the design principles. For these reasons, new generations of landfill cover components and systems have been proposed and are entering the regulatory guidance approval cycle that may be issued by FY96. An opportunity exists to perform field demonstrations of advanced cover design elements and/or systems to provide an evaluation of the engineering design before large scale applications are constructed.

Four subtasks are planned: [1] Landfill cover demonstration design, [2] Construction of test cells, [3] Passive and active/extreme cover tests, and [4] Data evaluation and interpretation.

Subtask 1- Demonstration design

The demonstration will be designed to evaluate a number of landfill cover designs. One of the cover designs will be the present conventional design as governed by EPA guidance; this is the cover design an environmental engineering firm would produce. Alternative cover designs developed through EPA/RREL and DOF/OTD projects will also be tested. At present, there are three designs which should be tested for comparison to the conventional design (EPA advanced composite cover, LANL bio-engineered cover, and the SNL/NM dry barrier layer).

Subtask 2- Implementation

The landfill cover performance demonstration will require fabrication of the instrumented cover designs. The test implementation will involve numerous efforts, including: construction (of covers themselves), plumbing (for water collection for water balance), electrical (for automated data acquisition), and landscaping (for cover vegetation).

Subtask 3 - Demonstration and Test

The core of the demonstration will be the monitoring of the water balance and atmospheric data for ambient conditions. This testing is referred to as passive testing. The data collection will include data for erosion, runoff, infiltration through the covers, and changes in the moisture content in the cover systems. Active/extreme tests will be performed where additional moisture is added to the cover components and systems. Flaws representative of those resulting from typical construction practices can be introduced to manufactured cover components (geomembranes, geosynthetic clay liners). A sprinkler system can be used to deliver a 10, 50, or 100-year rainfall event as a test of the cover performance.

Subtask 4 - Evaluations

The evaluation of the cover designs will focus on the water balance through the different cover designs, ability of the barrier designs to redirect infiltration, and the implications of cover construction defects and unanticipated settlement.

APPLICATION

DOE Applications/Waste Streams: Many DOE facilities have landfills which by regulation require covers. This technology being demonstrated applies to any non-clean closure of a landfill or surface impoundment, and therefore includes all hazardous and mixed waste forms.

Non-DOE Applications/Waste Streams: Because every community and Federal facility have landfills which by regulation require covers, this project will be demonstrating technology which will be nearly universally applicable. As noted above, includes all hazardous and mixed waste forms.

Size of Problem: The need for effective landfill covers is tremendous. There are literally thousands of landfills in the western US which require covers to limit water flow into the waste. There is growing evidence that conventional designs developed for the more humid eastern US are not effective in the arid and semi-arid west.

Direct Leverage with Other DOE Sites: Site-specific non-conventional designs which emphasize vegetation and capillary barriers are being demonstrated at LANL and PNL. Numerous other western DOE sites contain landfills which by regulation require covers. This project will be demonstrating technology which will be nearly universally applicable.

INVOLVEMENT OF OTHER GOVERNMENT AGENCIES

Federal

This project includes direct participation by the United States Department of Agriculture (Research Station, Tucson), the Environmental Protection Agency (Risk Reduction Laboratory, Cincinnati), and the Air Force (Kirtland Air Force Base).

State

Consistent with other demonstration projects at Sandia, the Environmental Department of the State of New Mexico will be involved.

INDUSTRY PARTICIPATION

Commercialization Prospects/Technology Transfer:

There is tremendous commercialization potential for the advanced landfill cover technology. First, every hazardous and mixed waste landfill, and many solid waste landfills, will require closure with a cover system. Second, conventional covers do not perform well in the western US and are expensive. Finally, regulator involvement in the demonstration (EPA and State Environment Department) will hasten the acceptability of the technology (tech transfer).

DEMONSTRATION

This demonstration project involves the construction, testing and evaluation of a number of intermediate-scale (<1 acre) landfill cover designs. This demonstration is planned to take place at an uncontaminated site in the Environmental Test Area at Sandia National Laboratories (SNL). SNL is located on Kirtland Air Force Base in Albuquerque, New Mexico.

Lead participant for this project will be Sandia. Colorado State University, Los Alamos National Laboratory, the United States Department of Agriculture, the Environmental Protection Agency, and the Air Force are key participants.

Size/Scale: The landfill cover designs will be intermediate-scale (<1 acre).

Locations: This demonstration is planned to take place at an uncontaminated site in the Environmental Test Area at Sandia National Laboratories (SNL). SNL is located on Kirtland Air Force Base in Albuquerque, New Mexico.

Nature of Material-Surrogate/Real: The demonstration will take place at an uncontaminated site in the Environmental Test Area at Sandia National Laboratories (SNL).

Performing Organization: Lead participant for this project will be Sandia. Colorado State University, Los Alamos National Laboratory, the United States Department of Agriculture, the Environmental Protection Agency, and the Air Force are key participants.

PROPOSED SCHEDULE AND BUDGET: FUNDING BASE/SOURCES

We will be leveraging many years of development and funding by DOE, DoD and the EPA. The alternative designs developed by Los Alamos, Sandia and contractors have been developed with DOE and some DOD funding. The USDA has been funded to develop a cover design decision support system by the DOE. The EPA has sponsored research and evaluations of landfill cover components for many years.

In FY93, the DOE through the Mixed Waste Landfill Integrated Demonstration Program funded about \$1.0 M which will be directly applied to this demonstration project. In FY94, we expect on the order of \$1.2 M through the DOE's MWLID Program which will be combined with any WGA funding.

REGULATORY ISSUES

The land used for this demonstration will require NEPA documentation. Because the site is uncontaminated, no other permitting is required.

INNOVATION

This project is innovative in both its approach and the technologies being demonstrated. The approach of this demonstration will fill a critical void in the state-of-the-art for containment technologies: a field-scale evaluation of cover components and systems in an arid/semi-arid environment which are explicitly benchmarked to the EPA RCRA landfill cover design. It will demonstrate three innovative cover designs as well as the current EPA-RCRA cover. Two of the alternative designs, the Los Alamos bio-engineered cover and

the Sandia dry barrier, are innovations which address shortcomings of the conventional design. Another innovation will be the use of the Landfill Cover Design optimization methodology developed by the USDA. This system considers the many complex and interrelated technical, regulatory, and economic issues involved in designing cover barrier systems. Success will be achieved if the alternative designs show enhanced performance when compared to conventional designs. Success is likely because these alternative designs have been developed in response to specific flaws in conventional design. Further, side-by-side comparison of the conventional and alternative designs will yield unambiguous results.

7.3 Mixed Waste Technology Demonstration Projects Site List

Mixed Waste Technology Demonstration Projects Site List

Los Alamos National Laboratory (LANL)

Four projects submitted by Rebekah Green for Bruce Erdal, LANL, Applied Environmental Technologies (AET)

- **Title:** Neighborhood Environmental Watch Network (NEWNET) Demonstration
Contractor: LANL
 - **Title:** Two-Stage Advanced Oxidation/Reduction Unit for Mixed Waste Treatment
Contractor: LANL
Principal Investigator/Phone: Louis Rosocha, 505-667-8493, fax: 505-665-2840
 - **Title:** Radiolytic Advanced Oxidation/Reduction Unit for Mixed Waste Treatment
Contractor: LANL
Principal Investigator/Phone: Louis Rosocha, 505-667-8493, fax: 505-665-2840
 - **Title:** Electrocatalytic Destruction of Organic Waste and Treatment of Mixed Hazardous Wastes
Contractor: LANL
Principal Investigator/Phone: Wayne H. Smith, 505-667-2365
-

DOE/San Francisco, AMEMs

Five projects submitted by Richard Scott, TPO, ERWM, DOE/SF & James T. Davis AMEM

- **Title:** Molten Salt Destruction Process
Contractor: Lawrence Livermore National Laboratory (LLNL)
Principal Investigator/Phone: R.S. Upadhye, LLNL
- **Title:** Use of Mediated Electrochemical Oxidation in the Decontamination of Mixed Wastes
Contractor: LLNL
Principal Investigator/Phone: Zohar Chiba, LLNL
- **Title:** Reusable Steel HEPA Filters for Mixed Waste Processing Facilities
Contractor: LANL
Principal Investigator/Phone: Werner Bergman, LLNL

AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

2 of 2

Mixed Waste Technology Demonstration Projects/Site & Office list

DOE/San Francisco, cont.

- **Title:** Use of Salt Splitting in the Treatment of Mixed Wastes
Contractor: LANL
Principal Investigator/Phone: Robert Hickman, LLNL
 - **Title:** Use of Direct Chemical Oxidation in the Treatment of Mixed Wastes
Contractor: LANL
Principal Investigator/Phone: Robert Hickman, LLNL
-

Idaho National Engineering Laboratory (INEL)

Ten projects submitted by T.F. Burns, Assistant Manager for Environmental Restoration and Waste Management

Highest Priority (in order)

- **Title:** Radiological and Hazardous Material Measurement System (RHMMS)
Contractor: EG&G Idaho, Inc.
Principal Investigator/Phone: Tim Roney, 208-526-9712
DOE Contact: George Snyder, 208-526-6789 fax 208-526-6249
- **Title:** The Fixed Plasma Hearth Treatment Process for Mixed Waste Treatment Applications
Contractor: EG&G Idaho, Inc., INEL
Principal Investigator/Phone: Steven Bates, 208-526-6790 fax 208-526-6802
DOE Contact: Mike Schultz, 208-526-0131 fax 208-526-6249
- **Title:** Biological Destruction of Tank Wastes
Contractor: EG&G Idaho, Inc.
Principal Investigator/Phone: Dr. Graham F. Andrews
- **Title:** Supercritical Water Oxidation Demonstration Program
Contractor: EG&G Idaho, Inc.
Principal Investigator/Phone: John Beller

Mixed Waste Technology Demonstration Projects/Site & Office list

Idaho National Engineering Laboratory, cont.

- **Title:** Freeze Crystallation Separations
Contractor: WINCO
Principal Investigator/Phone: J.A. McCray
- **Title:** Metal Recycle Program
Contractor: WINCO
Principal Investigator/Phone: Brad Frazee

High Priority (not ranked in order of priority)

- **Title:** Crown Ether Mixed Waste Remediation
Contractor: WINCO
Principal Investigator/Phone: Kraig M. Wendt
 - **Title:** Dig Face Characterization
Contractor: EG&G Idaho, Inc.
Principal Investigator/Phone: Nick Josten
DOE Contact: George Snyder, 208-526-0131 fax: 208-526-6249
 - **Title:** Sulfur Polymer Cement Stabilization of Mixed Waste Treatment Residuals
Contractor: WINCO
Principal Investigator/Phone: Craig L. Porter
 - **Title:** Rapid Transuranic Monitoring Laboratory
Contractor: EG&G Idaho, Inc.
Principal Investigator/Phone: Chuck McIsaac, 208-376-3529
DOE Contact: Tim Stafford, 208-526-5670
-

Rocky Flats Office

Four projects submitted by R.W. Tyler, DOE/RF, Waste Programs Branch

- **Title:** Polymer Solidification
Contractor: EG&G Rocky Flats, Inc.
Principal Investigator/Phone: A.M. Faucette, 303-966-6420

Mixed Waste Technology Demonstration Projects/Site & Office list

Rocky Flats Office, cont.

- **Title:** Microwave Solidification
Contractor: EG&G Rocky Flats, Inc
Principal Investigator/Phone: G.S. Sprenger, 303-966-3159
- **Title:** Alternatives to Incineration -- DETOX Process
Contractor: EG&G Rocky Flats, Inc
Principal Investigator/Phone: Charles M. Brown 303-966-5277
- **Title:** VAC*TRAX™ Thermal Desorption Process
Contractor: Chemical Waste Management, Inc. , RUST Remedial Services
Principal Investigator/Phone: Peter L. Montez, 303-966-7681

Two projects submitted by Scott Grace, DOE Environmental Restoration Division

- **Title:** In Situ Total VOC/Actinides Detectors/Sensors Demonstration
Contractor: EG&G Rocky Flats, Inc
Principal Investigator/Phone: Scott Grace, DOE/RFO/ERD/TD 303-966-7199
Tom Greengard, EF&G/RF 303-966-6959
- **Title:** VOC/Actinides In Situ Mobilization with Chemically Modified Dynamic Steam Stripping At Rocky Flats
Contractor: EG&G Rocky Flats, Inc
Principal Investigator/Phone: Scott Grace, DOE/RFO/ERD/TD 303-966-7199
Tom Greengard, EF&G/RF 303-966-6959

DOE Nevada Operations Office

One project submitted by Katie McWilliams, TPO

- **Title:** Associated Particle Imaging
Contractor: EG&G Special Technologies Laboratory
Principal Investigator/Phone: Paul Hurley, 805-681-2472

Batelle/ Pacific Northwest Laboratories (PNL)

Thirteen Projects submitted by Jerry Scott/Dennis Kreid, Waste Operations and Technology,
Environmental Restoration/Waste Management

- **Title:** Terra VIT Solid Mixed Waste Demonstration
Contractor: PNL
Principal Investigator/Phone: Leo Thompson, 509-376-5150 fax: 509-372-0867
- **Title:** Catalyzed Electrochemical Oxidation (CEO) Treatment of Mixed Waste
Contractor: PNL
Principal Investigator/Phone: Jeff Surma, 509-376-4905 fax: 509-376-1867
- **Title:** Data Set and Validation Rationale for Source-Term Release Codes
Contractor: PNL
Principal Investigator/Phone: R. Jeffery Serne, 509-376-8429
- **Title:** Treatment of Heterogenous, Low-Level/Radioactive, Mixed Wastes Containing a High Percentage of Metals
Contractor: PNL
Principal Investigator/Phone: Hurshal G. Powers, 509-376-4973
- **Title:** High Energy Corona for Destruction of VOC's in Process Off-Gases
Contractor: PNL
Principal Investigator/Phone: William Heath, 509-376-0554
- **Title:** Ultra High Efficiency ESP with in Place Cleaning
Contractor: PNL
Principal Investigator/Phone: Jim Watkins, 509-376-0532
- **Title:** A High-Sensitivity X-Ray Fluorescence Spectrometer for In Situ Determination of Elemental contaminants
Contractor: PNL
Principal Investigator/Phone: Dr. R.L. Brodzinski, 509-376-3529
- **Title:** Technology Transfer of Six-Phase Soil Heating to Enhance SVE
Contractor: PNL
Principal Investigator/Phone: Theresa Bergsman, 509-376-3638

Mixed Waste Technology Demonstration Projects/Site & Office list

PNL, cont

- **Title:** Electrokinetic Remediation of Solids, Sludges and Cements Contaminated with Heavy Metals and Radionuclides
Contractor: PNL
Principal Investigator/Phone: Jud Virden, 509-375-4404
 - **Title:** Transportable Vitrification System
Contractor: PNL
Principal Investigator/Phone: Richard Peters, 509-376-4579
 - **Title:** Development of the PNL Neutron and Segmented Gamma Mobile Assay System
Contractor: PNL
Principal Investigator/Phone: Cecelia Lemons, 509-375-2741
 - **Title:** Surface-Barrier Technology Development at Hazardous Waste Sites
Contractor: PNL
Principal Investigator/Phone: Glenndon W. Gee, 509-376-8424
 - **Title:** 3-D Imaging and Rapid Inspection of Buried Waste Using Holographic Impulse Array Techniques
Contractor: PNL
Principal Investigator/Phone: Dale Collins, 509-375-2726
-

DOE/Office of Technology Development, EM-50

Forty-one projects have been submitted by EM-50

Waste Retrieval and Processing
Decontamination and Decommissioning:

Microwave Concrete Decontamination
System
OR 101204
MMES

Electro-Osmotic Concrete Decontamination
OR
MMES

Stainless Steel Beneficial Reuse Demo
SR
MMES

Mixed Waste Technology Demonstration Projects/Site & Office list

EM-50 TTPs, cont.

**Waste Retrieval and Processing
MWIP:**

Radioactive Mat Test of Plasma HP
CH232007
ANL-W

Phosphate-Bonded Ceramic Waste Forms
CH242004
ANL

Mixed Waste Treatability-Thermoplastic
Final Forms
CH24001
BNL

Fixed Hearth Plasma Treatment Process
ID142001
INEL

MWIP Mercury Control
OR132010
MMES

Cleanable HEPA
OR142001
MMES

Rocky Flats Compliance:

Polymer Solidification
RF111203
BNL

**Groundwater and Soils
VOC Arid ID:**

Destruction of CCl₄ and CHCl₃ by Steam
Reforming
AL221106
SNL

Arid Sonic Drilling
AL231005
SNL

Arid Monitoring Microbial Population
Changes
ID141001
MMES

VOC Off Gas Membrane Separation
RL421104
WHC

Groundwater and Soils

ISR:

Gel Barriers
AL141003
LANL

Eval/Flowable Grout
AL231008
LANL

Cryogenic Barriers in Arid Sites
AL921201
WZWP

Mixed Waste Technology Demonstration Projects/Site & Office list

EM-50 TTPs, cont.

Development and Demonstration of
Horizontal Barrier

FN131003

FERMCO

Bioremediation of PCB Contamination

OR121110

MMES

In Situ Corona

RL331006

PNL

MAWS:

Minimum Additive Waste Stabilization

CH221213

GTS/Duratek/C

Glass composition Envelope Study

CH231007

GTS/Duratek/C

Glassy Slag composition Envelop Study

CH231008

ANL

High Temperature Vitrification Systems
Evaluation

CH241002

GTS/Duratek/C

MAWS Technical Evaluation

PE021105

MSE

Buried Waste:

Preparation of Rapid Tru Monitoring Lab

ID121112

INEL

RHMMS

ID121210

INEL

Groundwater and Soils

Mixed Waste Landfill:

Electrokinetics Demonstration

AL241001

SNL

Metal Detection with XRF

RL321113

PNL

Uranium in Soils:

Selective Extraction of Uranium from Soil

AL121112

LANL

CMST:

Portable Acoustic Wave Sensor

AL221104

SNL

Raman Probe Radiation Study

AL141005

LANL

Mixed Waste Technology Demonstration Projects/Site & Office list

EM-50 TTPs, cont.

Data Fusion for Buried Waste Location
and Monitoring
AL241008
SNL

Data Fusion
RL341006
PNL

Cone Penetrometer Characterization
AL241010
SNL

Infrared analysis of Wastes: Novel Lab
and On-Line Measure
CH131001
AMES

Zero Tension Lysimeter
CH131002
AMES

Ames Mobile Laboratory
CH131003
AMES

Expedited Site Characterization
CH231004
ANL

Remote Sensing Systems Development and
Applications
NV001102
NV-FO/EG&G

Direct Measurement of Sr-90 in Surface
Soils
RL331007
PNL

Sandia National Laboratory (SNL)

- **Title:** Dry Barrier Applications for Landfills
Contractor: SNL
Principal Investigator/Phone: John Stormont, 505-845-9347
-

Morgantown Energy Technology Center (METC)

Eight projects submitted by Bob Bedick

- **Title:** Innovative Fossil Fuel Vitrification Technology for Soil Remediation
Contractor: Vortec Corporation
Principal Investigator/Phone: John Patten, 215-489-2255 fax: 215-489-3185
- **Title:** Decontamination and Recycle of Concrete
Contractor: AWD Technologies
Principal Investigator/Phone: Dr. Barry Naft, P.E., 301-948-0040
- **Title:** Electromagnetic Mixed Waste Processing System for Asbestos Decontamination
Contractor: KAI Technologies, Inc.
Principal Investigator/Phone: Dr. T. S. Snyder, 412-256-2174
- **Title:** Advanced Technologies for Decontamination and Conversion of Scrap Metal
Contractor: Manufacturing Sciences Corporation
Principal Investigator/Phone: Alan L. Liby, 615-481-0455
- **Title:** Decontamination of Process equipment Using Four Technologies
Contractor: Scientific Ecology Group, Inc.
Principal Investigator/Phone: H. W. Arrowsmith, 615-481-0222
- **Title:** Recycle and Reuse of Radioactively Contaminated Scrap Metals
Contractor: Scientific Ecology Group, Inc.
Principal Investigator/Phone: Duane Rencken, 615-376-8032
- **Title:** Recycle of Contaminated Scrap Metal
Contractor: Molten Metal Technology, Inc.
Principal Investigator/Phone: Dr. Victor Gatto, 617-487-7642

Mixed Waste Technology Demonstration Projects/Site & Office list

METC, cont.

- **Title:** Vax*Trax™ Mobile Vacuum/Thermal Treatment System
Contractor: Chemical Waste Management, Inc.
Principal Investigator/Phone: Dr. Charles Reece, 803-646-2413
-

EM-552, Waste Management DT&E Division

Twelve BWID-Sponsored Technologies

Remote Characterization System
Remote Excavation System
Contamination Control Unit
Rapid Monitoring Unit
Polysaccharide Soils Fixation Technique
Rapid Geophysical Surveyor
Radiological and Hazardous Material Measurement System (RHMMS)
DC Graphite Plasma Arc Furnace
Dig Face Characterization Technology
Innovative Group Technology
Monolithic Confinement Technology
Cryogenic Retrieval System

EM-431, Off-Site Program Division

- **Title:** National Molten Salt Oxidation (MSO) Project - Final Management of Mixed Waste
Contractor: ETEC, PNL, LLNL, NREL, ORNL, Oak Ridge K-25 Site, LANL, Alberta (Canada) Environment Centre, RUST/Geotech
Principal Investigator/Phone: Lawnie H. Taylor 301-903-8119

7.4 Projects Short List

Mixed Waste Demonstration Subgroup Technology Projects Short List

Characterization Projects

- **Title:** Neighborhood Environmental Watch Network (NEWNET) Demonstration
Contractor: LANL
- **Title:** Radiological and Hazardous Material Measurement System (RHMMS)
Contractor: EG&G Idaho, Inc.
Principal Investigator/Phone: Tim Roney, 208-526-9712
DOE Contact: George Snyder, 208-526-6789 fax 208-526-6249
- **Title:** Rapid Transuranic Monitoring Laboratory
Contractor: EG&G Idaho, Inc.
Principal Investigator/Phone: Chuck McIsaac, 208-376-3529
DOE Contact: Tim Stafford, 208-526-5670
- **Title:** A High-Sensitivity X-Ray Fluorescence Spectrometer for In Situ Determination of Element Contaminants
Contractor: PNL
Principal Investigator/Phone: Dr. R.L. Brodzinski, 509-376-3529
- **Title:** Dig Face Characterization
Contractor: EG&G Idaho, Inc.
Principal Investigator/Phone: Nick Josten
DOE Contact: George Snyder, 208-526-0131 fax 208-526-6249
- **Title:** Portable Acoustic Wave Sensor (PAWS) Down Hole Monitoring
Characterization, Monitoring and Sensor Technology IP
Contractor: SNL
Principal Investigator/Phone: Program Manager, Caroline Purdy, 301-903-7672
- **Title:** Zero Tension Lysimeters
Characterization, Monitoring and Sensor Technology IP
Contractor: AMES
Principal Investigator/Phone: Program Manager, Caroline Purdy, 301-903-7672
- **Title:** Infrared Analysis of Wastes (FTIR-PAS & TIRS)
Characterization, Monitoring and Sensor Technology IP
Contractor: AMES
Principal Investigator/Phone: Program Manager, Caroline Purdy, 301-903-7672

- **Title:** Direct Measurement of Sr-90 and U-238 in Soils on Real-Time Basis
Characterization, Monitoring and Sensor Technology IP
Contractor: PNL
Principal Investigator/Phone: Program Manager, Caroline Purdy, 301-903-7672
-

Treatment Projects

- **Title:** Vac*Trax™ Thermal Desorption Process
Contractor: Chemical Waste Management, Inc. , RUST Remedial Services
Principal Investigator/Phone: Peter L. Montez, 303-966-7681
- **Title:** Catalyzed Electrochemical Oxidation (CEO) Treatment of Mixed Waste
Contractor: PNL
Principal Investigator/Phone: Jeff Surma, 509-376-4905 fax: 509-376-1867
- **Title:** Electrocatalytic Destruction of Organic Waste and Treatment of Mixed Hazardous Wastes
Contractor: LANL
Principal Investigator/Phone: Wayne H. Smith, 505-667-2365
- **Title:** Radiolytic Advanced Oxidation/Reduction Unit for Mixed Waste Treatment
Contractor: LANL
Principal Investigator/Phone: Louis Rosocha, 505-667-8493, Fax: 505-665-2840
- **Title:** Two-Stage Advanced Oxidation/Reduction Unit for Mixed Waste Treatment
Contractor: LANL
Principal Investigator/Phone: Louis Rosocha, 505-667-8493, Fax: 505-665-2840
- **Title:** Terra VIT Solid Mixed Waste Demonstration
Contractor: PNL
Principal Investigator/Phone: Leo Thompson, 509-376-5150 fax: 509-372-0867
- **Title:** Microwave Solidification
Contractor: EG&G Rocky Flats, Inc
Principal Investigator/Phone: G.S. Sprenger, 303-966-3159

Mixed Waste Short List

- **Title:** Polymer Solidification
Contractor: EG&G Rocky Flats, Inc.
Principal Investigator/Phone: A.M. Faucette, 303-966-6420
DOE Contact: Program Manager, Jim Taylor , 301-903-7686
 - **Title:** The Fixed Plasma Hearth Treatment Process for Mixed Waste Treatment Applications
Contractor: EG&G Idaho, Inc., INEL
Principal Investigator/Phone: Steven Bates, 208-526-6790 fax: 208-526-6802
DOE Contact: Mike Schultz, 208-526-0131 fax: 208-526-6249
 - **Title:** Innovative Fossil Fuel Vitrification Technology for Soil Remediation
Contractor: Vortec Corporation
Principal Investigator/Phone: John Patten, 215-489-2255 fax: 215-489-3185
 - **Title:** Minimum Additive Waste Stabilization (MAWS)
MAWS (GS21)
Contractor: GTS/Duratek/C
Principal Investigator/Phone: Program Manager, Grace Ordaz, 301-903-7440
 - **Title:** Selective Extraction/Leaching
Uranium in Soils ID (GS05)
Contractor: LANL
Principal Investigator/Phone: Program Manager, Mike Malone, 301-903-7996
-

Disposal/Storage Projects

- **Title:** Dry Barrier Applications for Landfills
Contractor: SNL
Principal Investigator/Phone: John Stormont, 505-845-9347
- **Title:** Eval./Two New Flowable Grout Technology for In Situ Barrier Const.
In Situ Remediation Technology Development IP (GS09)
Contractor: LANL
Principal Investigator/Phone: Program Manager, Jeff Walker, 301-903-7966
- **Title:** Developing Demonstrating Methods of Placing In Situ Grout Barriers
In Situ Remediation Technology Development IP (GS09)
Contractor: FERMCO
Principal Investigator/Phone: Program Manager, Jeff Walker, 301-903-7966

7.5 DOIT Demonstration Projects Matrix

*Western Governors Association (WGA) DOIT Committee***Mixed Waste Working Group Demonstration Projects
Identified for Submittal to the DOIT Committee**

Title	Waste Type Addressed	Contractor	Site	Contact/Principle Investigator
Characterization Projects				
Radiological and Hazardous Material Measurement System (RHMMS)	Various: soils, containerized solid low level, hazardous, mixed, TRU and post-treatment final waste forms	EG&G Idaho, Inc.	INEL	DOE: George Snyder, 208-526-6789 fax: 208-526-6249 PI: Tim Roney, 208-526-9712
Rapid Transuranic Monitoring Laboratory	TRU: buried, D&D, and other	EG&G Idaho, Inc.	INEL	DOE: Tim Stafford, 208-526-5670 PI: Chuck McIsaac, 208-376-3529
Dig Face Characterization	Various: buried low level, hazardous, mixed, and TRU	EG&G Idaho, Inc.	INEL	DOE: George Snyder, 208-526-6789 fax: 208-526-6249 PI: Nick Josten, 208-526-7691
Treatment Projects				
VAC*TRAX - Mobile Vacuum/Thermal Desorption Process Treatment System	Organically contaminated hazardous and mixed soils, sediments, sludges, debris, combustibles, glass, ceramics, metals, leaded materials	EG&G Rocky Flats, Chemical Waste Management, Inc., Rust Remedial Services, Clemson Technical Center and Clemson University	Rocky Flats	DOE: Reg Tyler, 303-966-5927 fax: 303-966-2256 PI: Peter L. Montez, 303-966-7681 Dr. Charles Reece, 803- 646-2413
Two Stage Advanced Oxidation/Reduction Unit for Mixed Waste Treatment	Mixed and other liquid organic wastes, aqueous liquids and sludges, combustible solids, and off-gases	LANL	LANL	PI: Louis Rosocha, 505-667-8493, fax: 505-665-2840
Microwave Solidification for Mixed Waste	Mixed and other homogeneous wet or dry inorganic solids: incinerator ash, nitrate salts, sludges, sand slag, crucibles, remediation soils	EG&G Rocky Flats, Inc.	Rocky Flats	DOE: Reg Tyler, 303-966-5927 fax: 303-966-2256 PI: Greg S. Sprenger, 303-966-3159

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Plasma Hearth Process Development for Mixed Waste Treatment	Mixed and other heterogeneous or homogeneous solids or sludges	Science Applications International Corporation (SAIC), MSE/Butte, Martin Marietta Energy Systems, Inc., EG&G Idaho, Inc., and Argonne National Laboratory-West	1) INEL Retech, Inc.'s plant in Ukiab, CA. 2) ANL-W facility	DOE: Mike Schultz, 208-626-0131 William Scott, (208) 526-8189 fax: 208-526-6249 PI: Milo Larsen, 208-528-2109 Grant McClellan, (208) 533-7257
Minimum Additive Waste Stabilization (MAWS)	Mixed and other various streams: soils, sludges, flyash, asbestos, groundwater, Hanford tank wastes, remediation streams	GTS-Duratek/Catholic University/Lockheed Environmental Service /Argonne National Laboratory (ANL) Westinghouse Hanford Co.	Hanford	DOE: Grace Ordaz, 301-903-7440
Disposal/Storage Projects				
Advanced Landfill Cover Demonstration Project (was Dry Barrier Applications for Landfills)	Containment of various wastes buried in hazardous and mixed-waste landfills in arid/semi-arid western climate regions	SNL	SNL Located on Kirtland AFB	PI: John Stormont, 505-845-9347

7.6 Request for Information

Department of Energy, Office of Technology Development, EM-50, 1000 Independence Avenue, S.W., Room 5B-014, Washington, D.C. 20585

REQUEST FOR INFORMATION (RFI) FROM INDUSTRY [Point of Contact (POC), Dr. George Coyle, EM-50, 202-586-6382]. The U.S. Department of Energy's (DOE) Office of Environmental Restoration and Waste Management (EM) is soliciting information from private sector technology developers regarding their capabilities to demonstrate new and innovative technologies that may accelerate site activities in characterization, treatment, remediation, and storage/disposal of mixed radioactive/hazardous waste at federal facilities in the West. This is not a solicitation for government proposals or bids for procurement or financial assistance, but rather a request for information on new and innovative technologies to address characterization, treatment, and storage/disposal of mixed waste. Based on information received from this RFI, a formal RFP(s) may be released focusing on specific needs and sites characteristics.

The responses to the RFI will be reviewed by the Mixed Radioactive/Hazardous Waste Working Group of the Federal Advisory Committee to Develop On-Site Innovative Technologies (DOIT Committee). The DOIT Committee consists of the heads of the U.S. Departments of Energy, Defense, Interior, the U.S. Environmental Protection Agency, and of members of the Western Governors' Association. The Federal Advisory Committee will serve as the vehicle for recommending a program to review information and technologies regarding

clean up and waste management in western states; by recommending demonstration projects for implementation; and by identifying regulatory, institutional, or other barriers to technology development. Pursuant to the Advisory Committee's Charter, the initial lead agency is the Department of Energy, in which the Office of Technology Development serves as the coordinating office.

The Department of Energy has requested funding in its budget proposal for a project to conduct field demonstrations of technology on mixed waste beginning in calendar year 1995. This program will implement the recommendations of the DOIT Committee. The goal of the recommendations will be to expedite clean-up of federal sites by addressing regulatory barriers and public concerns throughout the technology demonstration project process.

The following factors are considered to be important by the Mixed Radioactive/Hazardous Waste Working Group of the Committee in its review of cleanup technologies:

- The project addresses Mixed Waste at sites in the following states and territories: Alaska, American Samoa, Arizona, California, Colorado, Guam, Hawaii, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Northern Mariana Islands, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming;
- Magnitude of the problem applicable to this technology (total volume, multiple sites, etc.); and
- Technology demonstration is conducive to stakeholder involvement.

Factors that should be addresses in descriptions of cleanup technology are:

- Risk to public health and safety and to the environment;
- Public acceptance, permit and regulatory issues;
- Extent of private sector and multi-agency involvement;
- Potential for technology transfer and commercialization;
- Likelihood of successful demonstration (technical risks, technology component and system);
- Total volume reduction - hazardous and radioactive components;
- Final waste forms and treated secondary waste forms (public acceptance, stable, meets regulatory criteria);
- Magnitude of recycling and material recovery potential; and
- Ease of scale-up.

Information must be provided by responders in the format of a technical concept paper not to exceed five (5) pages. Do not include corporate and proprietary information. Respondents are advised to clearly identify any and all proprietary data submitted in response to this RFI, so the Department is made aware of information needing such protection. The onus to both identify and protect privileged information is not the responsibility of the Department of Energy. In addition, the Department is under no obligation to pay for the expenses of submitting responses to the RFI. The dates on which the Working Group will discuss specific concept papers will be published in advance in the Federal Register and submitters may attend those meetings, which are open to the public.

**7.7 Draft Mixed Waste Working Group
Demonstration Technology Implementation
Plan**

WESTERN GOVERNORS' ASSOCIATION
INNOVATED TECHNOLOGY DEMONSTRATION INITIATIVE
MIXED WASTE DEMONSTRATION
TECHNOLOGY IMPLEMENTATION PLAN

DRAFT OCTOBER 20, 1993

Steve Stein, Pacific Northwest Laboratory
Gretchen McCabe, Battelle Seattle Research Center

Introduction

The Western Governors' Association (WGA), in cooperation with four Federal Agencies (U.S. Department of Energy, U.S. Environmental Protection Agency, U.S. Department of Defense, U.S. Department of Interior) has initiated an effort to accelerate development and deployment of waste management and environmental cleanup technologies. The ultimate objective of this initiative is to reduce the cost and schedule of cleanup by more rapidly introducing new, more effective technologies into operations in a timely manner. Demonstration of new technologies, coupled with proactive stakeholder involvement has been selected as the strategy for this effort. The motivation for, and the objectives of, this initiative are described in the WGA Management and Public Involvement Plan.

This Implementation Plan is focused on the Mixed Waste Technology Demonstration Project but is sufficiently generic that it may offer insight into preparing implementation plans for the other WGA demonstration projects. This Implementation Plan was prepared assuming the technology and the site for demonstration had been selected. Thus, the focus of this document is on the goals of the demonstration effort and the approach that would be used to prepare for the demonstration, conduct the demonstration, evaluate a technology's performance, decide whether the technology can be recommended for deployment, and as appropriate deploy the technology. Active stakeholder involvement at all phases of this effort is critical and has been included in the approach giving equal significance to the technical and institutional requirements.

Technology Demonstration Goals

The goals for this demonstration effort are:

- Demonstrate an accelerated demonstration/deployment model
- Identify/demonstrate a streamlined bureaucratic process for remedy selection
- Demonstrate a more cooperative approach between agencies and stakeholders
- Test effective public/stakeholder involvement mechanisms
- Demonstrate technologies once and deploy them broadly
- Transition from demonstration to operation rapidly

Operating Philosophy

This project will be designed to provide comprehensive technical solutions to a given problem. A systems approach will be used to identify technical requirements and demonstrate technologies. Full-scale systems will be demonstrated in the field under actual operating conditions. The demonstration project will serve as the host for demonstrating new and innovative technologies that are being advanced by U.S industry. The demonstration project will define site access and operational requirements for the industrial partners who, in turn, will need to modify their activities so that they are compatible with these requirements. The industrial partners will also assume responsibility for set up and operation of the equipment during testing and demonstration. The demonstration project will assume responsibility for detailed evaluation of the technology's performance and timely reporting. The demonstration project will also support the industrial partners with the early stages of broad deployment of the technology.

What is truly unique about this effort is the integration of stakeholder acceptance issues with technical performance data of new technologies. Stakeholder is used here to mean all the various individuals and groups who feel they have a stake in the deployment of a technology. Stakeholders can include regulators, interest groups, citizens in a community where an environmental technology may be used, and potential industrial co-developers and deployers of a technology. There is a general consensus that the major obstacles to deploying new technologies come from one or several of these stakeholder groups. It is, therefore, critical that stakeholder issues and concerns be considered in parallel and on an equal basis with the technical issues. Stakeholder involvement will be sought at each step of the process and feedback to the technology developers will be continual. A transparent decision process will be defined so that all parties can see how decisions are made and how their input impacts the process. The approach will be flexible and responsive to stakeholder issues and concerns. All aspects of the project will be conducted in a manner that allows the technologies to be tested, demonstrated, and evaluated in a credible manner.

One of the challenges of conducting a demonstration is to have the project design consider the incentives and disincentives. Incentives need to be capitalized while disincentives need to be minimized in the affect they can have on the project. The primary groups for which incentives and disincentives need to be considered could include: industrial partners, management and operations contractors, site community residents, federal agency officials, and federal and state regulators. The following is a draft list of incentives and disincentives for these groups.

INCENTIVES

Industrial Partners

Access to broad market
 Shorter path to commercialization
 Indemnified
 Enhanced regulatory facilitation
 Access to real conditions
 Visibility on public relations
 Credibility
 Access to operations/experience
 Limited financial investment
 Ability to convert to operations if done successfully

M&O Contractors

Jobs to the community
 Long-term funding stability
 Recognition
 More streamlined approach via the systems
 Credibility

DISINCENTIVES

Industrial Partners

Disclosure
 Bureaucratic process
 Potential limited return on investment
 Perceived conflict of interest
 Perceived length of duration - life cycle
 Lack of control

M&O Contractors

Risk of failure
 Inter/intra turf battles/relationships
 Milestones delayed or real perception
 Diversion of funds/labor/equipment/resources
 Procurement constraints
 Liability - safety - increased risk issues
 Labor/work issues
 Hassles of non-standard way of doing business
 Conflict with existing programs/systems inflexible to change
 Financial hardships - workforce/funds

Community

Jobs to the community
Success with cleanup
Improved stakeholder involvement
Economic transition

Agency

Success with cleanup
Long-term funding stability
Recognition
Improved stakeholder involvement
Credibility

Regulators

Credit for success
Innovation
Meeting milestones
Availability of critical technologies
Improve stakeholder relationships

Community

Perceived as slowing down cleanup
Destruction, resources allocation

Agency

Increased work load with no incentive
Risk of failure
Public involvement
Inter/intra turf battles/relationships
Milestones delayed or real perception
Diversion of funds/labor/equipment/
resources

Regulators

Increased work load with no incentive
Risk of failure
Public involvement
Inter/intra turf battles/relationships
Milestones delayed or real perception
Diversion of funds/labor/equipment/
resources
R&D versus enforcement

Demonstration Operations

The following two sets of bullets highlight the activities that would be performed by the demonstration operations team prior to and during the demonstration. These activities would be conducted in parallel with stakeholder involvement activities described in the section “Methodology for Stakeholder Involvement.”

Planning and Preparation

- Prepare team organization and logistical plans
- Prepare schedules and budgets
- Prepare operations and maintenance procedures
- Prepare training requirements
- Develop quality assurance criteria and safety protocol
- Address regulatory compliance concerns
- Identify material resources and delivery logistics
- Subcontract necessary resources (procurements)

Demonstration Implementation

- Manage field operations
- Install equipment and conduct operational acceptance test
- Conduct on-site training
- Perform operations and maintenance
- Conduct performance evaluation and monitoring
- Conduct Health and Safety monitoring
- Manage for treating, storing, and/or disposing of wastes

Why There is a Need for Stakeholder Involvement

Involving interest groups, citizens, regulators, and industry in environmental restoration and waste management programs is a challenge for government agencies and the organizations that support them. To be effective, such involvement activities must identify all individuals and groups who have a stake in the cleanup. Their participation is most effective if it is early and substantive. It is critical that stakeholders see how their input was considered and used, and feel that a good-faith effort was made to reconcile conflicting objectives.

The WGA Initiative is a challenge in that stakeholders are not limited by geography to the site where a cleanup is planned. To fulfill the objective of the initiative, the demonstration of a system of technologies at one site should take into consideration the interests and concerns of stakeholders at all similar sites where the system of technologies could be deployed. This demonstrate-once-and-deploy-broadly approach is intended to accelerate technology transfer and full-scale deployment by eliminating the need to reinvent the wheel at each similar site around the country. In turn, sites can be cleaned up much more quickly.

A similar approach is being used by the Department of Energy's (DOE) Office of Technology Development's Integrated Demonstration Program. Environmental problems, which are common to many DOE sites, are being addressed by choosing one site that is representative of a particular problem and using it as a test bed for demonstrating technologies that are envisioned to be deployed broadly at similar sites. It is, therefore, critical that each integrated demonstration take into consideration the concerns of all similar sites in designing its technology demonstrations. Technology project managers have historically considered mainly only technical concerns and not stakeholder acceptance issues. Over the past two years a new paradigm has been used to reframe project implementation. This paradigm considers public and regulatory acceptance in parallel with technical effectiveness in developing and demonstrating innovative technologies. It is believed that a technology will have a high likelihood of being deployed broadly if it performs effectively during demonstration **and** is accepted by the regulatory community and the public.

The WGA initiative advances the DOE integrated demonstration concept a step further by coordinating cleanup efforts of four federal agencies and all WGA states. Stakeholder involvement becomes even more of a challenge when taking on this broad scope. Nonetheless, it can result in an even faster commercialization of technologies and accelerated cleanup of sites due to the coordination.

Methodology for Stakeholder Involvement

Technology acceptance would be enhanced by involving a broad cross-section of stakeholders from the western states. One approach would be to organize the 22 states into some small number of regions to facilitate involvement activities. In the case of the Mixed Waste Technology Demonstration Project, it may make the most sense to organize public involvement activities around each of the six western state sites that have the majority of the mixed waste -- the Idaho National Engineering Laboratory in Idaho Falls, Idaho; Hanford in Richland, Washington; the Nevada Test Site outside of Las Vegas, Nevada; Rocky Flats near Boulder, Colorado, the Sandia National Laboratories in Albuquerque, New Mexico and the Los Alamos National Laboratory in New Mexico; and the Lawrence Livermore National Laboratory east of San Francisco. In the case of sites that border other states, stakeholders from these states (e.g., Oregon which, in addition to Washington and Idaho, depends on the Columbia River as a major resource) would be included in involvement activities for the site that they see as affecting them. Stakeholders from each of these sites would likely include interest groups, elected officials, regulators, Native American tribe

representatives in appropriate cases, industrial developers and users of environmental cleanup technologies, the agricultural community, other businesses and labor in the vicinity of potential sites, government contractors, and other citizens of potentially affected communities.

A three-phased approach could be used to identify stakeholder interests and concerns in the technologies that may be demonstrated to address a particular problem (e.g., mixed waste treatment). Assuming that the Mixed Waste Technology Demonstration site and technologies have already been chosen, Phase I would include briefing the stakeholders on the overall mission of the WGA initiative, briefing them more thoroughly on the planned demonstration that has relevance to them, and giving them the opportunity to provide comments on this demonstration's implementation plan. Furthermore, these stakeholders would be asked to identify criteria they feel should be used to evaluate innovative technologies and asked to use these criteria to provide some general comments on the technologies targeted for demonstration. Site reports and an integrated Phase I report would be prepared including this information and a list of technology evaluation criteria.

Under Phase II, the demonstration operations team would consider the stakeholder comments provided in revising its implementation plan for technology demonstration. The revised implementation plan would be sent to the stakeholders, giving them the opportunity to see how their comments were used. The list of technology evaluation criteria developed from integrating stakeholder comments from all of the mixed waste states would be used by the stakeholders to more thoroughly evaluate the technologies targeted for demonstration. Concerns raised by stakeholders about the innovative technologies would be reported to the appropriate technology developers who would be expected to consider these concerns in developing their demonstration plan and, in some cases, designing their actual technology.

Phase III would involve reporting back to the stakeholders on the changes made to the technologies and/or demonstration plans, based on their concerns, and on the results of the demonstration. Stakeholders would be asked to describe their views on seeing a technology or system of technologies broadly deployed now knowing the data from the demonstration. Their views would be considered along with those of technical experts, judging the technical effectiveness of the demonstration, in the decision of whether or not a particular technology or system of technologies is ready for deployment. A report would be prepared describing the range of views provided on a technology so that a potential user of a technology or technology system would be aware of the possible deployment obstacles.

Each of these phases is further described below with respect to stakeholder involvement.

Phase I

Stakeholders who represent each of the perspectives listed above would be identified for each of the six mixed waste sites. Interviews would be conducted with stakeholders from these sites. Each interview would include one to six individuals representing a particular perspective from a

site. As mentioned above, the stakeholders would be briefed on the overall mission of the WGA initiative, briefed in more depth on the mixed waste demonstration, and given the opportunity to provide comments on this demonstration's implementation plan.

Following this discussion, stakeholders would be asked to describe those criteria they feel should be considered in evaluating a technology. After a list is developed, they would be shown the list developed for a DOE integrated demonstration (the Volatile Organic Compound (VOC) - Arid Site Integrated Demonstration (VOC-Arid ID)). Stakeholders would be shown the VOC-Arid ID list after they provide their list to ensure they are not biased. The VOC-Arid ID criteria list (see Figure 1; definitions for the criteria are in Appendix A) is based on 40 interviews and two workshops to reach consensus on the list. Together the interviewer and interviewees would compare the lists to identify criteria the interviewees failed to mention but find important and to identify differences in the lists. All of the comments received would be incorporated into an interview report, which the interviewees would be asked to review to ensure that their perspectives are accurately reported.

Site reports would be developed to describe the range of technology evaluation criteria identified by all of the stakeholders interviewed in a particular site. Furthermore, comments on the demonstration implementation plan and issues and concerns raised about the system of technologies planned to be demonstrated would be included in the site report. Finally, information from all of the site reports, including a summary list of technology evaluation criteria, would be summarized in a Phase I report.

Phase II

Under Phase II, the demonstration implementation plan would be modified based on comments received during Phase I and mailed to all stakeholders to give them the opportunity to see how their comments were incorporated.

Phase II would also include an opportunity for stakeholders to more rigorously evaluate the technologies planned to be demonstrated by using the list of technology evaluation criteria developed in Phase I. Interviews would be conducted with stakeholders from each of the sites, as occurred in Phase I. The same method would be used to aggregate the comments by site. An integrated western states workshop would be held to report on the range of issues and concerns raised by the stakeholders. The principal investigators (PIs) responsible for developing the technologies planned for demonstration would participate in the workshop. They would review the site reports prior to the workshop and consider them in developing their draft test plan for demonstrating their technology. The workshop would serve as an opportunity for the PIs to discuss the test plans and hear first-hand the stakeholders' ideas and concerns. A Phase II report would be prepared describing the range of these concerns.

Following the workshop, the PIs would modify their test plan and, in some cases, modify their technology design after considering the stakeholder comments. The revised test plan would be mailed to stakeholders to give them the opportunity to see how their comments were incorporated.

Phase III

Under Phase III, the technology system demonstration would be conducted using the revised test plan and data would be collected to improve the working knowledge of the technologies. This information would be used to update the knowledge known about each of the criteria used to evaluate the technologies. This information would be forwarded to the stakeholders. Interviews or a survey would be conducted with stakeholders at the various sites on those technologies found by the stakeholders to be controversial. The purpose would be to determine how and to what degree stakeholder opinion of the technologies changed based on this new data. Uncertainties associated with the technologies would likely decrease based on knowledge gained through the demonstration. Stakeholder views with regard to technology acceptance would be considered along with those of technical experts in deciding whether or not a particular technology or system of technologies is ready for deployment. A report would be prepared describing the range of views provided on a technology so that a potential user of a technology or technology system would be aware of the possible deployment obstacles.

APPENDIX A

DEFINITIONS OF THE TECHNOLOGY EVALUATION CRITERIA

TECHNICAL EFFECTIVENESS

Three primary criterion categories are associated with the evaluation of technology effectiveness. These include performance, cost, and time.

PERFORMANCE:

The elements that comprise the performance criterion include remaining contamination, process waste, practicality, and whether the technology "works" or functions as intended. The criterion for remaining contamination refers to contaminants remaining after the technology has been applied (e.g., the 1 percent remaining after a 99 percent-effective groundwater treatment technique is completed). The remaining contamination is to be measured according to how much contaminant mobility, volume, and toxicity are reduced by the technology.

The criterion for process waste refers to waste produced by the technology itself, or the process of its application. The status of the waste can be assessed, including consideration of waste mobility, volume, degree of hazard represented by the character of the waste, and recycle potential. The ability to characterize the waste, handle it safely, and transport it with minimal risk, are also important. Waste treatment requirements needed to address a given technology's residuals can be assessed, and the availability of the needed treatment technology defined. Requirements for decontamination and decommissioning of a technology, and the resulting waste, can be evaluated. The technology can also be evaluated according to the need for waste disposal, and whether such disposal capacity is available. The nature of available disposal (e.g., landfill versus more progressive disposal method) should also be considered.

Practicality is defined by several criteria. It assesses whether use of a given technology will preclude or foreclose future cleanup options. It evaluates whether a technology is reliable, and can be expected to operate with minimal operational problems and production downtime. If the technology fails, it should be possible to control the effects of that failure easily and rapidly. Other criteria include whether the technology is easy to use and capable of operating with the existing facility infrastructure (e.g., buildings, power sources, personnel). Versatility of the

technology to address other types of contamination, in other media, or at other locations, can also be assessed.

A systems analysis perspective on the technology will evaluate whether the technology is compatible with the other elements of the remediation system. The ability to procure the technology "off the shelf", with the simplest possible development approach, is another criterion. How easy the technology is to routinely maintain, and how often maintenance is required, should be considered. Also, the safety measures required to protect workers and the public can be evaluated. Finally, determining whether a technology actually works as intended is also a consideration.

COST: Two elements that comprise the cost criterion include technology startup cost, and operations and maintenance cost. These factors are to be considered first, as they represent some certainty in the data available for evaluation. Startup cost is intended to cover reasonable developmental costs, procurement and construction costs, permitting costs, and other elements prior to starting operation and conducting full-scale deployment. Operations and maintenance costs cover the elements of labor, supplies, maintenance, replacement parts, process waste management, ongoing regulatory compliance, etc., for the life of the use of the technology.

Total life-cycle cost should be considered as a secondary criterion. Total life-cycle cost considerations typically include not only facility capital cost, startup and operation costs, and maintenance, but also less distinctly attributable costs such as decommissioning costs, ongoing regulatory or institutional oversight, and future liability. While it is probably a more meaningful overall measure, the elements of defining total life cycle cost are highly uncertain. Therefore, it should be considered only as a secondary criterion following evaluation of startup and operations and maintenance costs. Workshop participants encouraged the use of cost/benefit analyses wherever feasible.

TIME: The elements that comprise the time criterion include the length of time until the technology is available, the speed or rate at which the technology operates, and the total time needed to achieve the given objectives. Years until available, while an estimate, is directly comparable between and among technologies. Speed or rate is measured differently for different categories of technologies (e.g., feet per hour for a drilling technology, pounds per day for an extraction technology), but is a useful measure of comparison of technologies within a category. Years to finish measures the total time required for setup and removal, as well as the total length of time

needed for a given technology or combination of technologies to achieve the given objective(s).

ENVIRONMENTAL SAFETY AND HEALTH

There are three elements included in the category of environmental safety and health. They include worker safety, public health and safety, and environmental impacts. In many ways these criteria are related to the regulatory compliance standards addressed in a later category, but they also represent stand-alone objectives to be addressed by specific criteria where possible.

WORKER SAFETY:

The criteria for evaluating a technology according to its worker safety aspects include the level of exposure of workers to hazardous materials or other hazards resulting from use of the technology, the physical requirements of developing and operating the technology, and the number of workers required. Factors to evaluate worker safety may include the number of days lost due to accidents or exposure, the concentration of contaminants in the workplace, or operational considerations such as the need for protective clothing or equipment. Technologies using remote handling techniques are preferred.

PUBLIC HEALTH AND SAFETY:

The term public health and safety is intended to refer to all those people who are not workers at the facility. Public health and safety aspects of a given technology can be evaluated based on the number, type and severity of accidents postulated to occur related to that technology's development, operation, and decommissioning. Routine releases to air, ground or water pathways from a technology can be evaluated, as can the potential impacts from transportation of equipment, samples, wastes, or other materials associated with the technology. Careful consideration needs to be given as to whether the risks from transporting contaminants offsite are offset by the risks of disposing of them onsite.

ENVIRONMENTAL IMPACTS:

The criteria for evaluating a technology's environmental impacts include effects on the ecology of the remediation site (e.g., wildlife, vegetation, air, water, soil, people), and aesthetic impacts (e.g., visual impacts, noise). Technologies are preferred in which contaminants are destroyed, not just dispersed. Preservation of undisturbed habitat should be emphasized. The use of natural resources in development, manufacture, or operation of the technology should be evaluated, including the energy demands of the technology.

SOCIO-POLITICAL INTERESTS

Acceptability of a technology by the range of various "publics" depends on many factors, including those described above. In addition, however, there are three categories of criteria termed socio-political interests. These include public perceptions of a technology, tribal rights and future land uses associated with technology demonstration and deployment, and socio-economic interests.

PUBLIC PERCEPTION:

The reputation of the proponent of a technology, whether the technology developer or deployer, affects public perception of that technology. This may apply to a government agency, national laboratory, academic institution, contractor firm, or private industry partner. The degree of familiarity of a technology and its use is a key factor affecting public perception of a given technology. Information needed for decision making (e.g., cost projections) is often unavailable or unreliable, thus causing public concerns. The ability to explain the technology in understandable terms is important to public acceptability. Involvement of the public in decisions about the use of different technologies is a key element of public acceptability of those technologies. Other factors that have been addressed elsewhere also affect public perception, including elements such as related employment, and the overall benefit a person perceives that would result from deployment of the technology. In addition, generalized public fear and dread of hazards, high technology solutions, and government actions may be factors affecting acceptability of some technologies.

TRIBAL RIGHTS/FUTURE LAND USES:

Native American values related to the land and its uses offer criteria for evaluating alternative cleanup technologies. In addition to the affected tribes, many other groups and individuals have interests in future uses of currently-contaminated land. The return of the land to a pristine state is a major goal. Capacity for future unrestricted use of the contaminated areas, including both terrestrial and aquatic uses, is a key criterion. This relates to spiritual values as well as traditional uses (e.g., hunting, fishing, recreation, living areas). To the degree possible, the physical nature of the land itself should not be changed (e.g., not vitrifying large solid blocks of earth in place).

SOCIO-ECONOMIC INTERESTS:

Effects of a technology or suite of technologies on the economic base of the community should be considered, including fiscal as well as less tangible impacts. Impacts may include local infrastructure requirements (e.g., sewer, fire protection, etc.), labor force turnover (if new or different capabilities are needed), housing

values, or other factors. Availability of the required labor force can be evaluated for different technologies, including the need for personnel training.

REGULATORY OBJECTIVES

Discussions with the regulatory community as well as other stakeholders revealed several criteria related to meeting regulatory objectives for the technologies to be evaluated. These include compatibility with facility cleanup milestones, regulatory infrastructure and track record, and regulatory compliance.

COMPATIBILITY WITH CLEANUP MILESTONES:

Evaluating the ability of a technology to support compliance with cleanup milestones involves assessing its ability to contribute to meeting the regulatory cleanup requirements that have been established for a given site, in a timeframe and in compliance with standards that would be applied in any other remediation situation.

REGULATORY INFRASTRUCTURE/TRACK RECORD:

The experience of regulators with a specific technology or a similar technology may result in the regulators being predisposed to find the technology acceptable. Furthermore, if a regulatory agency has experience with a type of technology, it can be expected that regulatory uncertainty about that technology will be reduced. The number and complexity of the regulatory programs that apply to a given technology should be evaluated.

REGULATORY COMPLIANCE:

The ability of a technology or suite of technologies to achieve regulatory cleanup standards, as well as ongoing protection of public and worker health and safety and the environment, can be evaluated. Permanent solutions are preferable, as well as the simplest possible technologies that will do the job. Substantial compliance with regulatory requirements, if full compliance is not yet possible, should be evaluated on a case-by-case basis. Compatibility with state waste management priorities is part of this criterion, as is compliance with NEPA. The level of uncertainty associated with regulatory compliance is also a factor that affects the ability to measure this criterion.

WGA
Mixed Waste Technology
Demonstration
Implementation Plan

Presentation to
Mixed Waste Working Group

Presented by
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Technology Demonstration Goals

- **Demonstrate an accelerated demonstration/deployment model**
- **Identify/demonstrate a streamlined bureaucratic process for remedy selection**
- **Demonstrate a more cooperative approach between agencies and stakeholders**
- **Test effective public/stakeholder involvement mechanisms**
- **Demonstrate technologies once and deploy them broadly**
- **Transition from demonstration to operation rapidly**

Operating Assumptions

- **Demonstrate complete systems versus stand alone technologies**
- **Conduct full scale demonstrations versus bench or pilot scale**
- **Operate under field conditions versus under clean, test bed conditions**
- **Leverage on-going demonstrations for short-term wins and identify new demonstrations in parallel**
- **Consider stakeholder acceptance issues in parallel with technical effectiveness**

Stage I: Funding Decision

Stage II: Preparation for Demonstration

Stage III: Demonstration and Evaluation

Demonstration Phases

Phase I

- Develop mixed waste Demonstration Implementation Plan
- Develop a list of technology evaluation criteria
- Submit technology proposal requests and make awards

Phase II

- Establish demo physical infrastructure
- Develop demonstration test plans
- Secure required permits and identify site access/safety requirements

Demonstration Phases (cont.)

Phase III

- Install equipment and conduct operational acceptance test
- Conduct demonstration and evaluate data
- Make deployment recommendations

Phase IV

- Commercialize technologies
- Deploy technologies

Stakeholder Involvement Methodology

Phase I

- **Conduct the following with stakeholders from mixed waste sites**
 - Brief stakeholders on the WGA/Mixed Waste Tech. Demo.
 - Solicit input on the Demonstration's Implementation Plan
 - Ask stakeholders to identify technology evaluation criteria
 - Prepare site reports to describe comments received
- **Integrate site reports into draft Phase I report**
- **Conduct Phase I Integrated Workshop and prepare Phase I final report**

Stakeholder Involvement Methodology

Phase II

- **Modify Implementation Plan based on Phase I stakeholder comments**
- **Ask stakeholders at each site to use Phase I criteria to identify issues and information needs for demonstration**
- **Prepare stakeholder reports for each site**
- **Integrate site reports into draft Phase II report**
- **Conduct Phase II Integrated Workshop and prepare Phase II final report**
- **Design test plans based on stakeholder comments**

Stakeholder Involvement Methodology

Phase III

- **Use test plans to conduct demonstrations**
- **Provide demonstration data to stakeholders**
- **Ask stakeholders at each site to evaluate demonstration technologies**
- **Prepare technology evaluation reports for each site**
- **Integrate site reports into draft Phase III report**
- **Conduct Phase III Integrated Workshop and prepare Phase III final report**
- **Provide comments for decisions regarding technology deployment**

Technology Evaluation Criteria

Decision-Making Framework: Primary Variables

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