Department of Energy
Washington, DC 20585

NOV 17 1999

The Honorable John T. Conway
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, N.W., Suite 700
Washington, D.C. 20004

Dear Mr. Chairman:

I have enclosed for your information a compilation of the current research activities of the Office of Science and Technology in the area of low-level waste. These activities span several of the Focus Areas that lead the research as well as support the actual deployment of the technologies that are developed.

As was discussed with your staff, the Offices of Science and Technology, Waste Management, and Environmental Restoration have coordinated their efforts to implement the Low-Level Waste Research and Development Plan developed by the Department in response to Recommendation 94-2. Through the processes outlined in the Plan, low-level waste technology needs are effectively identified, prioritized, and addressed. The plan provides a sound basis for our continuing efforts.

The Office of Science and Technology is committed to developing technologies for this widespread problem. We will provide updates and review progress with the Office of Waste Management so that we can continue to reduce the cost of this effort through innovative technologies.

If there are any questions or expansion of the information for a technology is desired, please contact Mr. Skip Chamberlain of my office at (301) 903-7248.

Sincerely,

Gerald G. Boyd
Acting Deputy Assistant Secretary
for Science and Technology
Office of Environmental Management

Enclosure

cc:
Mark Whitaker, S-3.1
Mark Frei, EM-30
Dermot Winters, DNFSB Staff

Office of Science and Technology

Providing Environmental Solutions
To
Low Level Waste Problems

October 21, 1999

Deactivation and Decommissioning Focus Area

Work Package	Work Package Title	*FY 99 Funding (K)	*FY 00 Funding (K)
DD-03	Canyon Disposition Initiative	$4,341	$9,450

- Technologies will be demonstrated and deployed to accurately characterize and determine the type, quantity and location to support the development of a ROD that will determine the final end state of the U-plant facility.
    - Potential reduction of $1B if agreed to end state is TRU removal / LLW disposal/ canyon entombment.
    - Mortgage reduction at other sites in the DOE complex
    - Major integration of work across formerly stovepiped organizations will be successful.

Work Package	Work Package Title	*FY 99 Funding (K)	*FY 00 Funding (K)
DD-05	Scrap Metal Recycling and Release	$2,216	$1,504

- Technologies to characterize, separate (contaminated and non-contaminated portions) and decontaminate metals for internal DOE recycle or free release will be demonstrated and deployed.
    - Avoidance of disposal costs for disposing all scrap metal as low-level waste.
    - Improved technologies for rapid radioactive analysis and separation into contaminated and non contaminated portions.

*** Funding is from the FY 2001 CRB**

Deactivation and Decommissioning Focus Area (cont.)

Work Package	Work Package Title	*FY 99 Funding (K)	*FY 00 Funding (K)
DD-13	Oversized Metallic TRU Waste Disposition at LANL (LSDDP #4)	$6,441	$3,329

- Technologies for characterization of contaminated surfaces to determine TRU, low-level waste or free release segregation and packaging of TRU contaminated waste will be demonstrated or deployed
  - LANL waste management operations are expected to realize improvements in cost, schedule and risk from this LSDDP and its associated ASTD.
  - Potential $75-$180 M mortgage reduction at LANL and Rocky Flats
  - Rocky Flats may also be able to advance site closure

SEE ATTACHED MATERIALS FOR DDFA DETAILS

*** Funding is from the FY 2001 CRB**

All material was gathered from the FY 1999 MYPP

DDFA Back up Material

Work Package DD03: Canyon Disposition Initiative

The U-Plant canyon at Richland is one of nine canyon facilities in the DOE Complex. The canyon has a mix of processing cells that have been inactive for a long time. Technologies will be demonstrated and deployed to accurately characterize and determine the type, quantity and location of contamination to support development of a ROD that will determine the final end-state of the U-plant facility. Without this project, DOE will not have the characterization data needed to complete the Comprehensive Environmental Response, Compensation, and Liability Act RI/FS study for the U-plant to determine the most cost effective end-state for the facility.

Impact: EM-30/40/60 will not have the characterization data needed to complete the CERCLA RI/FS study on the Hanford U-Plant. They will lose credibility with the regulators (Washington Department of Ecology and EPA) and the stakeholders (Hanford Advisory Board, SSAB, Tribal Nations). DDFA/EM-50 will lose credibility with EM-30/40/60. The ROD will not be established in FY2000. The entire alternative end state of TRU removal, LLW disposal and canyon entombment will be adversely affected (potential mortgage reduction opportunity of $1 billion at Hanford may well be lost). The bottom line is that the DDFA cannot withdraw in mid-stream from such an EM-30/40/50/60 combined effort.

Benefit: The Hanford U-Plant characterization will be completed so that the CERCLA RI/FS process can be completed, and the ROD established in FY2000. The potential mortgage reduction is $1 billion if the agreed-on end state is TRU removal/LLW disposal/canyon entombment. DDFA/EM-50 will increase its credibility with EM-30/40/60, and a major effort to integrate work across formerly-stovepiped organizations will be successful. Specific application sites are Hanford, Savannah River, INEEL, and Oak Ridge.

Success Indicators:
- Deploy 4-6 improved characterization systems (remote/robotic)
- CERCLA RI/FS completed and Record of Decision established in FY2000
- Potential mortgage reduction of $1.1B at Hanford if end state is an in-placed, entombed LLW disposal facility
- Major mortgage reductions at SRS (F and H Canyons), INEEL (ICPP) and ORR (Y-12) for same end state

Work Package DD05: Scrap Metal Recycling and Release

Technologies to characterize, separate (contaminated and non-contaminated portions) and decontaminate metals for internal DOE recycle or free release will be demonstrated and deployed. This will result in substantial life-cycle cost savings. Without this effort, most of the metals generated during deactivation and decommissioning will be disposed of as low-level waste at typically high life-cycle cost.

Impact: Most of the scrap metal will be disposed of in LLW disposal facilities at typically high life-cycle disposal costs. Little will be recycled and reused as waste containers and for other applications. It is likely that little or none will be decontaminated for free release even though release standards do exist for surface-contaminated material. Huge amounts of non-contaminated scrap metal will be disposed of as contaminated waste.

Benefit: Improved technologies for rapid radioactive analysis and separation into contaminated and non-contaminated components will be demonstrated and deployed, so that substantial life-cycle cost savings will be realized. Additional disposal costs will be avoided through recycle/reuse of the rad fraction (waste containers), and through decontamination for free release.
Specific application sites are Oak Ridge, Paducah, Portsmouth, Rocky Flats, and Savannah River.

Success Indicators:
- 8-12 deactivation and decommissioning technologies demonstrated with validated cost and technical performance
- 5 deactivation and decommissioning technologies deployed
- Life-cycle costs documented for radioactive scrap metal decontamination/free release vs. reuse as useful products for DOE
- Avoided cost determined for disposal of all potential radioactive scrap metal as LLW

Work Package DD13: Oversized Metallic TRU Waste Disposition at LANL (LSDDP #4)

Across the DOE weapons complex, there is a large number of surplus plutonium-contaminated processing equipment including piping, ducts, tanks and gloveboxes. Technologies for characterization of contaminated surfaces to determine TRU, low-level waste or free-release segregation and packaging of TRU contaminated waste will be demonstrated and deployed. Remotely-operated and robotic devices for size reduction, packaging and characterization will be deployed. This will minimize the amount of glovebox material requiring disposal as TRU waste. This work package includes the LANL LSDDP #4 and the Rocky Flats D&D Initiative.

Impact: LANL currently has approximately 2,400 m^3 of oversized metallic TRU waste in storage and expects to generate another 3,000 m^3 from ongoing waste management operations in coming years (starting in FY2000). Much of the waste is currently stored in fiberglass reinforced plywood (FRP) boxes that do not meet WIPP's Waste Acceptance Criteria (WAC). In order to limit the amount of waste classified as TRU, which will ultimately be sent to WIPP, these 2,400 m^3 need to be characterized, sorted and segregated into TRU and LLW. In addition, this waste must be repackaged in containers, which meet the WIPP acceptance criteria. Rocky Flats cannot develop and implement a new technical baseline for site closure in FY2006 without the improved systems to size reduce the Pu gloveboxes and tanks, and then package and characterize the resulting TRU waste.

Benefit: This LSDDP provides opportunities to demonstrate and deploy improved technologies that can enhance or improve the TRU metallic waste management process, including aspects of characterization, decontamination, size reduction, material handling, and worker safety. LANL waste management operations are expected to realize improvements in cost, schedule and risk from this LSDDP and its associated ASTD project. This work package has direct applicability to Rocky Flats plutonium processing facility D&D projects. Rocky Flats will be able to advance site closure from FY2010 to FY2006.

Success Indicators:
- 10-12 deactivation and decommissioning technologies demonstrated with validated cost and technical performance
- 5 deactivation and decommissioning technologies deployed with average 25% cost savings
- Improved cutting tools deployed at Rocky Flats in FY1999
- Remotely-operated robotic arm with tooling deployed in a Permacon enclosure at Rocky Flats in FY2000.
- Central size reduction facility (enabling simultaneous D&D of multiple buildings) deployed at Rocky Flats in FY2001.
- Potential $75-180M mortgage reduction at LANL and Rocky Flats after broad deployment

Mixed Waste Focus Area

Work Package	Work Package Title	*FY 99 Funding (K)	*FY 00 Funding (K)
MW-07	Alternatives to Incineration to Reduce Emission Hazards	$1,115	$1,025

- Technologies will be deployed at several sites to fulfill the needs to reduce emission hazards. The Mixed Waste Focus Area has supported several alternative oxidation projects as developmental projects, quick wins dedicated to rapidly deploying a technology on a small scale while eliminating problematic waste streams.

  – This work package addresses cost effective and proper treatment of low-level mixed waste at Albuquerque.

Work Package	Work Package Title	*FY 99 Funding (K)	*FY 00 Funding (K)
MW-08	Facilitating Deployment for Unique Wastes	$1,819	$4,510

- 10-15% of DOE's mixed waste inventory cannot be disposed using existing capabilities. Reasons for this include the nature and concentrations of hazardous contaminants, presence and concentration of radioactive isotopes, new or changing requirements, etc. Technologies will be demonstrated and deployed to address these reasons.

  – Technologies will address LLW needs at AL, CH, and ID

SEE ATTACHED MATERIALS FOR MWFA DETAILS

*** Funding is from the FY 2001 CRB**

MWFA Back up Material

MW-07

6.2.4 Alternatives to Incineration to Reduce Emission Hazards Work Package

The portion of the Department of Energy mixed waste inventory containing organic materials is difficult to stabilize; therefore, it is preferable to oxidize or destroy the organic materials prior to final treatment for stabilization. The presence of certain non-organic substances in the waste can eliminate incineration as a choice for organic destruction. Incinerators are becoming more complex, difficult and expensive to permit and operate in both the Department of Energy complex and the private sector. These combined technical and policy considerations (that is, the Maximum Achievable Control Technology Rule) drive needs for alternative methods to oxidize organic materials in the waste.

Alternative oxidation technologies are defined as those that have the potential to:

- Destroy organic material without use of open-flame reactions with free gas-phase oxygen as the reaction mechanism.
- Reduce the off gas volume and associated contaminants emitted under normal operating conditions per unit mass of waste fed.
- Reduce the metals, radionuclides, and particulates suspended in the off gas exiting the process.
- Eliminate, or greatly reduce, the dioxin and furan precursors in the primary treatment process, especially in the off gas streams.
- Avoid conditions which allow free chlorine production and allow dioxin and furan precursors to form and to continue to react *de novo* with chlorine to produce dioxins and furans.
- Reduce the potential for excursions in the process that can lead to accidental release of harmful levels of chemical or radioactive materials, and minimize the volume of gaseous emissions that are subject to release during excursions or accident conditions.

This Product Line is developing alternatives to incineration for the destruction of hazardous organic wastes. Alternatives to open-flame, free-oxygen combustion (as exemplified by incinerators) are needed to process combustible wastes for volume reduction, or to meet regulatory requirements at sites that do not have incineration as an acceptable technology.

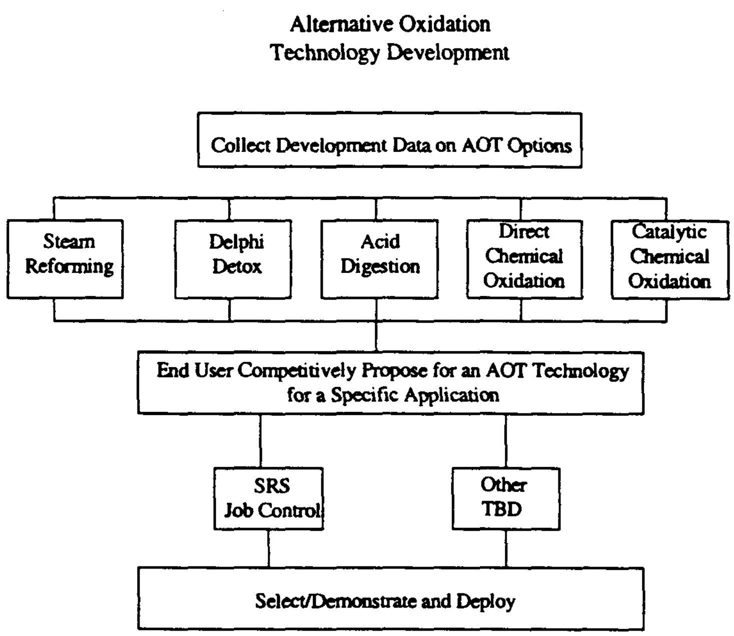
These problem statements have been defined based on the site Technology Coordination Group needs in the following table.

Site Technology Coordination Group Need Number	Site Technology Coordination Group Need Title	Date that Solution Is Needed
AL-07-01-06-MW	Cost Effective Treatment for Low Level Mixed Waste	2000
AL-07-01-10-MW	Proper Treatment of Certain Low Level Mixed Waste Streams	2006
AL-07-06-01-MW	Advanced Methods for Destruction of 1,3,5-Triamino-2,4,6-Trinirobenzene High Explosive	Now
AL-07-06-02-MW	Biological Treatment of Spent Solvents	Now
OK-03	Treatment and Disposal of Tritiated Waste of High Specific Activity	1999
OK-09	Destruction of Mixed Chlorinated Solvents	1999
OR-WM-23	Treatment of Heterogeneous Waste	Now
OR-WM-30	In Situ Destruction of Polychlorinated Biphenyls and Stabilization of Mercury in Soils, Sludges, and Debris	Not provided
RL-MW-05	Remote Treatment of Remote Handled Soils and Other Solid Wastes Contaminated with Organics	2003

RL-MW-06	Treatment of Contact Handled Transuranic Liquid Wastes Contaminated with Polychlorinated Biphenyls and Ignitables	2001
SR-1002	Treatment for Mixed Waste Soils to Immobilize Radionuclides and Resource Conservation and Recovery Act Constituents for Disposal	1999
SR-1007	Treatment of High Activity Transuranic (plutonium-238) Waste for Destruction of Organic Constituents	Now

6.2.4.2 Strategy to Address Problem

The strategy to resolve these stakeholder driven problems involve two areas: solution development and solution deployments. This is illustrated in Figure 6.X.



Solution Development. The Mixed Waste Focus Area has supported several alternative oxidation technologies as either developmental projects, or Quick Wins dedicated to rapid deployment for demonstrating a technology on a small scale while eliminating one or more problematic waste streams. Examples of these technologies include Acid Digestion, Direct Chemical Oxidation, Catalytic Chemical Oxidation, Delphi Detox, and steam reforming. Although the development stage among these selected technologies vary greatly, several candidates are now at a level requiring a significant infusion of capital to attain the next level, namely a semi-scale or full-scale demonstration facility.

Solution Deployment. The strategy to bring one or several of these technologies to deployment at a given site to address a particular need. The deployment strategy is focused on a competitive bid process cosponsored by the Federal Energy Technology Center to select and demonstrate a technology for treating plutonium-238 contaminated debris at the Savannah River Site.

MW-08

6.2.7 Facilitating Deployment for Unique Waste Work Package

Approximately ten to fifteen percent of the Department of Energy's mixed waste inventory cannot be disposed using existing capabilities. The reasons include the nature and concentrations of the hazardous contaminants, presence and concentrations of radioactive isotopes, new or changing requirements, stakeholder concerns with the preferred treatment solutions, and limitations of resources. These waste streams include organic, highly energetic, radioactive sources, and other problematic waste streams. The disposition of these waste streams requires highly specialized solutions, and is not typically being included in the scope of privatized treatment contracts. The low volumes and highly specialized solutions associated with these waste streams have kept them in relatively low priority at most sites. However, taken altogether, these waste streams represent a significant portion of the Department of Energy's mixed waste inventory.

Organic Waste Streams. The organic waste streams include those that are not being addressed in the Alternative Organic Technology demonstrations (plutonium-238 job control waste at Savannah River) and organic waste streams at other sites that cannot be treated using conventional solutions due to regulatory, facility or technical limitations. Examples of these waste streams include combustible organic debris with high chlorine, lead or tritium concentrations that exclude them from treatment in existing Department of Energy incinerators.

Highly Energetic Waste Streams. Highly energetic waste including water reactives (sodium, lithium hydride, NaK), pyrophorics and high explosives exist at several Department of Energy sites. Treatment options are currently not available for these waste streams.

Radioactive Sources. Many radioactive sources no longer have a useful life. For some, the need for the source no longer exists; for others, the source has decayed to the point that it is no longer usable. These sources may be transuranic, non-transuranic alpha emitters, packaged in hydrochloric acid, in liquid form or in solid form.

Problematic Waste Streams. Other miscellaneous problematic waste streams currently do not have disposition options. These include non-defense, non-transuranic alpha contaminated materials (waste that is not acceptable at the Waste Isolation Pilot Plant, but exceeds commercial and Department of Energy facility capabilities), non-compliant materials (tritium waste streams that exceed the acceptance criteria of available commercial and Department of Energy treatment and disposal facilities), small quantity waste streams than cannot be cost effectively treated at commercial facilities, and bulk materials (radioactive batteries, activated lead, large lead pieces, and gas cylinders)

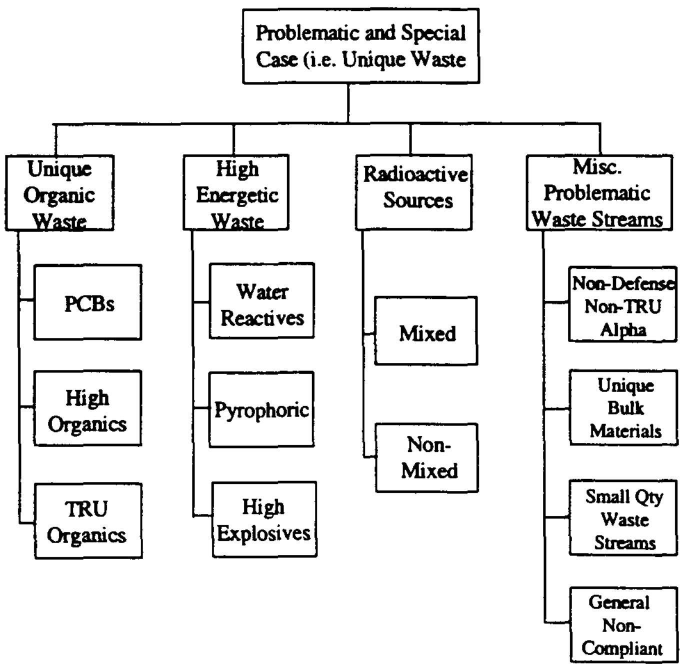
These problem statements have been defined based on the Site Technology Coordination Group needs in the following table.

Site Technology Coordination Group Number	Site Technology Coordination Group Need Title	Date that Solution is Needed
AL-07-01-06-MW	Cost Effective Treatment of Low Level Mixed Waste	2000
AL-07-01-08-MW	Remediation of Compressed Gas Cylinders	2003
AL-07-01-09-MW	Mixed Waste Treatment – Water Reactives	2004
AL-07-01-10-MW	Proper Treatment of Certain Low Level Mixed Waste Streams	2006
AL-07-01-01-SC	High Explosive and Barium Remediation of Soils, Surface Water and Ground Water	2001
AL-07-02-01-MW	Treatment of Classified Inorganic Debris with Toxic Leach Characterization Procedure Metals	2001
AL-07-06-01-MW	Advanced Methods for Destruction of TATB High Explosive	Now
AL-08-06-04-MW	Enzyme Based Method for Destruction of TATB and Tetryl Bulk High Explosive	Now

AL-08-06-05-MW	Catalyzed Electrochemical Oxidation of Organic Waste and Bulk High Explosive	Now
CH-0009	Treatment of Polychlorinated Biphenyl Contaminated Low Level Radioactive Waste	Now
CH-0011	Lead Removal, Segregation and Disposal	Not provided
ID-5.1.01	Develop Disposal Process for Site Specific Disposal Problem Low Level Waste	2003
OH-F008	Tri-Mixed (Radionuclides, Resource Conservation and Recovery Act Materials, Toxic Substances Control Act Materials) Waste Organic Extraction	2000
OH-F033	Treatment of Various Nuclear Materials	Not provided
OH-MD-02	Treatment of Tritiated Pump Oils and Tritiated Mercury	Not provided
OK-12	Process to Decontaminate Lead for Recycle	Now
OR-HG-04	In Situ Mercury Remediation of Soils	2000
OR-WM-07	Removal of Mercury from Mixed Waste	Not provided
OR-WM-30	In Situ Destruction of Polychlorinated Biphenyls and Stabilization of Mercury in Soils, Sludges, and Debris	Not provided
RL-MW-06	Treatment of Contact Handled Transuranic Liquid Wastes Contaminated with Polychlorinated Biphenyls and Ignitables	2002
SR-1006	Large Scale Treatment of Defense Waste Production Facility Mercury	Now

6.2.7.2 Strategy to Address Problem

The strategy to resolve the problems associated with the small quantity, problematic waste streams is based upon logical groupings of the problems: organic waste streams, high energetic waste streams, radioactive sources and problematic waste streams. This is illustrated in Figure 6.X.



Organic Waste Streams: The Focus Area will provide end users with the necessary information to select those technology solutions potentially suited for their organic waste streams. In the past, the Focus Area has used to Quick Win Program to address these waste streams, and eliminate them from the waste inventory. In addition to the Site Technology Coordination Group needs, the Focus Area has used site visits, workshops and teleconferences to collect and clarify the needs associated with these waste streams and to define the requirement sets for the solution. The identification of these waste streams is scheduled to start in FY 1999, with the work continuing through FY 2003.

Highly Energetic Waste Streams, Radioactive Sources, and Problematic Waste Streams: The Focus Area will develop national strategies for each element (including the use of national initiatives, case by case resolution, and multiple site coordination), and establish a National Initiative to address the water reactive wastes. The development of the Highly Energetic Waste Stream Strategy is scheduled to start in FY 1999, with the work continuing through FY 2002. The development of the Radioactive Sources Strategy is scheduled to start in FY 2000, with the work continuing through FY 2002. The development of the Problematic Waste Stream Strategy is scheduled to start in FY 2000, with the work continuing through FY 2004.

Figure 6.X shows the timelines for the resolution of problems associated with each strategy element.

	FY-98	FY-99	FY-00	FY-01	FY-02
Organic Waste		------------	------------	------------	------------
Highly Energetic Waste		------------	------------	------------	---
Radioactive Sources			------------	------------	---
Problematic Waste			------------	------------	------------

6.2.7.3 Solutions to Execute Strategy

The Idaho National Engineering and Environmental Laboratory will start the identification of the organic waste streams, and the development of the Highly Energetic Waste Disposition Strategy in FY 1999. The Technical Task Plans for the Facilitating Deployment for Unique Waste Work Package are summarized in Appendix E.

Tanks Focus Area

Work Package	Work Package Title	*FY 99 Funding (K)	*FY 00 Funding (K)
WT-06-01	Enhanced Immobilization Productivity	$5,325	$4,775

- INEEL has identified a need for evaporator systems to reduce the size and duty of the high activity waste melter and to reduce the volume of low activity liquid waste to be grouted.
  - Excess water increases the volume of low activity liquid waste to be grouted. By removing the excess water by evaporation, the volume of low-level waste will be greatly reduced and the cost of disposal will reduce as well.

Work Package	Work Package Title	*FY 99 Funding (K)	*FY 00 Funding (K)
WT-07-01	Acceptance Criteria and Canister Storage	$5,325	$4,775

- Product quality assurance is a necessary step in the LLW immobilization process. Product quality assurance is well established for HLW glass at SRS DWPF and for LLW saltstone at SRS. LLW glass for Hanford still requires product quality assurance methods and waste form performance testing to allow for LLW disposal preparations and receipt of LLW glass product from privatization vendors.

*** Funding is from the FY 2001 CRB**

Tanks Focus Area (cont.)

Work Package	Work Package Title	*FY 99 Funding (K)	*FY 00 Funding (K)
WT-08-01	Solids Pretreatment	$3,151	$3,807

- Savannah River has identified a need for a modular evaporator system to reduce the volume of liquid waste generated by their Consolidated Incinerator Facility. The CIF generates mixed, low-level, and hazardous wastes.

- Liquid wastes retrieved from storage tanks require clarification (i.e. filtration, centrifugation, decanting) to remove suspended solids such as sludges or precipitates that may interfere with downstream processing.

  - CIF Evaporator will reduce the volume of off gas stabilized waste forms
  - Crossflow Filtration will ensure LLW waste stream will have acceptably low concentrations of insoluble radio isotopes at Hanford.

*** Funding is from the FY 2001 CRB**

Tanks Focus Area (cont.)

Work Package	Work Package Title	*FY 99 Funding (K)	*FY 00 Funding (K)
WT-09-01	Radionuclide Removal	$7,554	$10,585

- Radionuclide removal from tank waste supernate is a primary requirement at all of the DOE waste tank sites because of the impact the have on immobilization decisions.

- Following Pre-treatment operations, supernate and sludge waste streams are transferred to high and low-level waste streams. A processing step is needed to ensure waste streams are acceptable for the immobilization unit.

  – Tanks Focus Area is addressing the need for counter current Flowsheets to remove TRU and strontium and technetium to U.S. Nuclear Regulatory Commission Class A low-level waste.

  – Caustic Recycle can reduce the concentrations of sodium nitrate and sodium hydroxide, thus reducing LLW volume generation.

SEE ATTACHED MATERIALS FOR TFA DETAILS

TFA Back up Material

WT-06-01

Consolidated Incinerator Facility (CIF) Evaporator

Savannah River Site has a need for a modular evaporator system to reduce the volume of liquid waste generated by their Consolidated Incinerator Facility (CIF). The CIF incinerates mixed, low-level, and hazardous wastes. The off-gas treatment system for the CIF generates a high salt, high solids liquid waste stream that is subsequently stabilized in drummed cement waste forms. Reducing the volume of the liquid waste will reduce the volume of the stabilized waste forms. Development of technical specifications for procurement of an evaporator system was initiated in FY98. Testing was conducted to provide input regarding design and operating parameters for the evaporator. Workscope to complete this activity includes

- Complete procurement, fabrication, and delivery of CIF evaporator (FY99, ASTD, TFA, EM-30, OR08SD11, SR08SD10).
- Complete laboratory testing to evaluate volume reduction, composition, partitioning of hazardous components, and foaming (FY99, ASTD, TFA, EM-30, OR08SD11, SR08SD10).
- Install and cold test CIF evaporator (FY00, ASTD, TFA, EM-30).
- Startup and begin operation of CIF evaporator (FY00, ASTD, TFA, EM-30).

Out-of-Tank Evaporator

INEEL has identified a need for evaporator systems to reduce the size and duty of the high-activity waste melter and to reduce the volume of low-activity liquid waste to be grouted. For both LLW and HLW, excess water in the waste can increase waste treatment costs and increase the volume of cementitious waste forms. Volume reduction through evaporation can reduce these costs. TFA work to develop and demonstrate evaporators is described in problem element 1.1.4, "Reduce Waste Volumes."

WT-07-01

Waste Form Product Acceptance Testing

Product quality assurance is a necessary step in the LLW immobilization process. The baseline LLW immobilization technology for INEEL and SRS is grout and saltstone, respectively, while Hanford is pursuing a glass waste form as part of privatization. Grout and glass waste forms are being evaluated for ORR (see problem element 1.2.3.1.3). While product quality assurance is well established for the high-level waste (HLW) glass at SRS's Defense Waste Processing Facility (DWPF), and for the LLW saltstone at SRS, LLW glass for Hanford still requires product quality assurance methods and waste form performance testing to allow for LLW disposal preparations and receipt of LLW glass product from the privatization vendors. Specific needs include

- Reference glass for ILAW: A standard reference material for ILAW applications must be identified for use in inter- and intra-laboratory comparisons between the private contractor and DOE to verify the accuracy of reported results. The identification, development, and qualification of ILAW form reference materials are required. These materials must have appropriate compositions typical of expected ILAW forms so that the reference materials have utility for verifying ILAW compositional and durability specifications and comparing inter- and intra-laboratory test results.

- Product Acceptance Inspection and Test Methods: Under the privatization (phase I) efforts at Hanford, DOE will provide tank wastes to the private contractors who will treat and immobilize the wastes and then return the final products to DOE for storage and final disposal. DOE will pay the private contractors for each waste package received that meets the product specifications. Acceptance of the immobilized wastes will be based on a combination of private contractor activities to qualify, verify, document, and certify the product and DOE activities to audit, review, inspect, and test the processes and products. The DOE may conduct nondestructive testing of the sealed immobilized waste containers and destructive and nondestructive testing of the process and product samples. Specific parameters of interest may include chemical composition of the waste forms, fillers, and containers; phase composition; radiochemical composition; thermal history and surface temperature; waste form volume and void space; waste form and container weight; container dimensions including wall thickness; effectiveness of container closure or seal (leak tightness); presence of prohibited materials including free liquids and explosive, pyrophoric or combustible materials; dose rate; surface contamination; waste form homogeneity; and waste form release rates. Generally, the inspection and test methods should not require opening or otherwise breaching the seal of the waste form containers. Appropriate sampling and analysis strategies need to be developed to provide the basis for making statistically based statements with respect to the confidence with which the products meet specifications. Similarly, ORR has identified a need for nondestructive examination methods for immobilized tank waste destined for the Waste Isolation Pilot Plant (WIPP).

To provide a technical basis for accepting ILAW and immobilized HLW, glass composition regions yielding waste forms meeting the specifications of the privatization contract must be identified and documented. The information will be used as 1) an independent verification of the results of the private contractor's waste form qualification activities, 2) a tool to accept actual ILAW and IHLW based on measured and reported compositions, and 3) a technical basis for product specifications for phase II of the privatization effort.

Work activities to support Hanford's need for ILAW product acceptance will include

- Define need for inspection and testing of ILAW packages based on product acceptance strategy and regulatory and permitting drivers (FY00, EM-30).
- Define acceptable ILAW glass composition region for phase I wastes (FY99-FY00, TFA, EM-30, RL37WT31, SR16WT31).
- Develop and validate reference glass for ILAW and document results of round robin testing (FY99, TFA, CH27WT31).

WT-08-01

Cross-Flow Filtration

The Savannah River Site (SRS) has a decade of experience designing, testing, and operating solid-liquid separation for in-tank precipitation; however, this technology is not directly applicable to all of the solid-liquid separation problems at the four sites. For example, at the Oak Ridge Reservation (ORR), treatability studies indicate that standard clarification/ filtration equipment will not be adequate. Testing of alternative filter systems is required to support the separation of the late wash precipitate at SRS; various liquid low-level waste (LLW) streams at ORR including transuranic (TRU) sludges; and strontium/TRU-bearing retrieval solutions, supernates, and wash solutions for phase I privatization at Hanford. Separation of fine solids and colloidal particles from Hanford supernates is required to ensure that the LLW stream will have acceptably low concentrations of insoluble radioactive material, principally strontium and TRU radioisotopes. At ORR, solid-liquid separation will be needed during the Gunite and Associated Tank retrieval demonstration to treat excess sluice water for disposal, to concentrate tank sludges for feed to a treatment process, or reduce volume of retrieved sludges before transfer to interim storage tanks in the ORR active waste system.

Small-scale, single-element tests with surrogates and selected samples of actual waste indicate that cross-flow filtration should be effective for removing suspended solids from ORR tank waste supernatant liquids. Full-scale testing is needed to evaluate the effectiveness of backpulsing, the cumulative effects of fouling, and the effectiveness of chemical cleaning techniques. The cross-flow filtration system has been designed and is being fabricated. Workscope to complete this activity includes

- Complete installation of cross-flow filtration system (FY99, EM-30, TFA, ASTD, OR16WT41).

- Demonstrate operation of the cross-flow filtration system by treating Melton Valley Storage Tank supernate (FY99, EM-30, TFA, ASTD, OR16WT41).
- Evaluate and document first deployment of cross-flow filtration system at treating Melton Valley Storage Tank (FY99, EM-30, TFA, OR16WT41).

WT-09-01

Caustic Recycle

Pretreated alkaline supernate containing large volumes of sodium nitrate and sodium hydroxide is sent to LLW immobilization processes. Nitrate concentration impacts the volume of LLW, because it is one of the chemical species driving waste form performance requirements. In addition, sodium hydroxide levels increase volume and could be reduced through recycle back to the processing facilities. At the Savannah River Site (SRS), large quantities of chemicals (chiefly sodium salts of nitrate, nitrite, hydroxide, and aluminate) are present in the liquid phase of high-level waste (HLW). Greater than 99.9% of the soluble salts will be disposed in saltstone after removal of radioactive species. Recovery of sodium hydroxide (caustic) from the salt solution could significantly reduce the volume of waste disposed in saltstone. Recycling caustic also reduces the quantity of new chemicals added to the HLW system at the SRS. The recovered caustic could be used to neutralize fresh waste from the separations canyons, Defense Waste Processing Facility (DWPF), and the Effluent Treatment Facility, used as a corrosion inhibitor in the tank farm, and used to dissolve alumina in Extended Sludge Processing.

At Hanford, the volume of tank waste is so large that enormous quantities of immobilized low-activity waste will be generated and require appropriate LLW disposal. By removal of essentially nonradioactive constituents from the waste through innovative chemical processes, the volume of LLW requiring disposal could be significantly reduced. Like SRS, recovery of sodium hydroxide from the Hanford salt solutions and Idaho National Engineering and Environmental Laboratory's sodium-bearing waste could significantly reduce the volume of LLW produced.

Work activities to address SRS and Hanford needs for LLW minimization through caustic or salt recovery will include

- Demonstrate and deploy caustic recovery system for SRS and Hanford LLW minimization.
    - Develop performance requirements for an industry solicitation to develop, demonstrate, and evaluate caustic recovery for DOE applications (FY00, TFA, EM-30).
    - Solicit industry and select vendor for phase I cold demonstration and evaluation (FY00, TFA, EM-30, EM-50 Industry Programs).
    - Complete cold simulant demonstration and evaluate economics for application of caustic recovery to SRS or Hanford LLW streams (FY01, TFA, EM-30, EM-50 Industry Programs). Decision point for demonstration.
    - Initiate phase II fabrication and hot demonstration contract. Construct pilot-scale caustic recovery system (FY02, TFA, EM-30, EM-50 Industry Programs).
    - Demonstrate caustic recovery at SRS or Hanford for LLW minimization. Complete performance evaluation (FY03, TFA, EM-30, EM-50 Industry Programs). Decision point for implementation.

Transuranic Extraction (TRUEX), Strontium Extraction (SREX), Technetium for Idaho Pretreatment

The TFA has supported the processing of tank waste by demonstrating the satisfactory removal of TRUs in FY96 and strontium and technetium in FY97. The successful removal of cesium from dissolved calcine solutions was demonstrated in FY98. Due to a shift in the emphasis of the separation processes to the dissolved calcine solutions, countercurrent flowsheets are needed to remove TRUs and strontium and technetium to U.S. Nuclear Regulatory Commission Class A low-level waste (LLW) levels. The successful flowsheets demonstrated with tank waste will form the basis for flowsheet development with dissolved calcine; however, the chemistry of the dissolved calcine is significantly different from the tank waste (higher zirconium, calcium, and fluorine). The countercurrent flowsheets are needed so that feed compositions to downstream unit operations in the Idaho National Engineering and Environmental Laboratory (INEEL) processing scheme (vitrification, grout, and denitration) can be determined.

These flowsheets will form the basis for all waste immobilization development activities and will be used to determine sequencing of unit operations for integrated testing.

Cesium, strontium, and TRUs comprise less than one percent of the total INEEL radioactive waste volume. If these elements can be removed from the bulk (inert) elements in the waste, a significant reduction in the volume of high-level waste (HLW) would be realized.

Workscope to support INEEL radionuclide separations from dissolved calcines includes

- Develop countercurrent TRUEX and SREX flowsheets for removal of TRUs, strontium, and technetium from dissolved INEEL calcine (FY01, TFA, ESP, EM-30).
- Demonstrate TRUEX and SREX flowsheets with actual dissolved calcine (FY01, TFA, ESP, EM-30).
- Develop integrated process flowsheet to remove TRUs, strontium, technetium, and cesium from dissolved calcine (FY01, TFA, ESP, EM-30).
- Demonstrate integrated process flowsheet with actual dissolved calcine (FY02, TFA, ESP, EM-30).

In addition, the Efficient Separations and Processing Crosscutting Program (ESP) is funding work to support INEEL's need including bench-scale testing of separation technologies for INEEL; development and testing of spheroidal, inorganic sorbents; and chemical separations work at Russia's Institute of Physical Chemistry and Khlopin Radium Institute.

Cross Cuts

- ESP- Treatment of PCB contaminated LLW at Chicago
- INDP- Segregation of TRU and LLW will reduce the amount of TRU waste required for repackaging (working with DDFA)
- Assisting in reducing the volume of immobilized LLW and HLW can be reduced by a better pretreatment system. (working with TFA)

SEE ATTACHED MATERIALS FOR CROSS CUTDETAILS

Crosscuts Back up material

IP4 Pretreatment to Reduce Volume of HLW and LLW Waste Forms at SRS, Idaho, Hanford, and Oak Ridge

Significant cost reductions for disposing of immobilized waste can be achieved by improving the pretreatment processes so that fewer HLW canisters and less volume of low activity waste results. Also required are processing and/or concentration methods for waste tank processing streams. Waste stored in tanks at Hanford , Oak Ridge, Idaho, and Savannah River must be retrieved and treated for proper disposal to support EM Accelerating Cleanup: Paths to Closure plan schedules and tank closure activities.

Savannah River Site has a need for a modular evaporator system to reduce the volume of liquid waste generated by their Consolidated Incinerator Facility (CIF). The CIF incinerates mixed, low-level, and hazardous wastes. The off-gas treatment system for the CIF generates a high salt, high solids liquid waste stream that is subsequently stabilized in drummed cement waste forms. Reducing the volume of the liquid waste will reduce the volume of the stabilized waste forms

Projects include:

- Liquid Membrane System for TRU Waste (277)
- CIF Evaporator
- Development of Chlorine and Sulfur Scrubbers for the GTS Duratek System (UNDEERC)
- Adapt Existing Laser Based System to Fulfill the Need for Monitoring the Low-level Fraction of HLW after Dissolution and Partitioning (DIAL)
- A nested array, multi-point, fixed-depth sampling system (AEA)
- Confirmation and improvement of thermodynamic predications of waste solubility and reaction kinetics to support processing and transfer operations (AEA/University)

IP14 Alternative Paths to Salt Waste Treatment at SRS

An alternative process for treating DWPF recycle streams. As part of sludge vitrification operations at the DWPF, for each gallon of sludge vitrified, SRS produces approximately seven gallons of aqueous waste that must be recycled to the tank farms for reprocessing. Removal of dilute concentrations of cesium, solids, and mercury from this stream would allow it to be processed through the site's water treatment plants for release through a National Pollutant Discharge Elimination System permitted outfall rather than being recycled through the DWPF system. There is no baseline technology for treating this stream; it is simply added back to the tanks for storage and eventual reprocessing.

Projects include:

- CSTs for DWPF Recycle Streams
- Countercurrent Decantation for Improved SRS Sludge Processing
- Caustic or Salt Recover Systems
- Evaluate Data on the Dissolution of Hanford Saltcake to Validate the Computer Code used to Predict Saltcake and to Establish the Behavior of Salts under Various Processing Conditions (DIAL)
- Parametric Investigation of Waste Glass Pouring Process (FIU)

IP5 TRU Contaminated Materials and Waste Disposition

Across the DOE weapons complex, there are a large number of surplus Pu contaminated gloveboxes. This work package will demonstrate and deploy cost-effective technologies for characterization of contaminated surfaces, segregation (TRU vs. LLW) and packaging of TRU contaminated waste through LSDDP #4 at LANL. This will minimize the amount of glovebox material requiring disposal as TRU waste. LANL currently has 2, 400 cubic meters (m^3) of oversized metallic TRU waste in storage and expects to generate another 3,000 cm from ongoing waste management operations in coming years (starting in FY2000). Much of the waste is currently stored in fiberglass reinforced plywood boxes that do not meet WIPP's Waste Acceptance Criteria. In order to limit the amount of waste classified as TRU, which will ultimately be sent to WIPP, these 2,400 m^3 need to be characterized, sorted and segregated into TRU and LLW. In addition, this waste must be repackaged in containers which meet the WIPP acceptance criteria. It is anticipated that the LSDDP will reduce TRU volume by greater than 75 percent.

Projects include:

- Alpha Continuous Emissions Monitor (2225)
- Initial characterization of the boxed waste containing TRU mixed waste.
- Characterization for in-process measurements to lactate contamination.
- Hot spot characterization before decontamination.
- In-process characterization systems to <100 nCi/gm TRU size reduction equipment.
- Final characterization of waste for the certification of the equipment.
- Criticality Monitors
- Decontamination of Pu glove boxes for reuse.
- Remote decontamination of TRU metal waste emphasizing no or low secondary waste.
- Final decontamination of large equipment (baler/shear) after use.
- Robotics technology for initial box opening and decontamination.
- Decontamination of fluid treatment.
- Remote size reduction technologies for Pu glove boxes.
- Removal of external lead shielding.
- Size reduction/packaging of removed materials.
- Removal of legs and other appendages prior to decon and shearing.
- Techniques for opening of fiberglass/plywood boxes and removing of packing materials.
- Opening of the glove boxes for removal of any remaining equipment or contaminated waste.
- TRU waste packing volume reduction technologies for disposal (baseline baler compactor of TRU waste).
- Removal of gloves and windows.
- Non-metallic waste removal/packaging/treatment.
- Liquid wastes (from glove boxes) removal/packaging/treatment.
- Material movement technologies in DVRS.
- Technologies to account/track plutonium contamination on glove boxes.
- Metal melting/recycle technologies.
- Personal protective equipment that improve worker efficiencies (does not include primary outer personal protective equipment).
- Shielding technologies.
- Air handling and air monitoring systems.
- Advanced record keeping and data management systems including project documentation
- Systems Engineering (UNDERRC)
- Material Characterization Model (UNDEERC)
- Pipe Cleaning using Sonic Pulses (DIAL)
- Wall Removal Techniques (DIAL)

Office of Science and Technology
Work Packages Addressing Low-level Waste

Skip Chamberlain

8/12/99

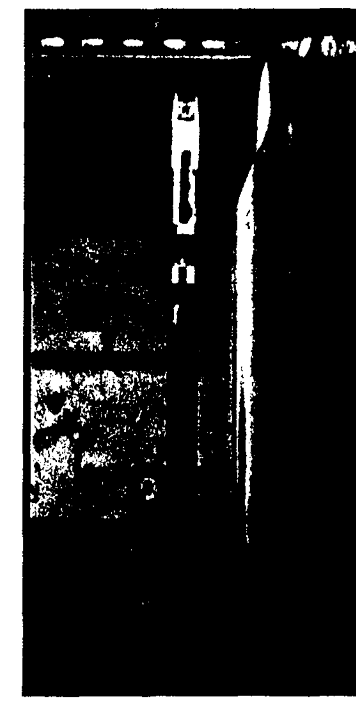
Tanks Focus Area

WT-07-01 Product Acceptance Criteria & Canister Storage

IPL Rank # 6

Problems Being Addressed:

- Low activity waste form product specifications, and acceptance criteria and test methods are required at Hanford, INEEL and ORR.
- Improved decontamination methods are required for HLW storage canisters at SRS and West Valley to reduce costs and enable transport.
- LAW conditioning methods and immobilization methods must be developed for INEEL.



Technological Solutions:

- Grout immobilization technology with preconditioning for INEEL.
- ILAW glass composition performance testing for Hanford.
- Procurement of an improved canister decontamination process.

Impacts/Benefits:

- Enable INEEL Title I Design for LAW immobilization.
- Reduce risk & cost of ILAW acceptance & disposal for Hanford & ORR.
- Reduce costs of HLW processing.

AL	CH	ID	NV	Oakland	Ohio	OR	Paducah	Portsmouth	RFETS	RL	SRS
											x

Mixed Waste Focus Area
MW 01 Nondestructive Characterization for Treatment, Transportation, and Disposal of MLL and MTRU Waste

Problems Being Addressed:

IPL Rank # 13

Contact Handled

- Technologies to characterize the radionuclide components in boxed waste destined for disposal at the WIPP or other Subtitle C facilities is currently limited. NDA technologies are needed for Standard Waste Boxes (SWBs) and larger crates.

RCRA

- Characterization costs and potential impacts resulting from the proposed MACT standard associated with operators at the TSCA, CIF, and WERF can be reduced by utilizing nondestructive characterization techniques to identify and quantify RCRA metals.

Remote Handled

- Technologies to characterize RH-TRU waste for disposal at WIPP and to support waste segregation into LLW and TRU components, to minimize RH volume impacts on WIPP, is currently limited. Improved radionuclide NDA characterization techniques are needed to support these activities. Mobile RH NDA characterization methods are needed to support elimination of waste from small quantity generator sites.

Technological Solutions:

Contact Handled & RCRA

Technical execution of all FY 2001 activities are under the direction of CMST

Radionuclide Characterization in CH Waste

- Develop and deploy advanced neutron and gamma systems to address the characterization boxed wastes.

RCRA Metals

- Demonstrate the measurement of RCRA metals in debris and sludge wastes.
- Initiate basic research in enhanced RCRA hazardous materials measurement systems.

Remote Handled Waste

Radionuclide Characterization in RH Wastes

- Develop and demonstrate solutions to meet WIPP RH waste assay requirements.

Non-Destructive Waste Assay Using Combined Thermal Epithermal Neutron Interrogation

Impacts/Benefits:

- Capability to characterize wastes to meet WIPP requirements.
- Reduced cost associated with characterization required to meet treatment facility waste acceptance criteria.

AL	CH	ID	NV	Oakland	Ohio	OR	Paducah	Portsmouth	RFETS	RL	SRS
		x									x

Mixed Waste Focus Area

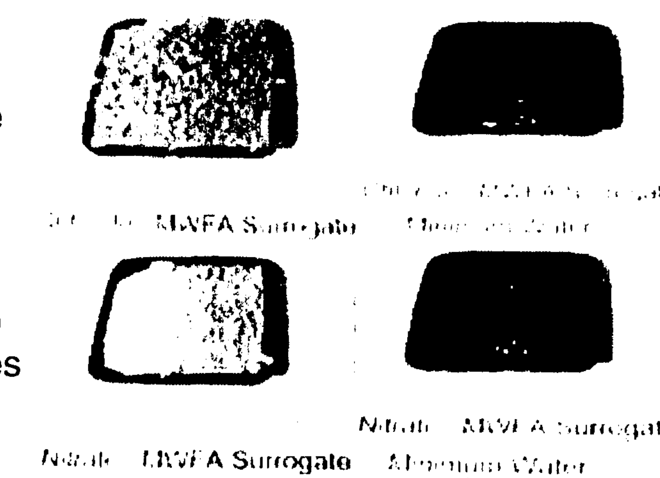
MW 08 Facilitating Deployment for Unique Waste

Problems Being Addressed: IPL Rank # 14

Unique Waste Stream Disposition

- An estimated 10% of the DOE mixed waste inventory cannot be dispositioned due to various logistical, regulatory and technical reasons.
- Waste stream quantities and perceived risk are relatively low, resulting in historically low priority at the sites, but will become critical path if not resolved.
- Almost 15% of the STCG needs assigned to the MWFA are not being addressed by any of the defined Work Package categories.
- Mound, LANL, SRS, LLNL, LBNL, and other DOE sites collectively have several hundred grams of tritium in organic and aqueous waste streams. This represents millions of curies of tritium. Alternative processing could cost-effectively eliminate the need for RCRA permitted storage.

Salt and Ash Stabilization-Stabilized High Salt Content Waste Using Cementitious Process



Mercury Waste Treatment

- The EPA-specified treatment for radioactive elemental mercury is amalgamation to stabilize the mercury for disposal. Cost-effective amalgamation technologies are not readily available.
- Mercury (Hg) contamination is one of DOE's highest priorities. The presence of Hg, because it is highly mobile and easily vaporized, complicates the design of off-gas systems, stabilization of treatment residues, and monitoring of all effluents. Technologies for the separation of mercury from mixed waste are not readily available.

Mixed Waste Focus Area

MW 08 Facilitating Deployment for Unique Waste (Cont.)

IPL Rank # 14

Problems Being Addressed: (cont.)

- Treatment method for Hg waste containing greater than 260 ppm Hg is roasting/retort. For many mixed wastes retorting is unacceptable because of the radionuclides or other co-contaminants and retorted residues must be stabilized. Data are needed to demonstrate that wastes with higher levels of mercury wastes can be safely stabilized.

Salt and Ash Stabilization

- Fly ash and salts from thermal processes are difficult to stabilize due to physical and chemical characteristics

Technological Solutions:

Unique Waste Stream Disposition

- Work with LLW/MLLW Center of Excellence and PAIT to identify a comprehensive inventory of unique wastes and develop resolution strategies for specific subcategories of unique waste streams.
- Issue three RFPs to industry to initiate resolution strategies and address specific unique waste subcategories.
- Complete FY 2000 issued RFPs that address specific unique waste subcategories.
- Work with Center of Excellence, PAIT, and DOE-HQ to develop strategies for addressing selected institutional issues.
- Issue a RFP to the DOE sites to identify near-term deployment opportunities.
- Identify and document potential basic and applied research activities associated with identified STCG needs.

Mercury Waste Treatment

- Coordination of a National Mercury Amalgamation Treatment Initiative. Deploy technologies through readily-accessible treatment contracts to cost-effectively treat the wastes of small-quantity generators.
- Deploy Hg separation processes to eliminate the Hg constituent in the treatment and disposal of a waste matrix.

Salt Stabilization

- MWFA has demonstrated numerous low-temperature stabilization technologies for salt containing mixed waste. Technologies involving enhanced ceramics, concretes, polycerams, and polymers. Continue to:
  - support end-user needs in the form of treatability studies as is required to support deployment of solutions ready for implementation.
  - support specific needs as they relate to the macroencapsulation of unique waste streams.

Mixed Waste Focus Area

MW 08 Facilitating Deployment for Unique Waste (Cont.)

IPL Rank # 14

Impacts/Benefits:

Unique Waste Stream Disposition

- LANL will be able to disposition their entire mixed waste inventory. LANL has identified 15% of their mixed waste that does not have a disposition.

Mercury

- Remove mercury from otherwise incinerable waste streams that have no treatment path. Deploy in FY 2001.
- Reduce extreme costs of mercury waste treatment ($75K-100K/drum) through deployment of competing technologies and coordinated use of national contracts.
- Support changes to EPA regulations to allow cost-effective treatment of DOE waste.

Salt and Ash Stabilization

- Advanced stabilization solutions reduce treatment and disposal costs and ensure waste form compliance.

AL	CH	ID	NV	Oakland	Ohio	OR	Paducah	Portsmouth	RFETS	RL	SRS
						x					

Mixed Waste Focus Area

MW 03 Handling Mixed Waste Contaminated Materials During Characterization, Treatment, Packaging, and Disposal

IPL Rank # 19

Problems Being Addressed:

- Transportation and disposal of high activity TRU waste requires repackaging to meet applicable requirements. Size reduction and packaging techniques are needed to support disposal and segregation of RH TRU and LLW wastes. Due to the hazard associated with these wastes, advanced remote handling systems are needed to improve efficiency and safety of the operations.

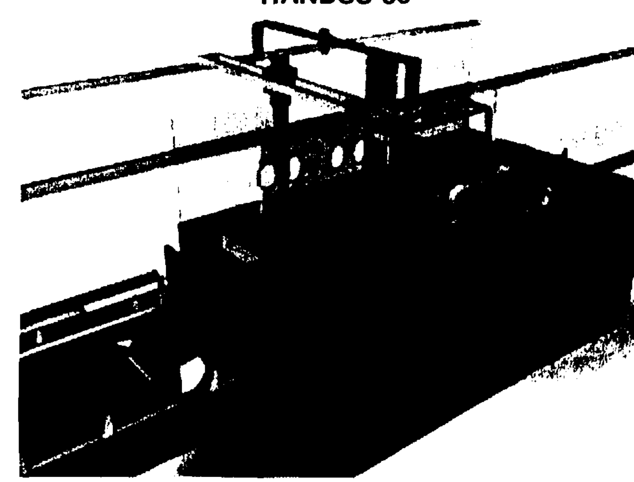
Technological Solutions:

- Deploy repackaging system components at SRS to verify and prepare drummed waste for transfer to WIPP. This system opens drums and liners, gains access to contents, removes non-compliant items and repackage waste to meet WIPP acceptance criteria. This is a collaborative effort with RBX and EM-30 at SRS.
- Initiate the design of the repackaging technology developed for SRS, and adapt it to a mobile format for use at small generator sites (Mound and Battelle Columbus) to prepare waste for transfer to WIPP.
- Initiate the design and development of robust sizing technology for use at Hanford to allow reduction in the final volume of TRU waste to be disposed of at WIPP by segregating TRU from LLW. This will be a collaborative effort with RBX and Industry Programs through FETC.

Impacts/Benefits:

- SRS will meet its 2002 Site Treatment Plan date for preparing waste for WIPP.
- A repackaging system for RH waste will be available to small generator sites, resulting in a significant cost savings over the building of individual facilities at each site.
- Retrieval of Hanford wastes from the concrete caissons and compliance with commitments in its Tri-Party Agreement will be possible.
- Remote segregation of LLW from TRU allows for the most cost efficient use of the strategic space available at WIPP.

HANDSS-55



AL	CH	ID	NV	Oakland	Ohio	OR	Paducah	Portsmouth	RFETS	RL	SRS
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Subsurface Contaminants Focus Area

SS-06-99 Biological Treatment Systems

IPL Rank # 37

Problems Being Addressed:

- Low to moderate concentrations of organic solvents, fuels and reactive compounds (explosives) are common in the soil and groundwater and in leaking buried waste at many DOE sites. Biological treatment can effectively remediate these low to moderate concentrations of contaminants.

Phytoremediation

Technological Solutions:

- Composting of high explosives in soils.
- Tritium removal using plant evapotranspiration.
- Enhanced Natural Attenuation Study in Poland.

Impacts/Benefits:

- Expensive and ineffective pump and treat or excavation will remain the baseline for remediation of low to moderate concentrations of organics and explosives in soil and groundwater. Biological treatment and Monitored Natural Attenuation can provide effective and low cost in-situ remediation of these contaminants.

AL	CH	ID	NV	Oakland	Ohio	OR	Paducah	Portsmouth	RFETS	RL	SRS
	x	x									

Subsurface Contaminants Focus Area

AR-SS-08 Saturated Zone Contaminant Transport and Destruction

Core WP IPL # 22

Problems Being Addressed:

- Current ability to understand and model metal and radionuclide transport must be improved by understanding of speciation in natural settings, and of colloid formation and transport.
- DNAPL removal by pump-and-treat is recognized as a control measure in many cases and improved DNAPL removal and destruction methods are needed.

Technological Solutions:

- Novel release and destruction methods for DNAPLs.
- Application of new understanding of transport mechanisms to control contaminant transport.

Impacts/Benefits:

Large metal, rad, and organic plumes are difficult to treat for a number of reasons including limited understanding of the mechanisms controlling contaminant distribution and movement. The better we understand these, the more effective remediation can be.

AL	CH	ID	NV	Oakland	Ohio	OR	Paducah	Portsmouth	RFETS	RL	SRS

Subsurface Contaminants Focus Area

S-SS-10 Fundamental Improvements to Soil Clean-up and Segregation Technology

Core WP IPL # 32

Problems Being Addressed:

Fundamental improvements to soil clean-up and segregation technology are key to limiting the volume of soil that must be excavated and stored in permitted waste facilities. The most difficult problems are generally related to plutonium and uranium finely dispersed at weapons test areas.

Technological Solutions:

- Research on chemical/radiological sensor-based systems to allow screening and segregation of contaminated and clean materials.
- Continued development of geostatistics-based remediation protocols to optimize clean-up.

Impacts/Benefits:

Identification and removal or treatment of contaminated soil is invasive and uses precious permitted disposal facility space. Improved methods to identify and dispose of only the material that is truly contaminated will reduce disposal costs and long-term monitoring costs.

Subsurface Contaminant Focus Area

SS-01-99 Subsurface Characterization, Monitoring, Modeling, and Analysis

IPL Rank # 7

Problems Being Addressed:

- Significant technology gaps limit our ability to understand the inventory, distribution, and movement of contaminants in the vadose and saturated zones.

Technological Solutions:

- Improved Analytical Tools.
- Improved In-Situ monitoring devices.
- Prediction and flow modeling tools.
- Improved understanding of permeability patterns.

Innovative DNAPL Characterization Technology: Hydrophobic Flexible Membrane by FLUTe

Impacts/Benefits:

- Lack of knowledge of the location of contaminants will significantly increase remediation costs and schedules. More precise knowledge of the location and distribution of contaminants allows more effective targeting of remediation technologies to reach desired and acceptable end-states. Greater remediation technology efficiency (in terms of schedule and location) directly influences remediation and O&M costs.

AL	CH	ID	NV	Oakland	Ohio	OR	Paducah	Portsmouth	RFETS	RL	SRS
			x			x				x	x

Mixed Waste Focus Area
MW 01 Nondestructive Characterization for Treatment, Transportation, and Disposal of MLL and MTRU Waste

Problems Being Addressed:

IPL Rank # 13

Contact Handled

- Technologies to characterize the radionuclide components in boxed waste destined for disposal at the WIPP or other Subtitle C facilities is currently limited. NDA technologies are needed for Standard Waste Boxes (SWBs) and larger crates.

RCRA

- Characterization costs and potential impacts resulting from the proposed MACT standard associated with operators at the TSCA, CIF, and WERF can be reduced by utilizing nondestructive characterization techniques to identify and quantify RCRA metals.

Remote Handled

- Technologies to characterize RH-TRU waste for disposal at WIPP and to support waste segregation into LLW and TRU components, to minimize RH volume impacts on WIPP, is currently limited. Improved radionuclide NDA characterization techniques are needed to support these activities. Mobile RH NDA characterization methods are needed to support elimination of waste from small quantity generator sites.

Technological Solutions:

Contact Handled & RCRA

Technical execution of all FY 2001 activities are under the direction of CMST

Radionuclide Characterization in CH Waste

- Develop and deploy advanced neutron and gamma systems to address the characterization boxed wastes.

RCRA Metals

- Demonstrate the measurement of RCRA metals in debris and sludge wastes.
- Initiate basic research in enhanced RCRA hazardous materials measurement systems.

Remote Handled Waste

Radionuclide Characterization in RH Wastes

- Develop and demonstrate solutions to meet WIPP RH waste assay requirements.

Impacts/Benefits:

- Capability to characterize wastes to meet WIPP requirements.
- Reduced cost associated with characterization required to meet treatment facility waste acceptance criteria.

Non-Destructive Waste Assay Using Combined Thermal Epithermal Neutron Interrogation

AL	CH	ID	NV	Oakland	Ohio	OR	Paducah	Portsmouth	RFETS	RL	SRS
		x									x

Mixed Waste Focus Area

MW 08 Facilitating Deployment for Unique Waste

IPL Rank # 14

Problems Being Addressed:

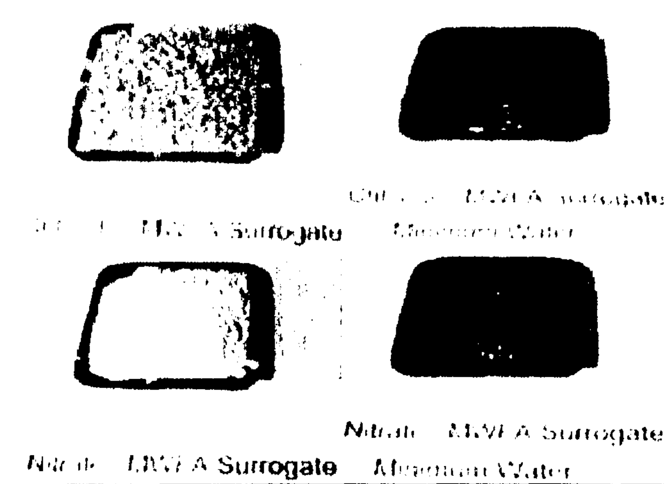
Unique Waste Stream Disposition

- An estimated 10% of the DOE mixed waste inventory cannot be dispositioned due to various logistical, regulatory and technical reasons.
- Waste stream quantities and perceived risk are relatively low, resulting in historically low priority at the sites, but will become critical path if not resolved.
- Almost 15% of the STCG needs assigned to the MWFA are not being addressed by any of the defined Work Package categories.
- Mound, LANL, SRS, LLNL, LBNL, and other DOE sites collectively have several hundred grams of tritium in organic and aqueous waste streams. This represents millions of curies of tritium. Alternative processing could cost-effectively eliminate the need for RCRA permitted storage.

Mercury Waste Treatment

- The EPA-specified treatment for radioactive elemental mercury is amalgamation to stabilize the mercury for disposal. Cost-effective amalgamation technologies are not readily available.
- Mercury (Hg) contamination is one of DOE's highest priorities. The presence of Hg, because it is highly mobile and easily vaporized, complicates the design of off-gas systems, stabilization of treatment residues, and monitoring of all effluents. Technologies for the separation of mercury from mixed waste are not readily available.

Salt and Ash Stabilization-Stabilized High Salt Content Waste Using Cementitious Process



Subsurface Contaminants Focus Area
SS-11-99 Validation, Verification and Long-Term Monitoring of Containment and Treatment

IPL Rank # 15

Problems Being Addressed:

- Methods that validate the performance of treatment and containment systems are required to gain regulator and stakeholder acceptance. Long term monitoring is a major cost of remedial actions.

Technological Solutions:

- Tools to predict the long term performance of landfill cover designs
- Non invasive sampling tools to provide real time verification

Rocky Flats Barrier

Impacts/Benefits:

- Extensive sampling and laboratory analysis will be required to demonstrate system performance. Validation will increase regulatory and stakeholder acceptance of new technologies and verification will demonstrate the effectiveness of treatment systems and containment barriers. The reliability of long term monitoring systems will be demonstrated.

AL	CH	ID	NV	Oakland	Ohio	OR	Paducah	Portsmouth	RFETS	RL	SRS
x										x	

Mixed Waste Focus Area

MW 05 Payload Enhancement for Transporting TRU Waste within Restrictive Regulatory Limits

Problems Being Addressed: IPL Rank # 20

Hydrogen gas generation and accumulation due to alpha radiolysis of hydrogenous waste and packaging materials, and the potential for explosion during transport, places restrictive limits and conditions on the CH- and RH-TRU waste shipped in the TRUPACT-II and 72B casks. Hydrogen gas generation potential is increased with high activity (e.g. Pu-238) waste. Hydrogen gas generation associated with RH waste is additionally complicated due to the presence of fission products and the resulting high gamma radiation. Additional TRU waste problems identified from the Site TRU Waste Management Programs and Carlsbad must be addressed.

Technological Solutions:

- Evaluate and deploy solutions, such as, improved H_2 getters, filters, techniques to reduce inner layers of confinement, and alternative packaging materials to minimize buildup of hydrogen gas during transportation.
- Evaluate effects of gamma radiation on hydrogen matrix depletion as it applies to the RH TRU transportation needs.
- Deploy Matrix Depletion and gas-generation studies through future SARP.

Payload Enhancement for Transporting TRU Waste

Impacts/Benefits:

- Expand the shipping envelope for the TRUPACT-II and the 72B shipping containers.
- Reduce costs by minimizing the number of drums and boxes which must be treated and/or repackaged to meet shipping requirements.
- Repackaging of 312 drums containing Pu-238 at LANL would have resulted in 4408 drums for WIPP disposal.

AL	CH	ID	NV	Oakland	Ohio	OR	Paducah	Portsmouth	RFETS	RL	SRS
		X									

Subsurface Contaminants Focus Area

SS-08-99 Saturated Zone Treatment Systems

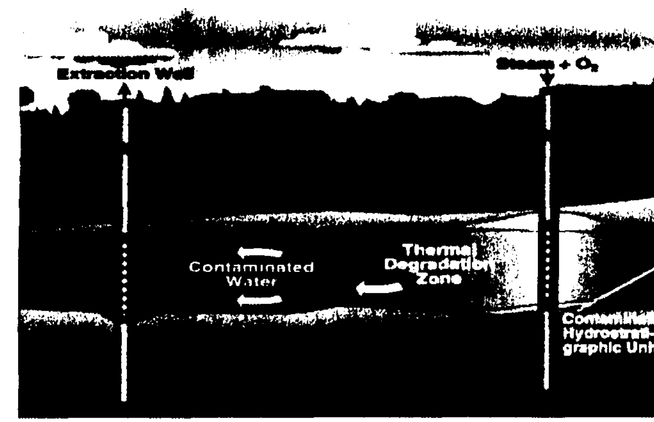
IPL Rank # 22

Problems Being Addressed:

- Dispersed contaminants in the saturated zone are a continuing remediation problem for AL, CH, ID, OAK, OR, RF, RL, and SR. Treatment methods are needed for in-situ treatment of both source and dispersed contamination.

Technological Solutions:

- Surfactant enhanced remediation for DNAPLs.
- In-situ chemical oxidation techniques.
- Hydrous Pyrolysis treatment.



Hydrous Pyrolysis/Oxidation

Impacts/Benefits:

- Long-term pump and treat will continue as the baseline treatment technology. Each gallon of DNAPL destroyed by an in-situ method reduces the pump and treat volume by 300 million gallons, assuming that drinking water standards are the ultimate remediation goal. Recovery or destruction of the source term will also benefit the SRS A/M Area and Solvent Storage Facility remediation duration.

AL	CH	ID	NV	Oakland	Ohio	OR	Paducah	Portsmouth	RFETS	RL	SRS
		x						x			

Subsurface Contaminants Focus Area

SS-04-99 Long-Lived Caps

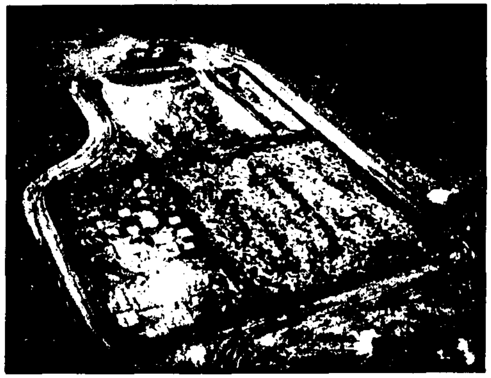
IPL Rank # 26

Problems Being Addressed:

- DOE waste sites must be isolated from the environment for an extended period of time. Systems must provide robust waste isolation over a range of climatic conditions and events' Current RCRA cap design life is 30 years.

Technological Solutions:

- Long-lived cover design manual.
- Evaluation of plant intrusion into alternate cover designs.
- Install long-term cover design at RFETS.



Alternative Landfill Cover Design

Impacts/Benefits:

- RFETS will not meet FY 2006 Site Closure milestone.
- Landfills at AL, NV, OR, RF, RL, and SR could apply.
- An improved alternative cover with improved design life and reduced cost verses the baseline 30-year RCRA cover which will require replacement every 30 years.

AL	CH	ID	NV	Oakland	Ohio	OR	Paducah	Portsmouth	RFETS	RL	SRS
			x						x	x	

Mixed Waste Focus Area

MW 07 Alternatives to Incineration to Reduce Emission Hazards

IPL Rank # 27

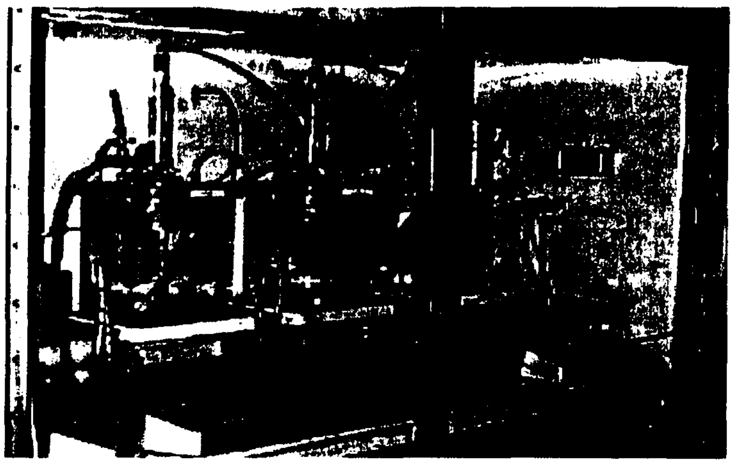
Problems Being Addressed:

- Incineration alternative technologies for the destruction of organic based mixed wastes are required for the following waste streams: a) organic TRU wastes, since TRU materials are not effectively incinerated and alpha radiolysis creates hydrogen gas, which is unacceptable for WIPP shipment or storage, and b) mixed waste containing volatiles, such as, mercury or tritium.
- Alternative oxidation technologies (AOT) are also required because of stakeholder concerns with respect to incinerator off-gas emissions and the exclusive and limited availability of the existing DOE incinerators.

Technological Solutions:

- AOTs are non-thermal and non-flame thermal processes that oxidize organic waste under significantly different physical and chemical conditions than incineration.
  - They operate at low temperatures, produce no toxic off-gas constituents nor discharge hazardous emissions to the atmosphere.
  - MWFA has sponsored development on six alternative oxidation technologies, four of which rely on wet chemical oxidation methods.
- Continued AOT advancement to deployment will involve:
  - MWFA /FETC will issue an AOT RFI/RFP to both the private sector and DOE National Laboratories to demonstrate solutions for treatment of SRS Pu-238 Job Control waste.
  - Demonstrate AOT solutions - technology "bake-offs" demonstrations.

Direct Chemical Oxidation



Impacts/Benefits:

- Benefits to DOE complex:
  - Less off-gas, less emission of hazardous substances
  - No dioxin formation
  - Ability to destroy organics containing mercury and tritium
  - AOTs will provide a pathway to ship to WIPP, TRU waste streams that prior to treatment contained organics
  - AOTs will ensure that small sites meet treatment deadlines for waste streams that cannot presently be shipped to existing DOE incinerators.

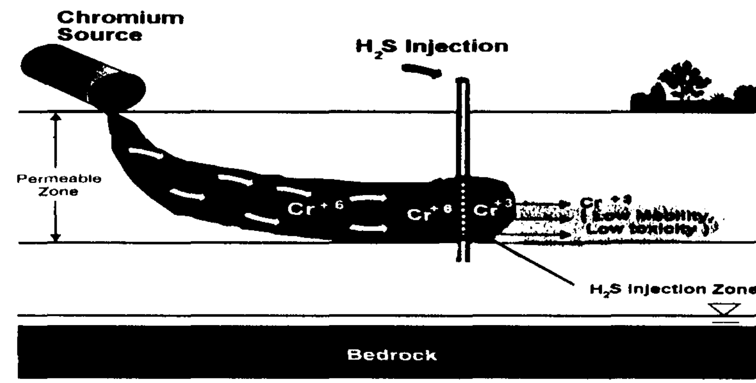
Subsurface Contaminants Focus Area

SS-07-99 Vadose Zone Treatment Systems

IPL Rank # 29

Problems Being Addressed:

- Conventional technologies to remediate metals, radionuclides explosive residues, DNAPLs and solvents in the vadose zone are costly, time consuming and generate significant secondary waste such as excavated soil.



In-Situ Gaseous Reduction

Technological Solutions:

- Vadose zone monitoring system at SRS in FY 1999 .
- Demonstrate barometric pumping with a twist at INEEL in FY 1999.
- Complete remediation of uranium contaminated soils at LANL in FY 2000.
- Demonstrate treatment of DNAPLs in low permeability media at Portsmouth in FY 2000.
- In-situ chemical treatment of soils by gaseous reduction at Hanford in FY 2000.

Impacts/Benefits:

- Hanford will not be able to treat the chromate plume at the 100-D and 100-H areas and the Sr plume at the 100-N area. The Vadose Zone Research and Development Study will provide a catalog of remediation methods to be applied at arid sites. Costs for in-situ treatment will be lower than excavate and dispose expenditures.

AL	CH	ID	NV	Oakland	Ohio	OR	Paducah	Portsmouth	RFETS	RL	SRS
		x	x			x				x	

Subsurface Contaminants Focus Area

SS-05-99 In-Situ Reactive Treatment Barriers

IPL Rank # 31

Problems Being Addressed:

- Remediation or control of dispersed contaminant plumes by pump and treat is ineffective, expensive, and produces significant secondary waste. Reactive Treatment Barriers (RTBs) allow the effective remediation of dispersed-contaminant plumes containing VOCs, DNAPLs, heavy metals, or radionuclides.

Technological Solutions:

- Reactive Treatment Barriers which utilize a variety of reactive media. Two types of barriers are available to intercept and treat dispersed contaminant plumes; Funnel and Gate; and Reactive trench designs.
- Development of improved treatment media material.

Envirowall

Impacts/Benefits:

- Ineffective and costly pump and treat will remain the baseline.
- RTBs minimize maintenance and operational costs; can be used at seeps and springs, and can be used where low permeability inhibits pumping. RTBs generate little or no secondary waste.

AL	CH	ID	NV	Oakland	Ohio	OR	Paducah	Portsmouth	RFETS	RL	SRS
						x					

Subsurface Contaminants Focus Area

SS-03-99 Stabilization Technologies

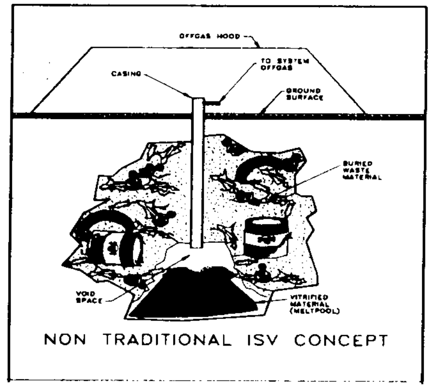
IPL Rank # 34

Problems Being Addressed:

- Unstable buried wastes continue to leach and contribute to increased spread of contaminants in the vadose and saturated zones. Subsidence of waste zones due to waste degradation compounds this problem by focusing infiltration of precipitation through the waste, resulting in contaminant migration to aquifers.

Technological Solutions:

- In-situ vitrification (bottoms up) demonstration at LANL.
- In-situ chemical stabilization technologies.



In-situ Vitrification

Impacts/Benefits:

- Will require continuation of baseline excavation and redisposal.
- In-situ stabilization reduces worker exposure risks and provides a cost-effective alternative to excavation.

AL	CH	ID	NV	Oakland	Ohio	OR	Paducah	Portsmouth	RFETS	RL	SRS
x						x					

Subsurface Contaminants Focus Area

SS-02-99 Barriers for Containment and Control

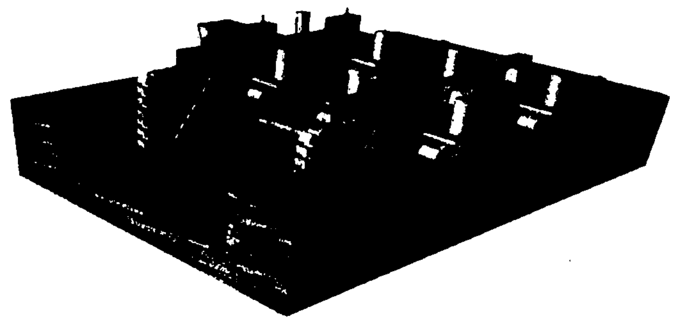
IPL Rank # 35

Problems Being Addressed:

- Leaking landfills, trenches, tanks and high concentration plumes must be contained as an interim measure to mitigate risk until a permanent remedial solution is found or natural attenuation occurs.

Technological Solutions:

- Subsurface Containment Barrier System at Oak Ridge.



Continuous Containment Barrier

Impacts/Benefits:

- Risks and costs associated with continual contaminant leakage will escalate. Provides interim solution and gives sites the ability to contain contaminants in landfills, trenches, and pits until a more permanent remedial solution is found.

AL	CH	ID	NV	Oakland	Ohio	OR	Paducah	Portsmouth	RFETS	RL	SRS
						x					

Mixed Waste Focus Area

MW 06 Monitoring and Removing Hazardous and Radioactive Contaminants from Off Gas Streams

IPL Rank # 36

Problems Being Addressed:

- A major challenge is associated with hazardous air pollutants (HAPs) resulting from thermal treatment of mixed wastes. It is anticipated that DOE facilities will be required to come into compliance with the regulations contained in the Maximum Achievable Control Technology (MACT) Rule for Hazardous Waste Incinerators by 2002, or be shut down, which will seriously impact DOE's ability to meet compliance agreements. Other MACT rules that may impact DOE facilities are also expected to be promulgated in the next five years.

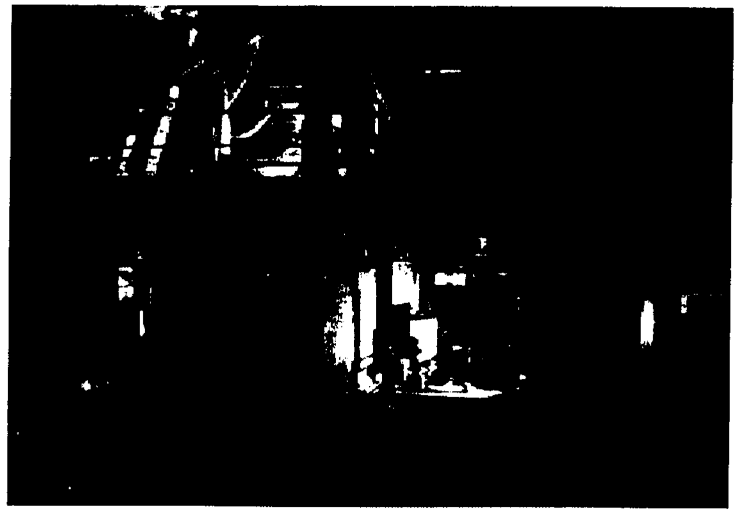
Technological Solutions:

- Research dioxin/furan formation and destruction mechanisms within thermal treatment systems including air pollution control systems.
- Develop control techniques or technologies for dioxins/furans generated in thermal treatment systems.
- Develop a continuous emission monitor (CEM) for stack emissions of dioxins/furans.
- Demonstrate viable CEMs for stack emissions of chlorine, mercury, and other heavy metals.
- Demonstrate/deploy control technologies for mercury from thermal treatment systems.
- Closeout activities at WETO, including disposition of all equipment.

Impacts/Benefits:

- Allows necessary emissions control technologies to be identified to allow all projected feeds to be treated at CIF.
- Necessary control technologies will be identified to allow all projected feeds to be treated as well as additional feeds; stakeholders concerns regarding emissions can be allayed at TSCA.
- Technical risk evaluation will allow lower-risk emissions control technologies to be implemented to assure acceptable probability that all projected feeds can be treated at WERF.
- Demonstration of suitable emissions control technologies will allow removal of emissions control barrier to continued operation, allowing all projected feeds to be treated at INTEC.

Graphite Electrode DC Arc Furnace



AL	CH	ID	NV	Oakland	Ohio	OR	Paducah	Portsmouth	RFETS	RL	SRS
		x				x					x

Subsurface Contaminants Focus Area

SS-09-99 Deep Access and Delivery Systems

IPL Rank # 38

Problems Being Addressed:

- Existing access, sampling, and delivery methods cannot cost-effectively place characterization and treatment technologies at depth greater than 50 feet or in difficult geologic settings.

Technological Solutions:

- Deep DNAPL access and delivery system at Oak Ridge.
- Access and remediation technologies for metals and radionuclides in fractured rock at Hanford.

Impacts/Benefits:

- The DOE will be able to address contamination in deep and complex geologies and lower its long-term cost of remediation.

Drilling at Depth

AL	CH	ID	NV	Oakland	Ohio	OR	Paducah	Portsmouth	RFETS	RL	SRS
		x				x				x	

Work Package Funding

			FY00 Funding ($M)	FY01 Funding ($M)
MWFA	MW-01	Non Destructive Characterization for Treatment, Transportation, & Disposal of MLL and MTRU Waste	5.457	4.297
MWFA	MW-03	Handling Mixed Waste Contaminated Materials During Characterization, Treatment, Packaging & Disposal	4.6	7.412
MWFA	MW-05	Payload Enhancement for Transporting TRU Waste within Restrictive Regulatory Limits	1.4	2.612
MWFA	MW-07	Alternatives to Incineration to Reduce Emission Hazards	1.025	3.354
MWFA	MW-08	Facilitating Deployment for Unique Waste	4.51	6.052
SCFA	SS-01-09	Subsurface Characterization, Monitoring, Modeling & Analysis	5.794	6.93
SCFA	SS-04-09	Long-Lived Caps	2.01	2.799
SCFA	SS-05-09	In-Situ Reactive Treatment Barriers	3.242	2.25
SCFA	SS-06-99	Biological Treatment Systems	2.103	2.004
SCFA	SS-07-99	Vadose Zone Treatment Systems	5.425	7.621
SCFA	SS-08-99	Saturated Zone Treatment Systems	4.111	3.801
SCFA	SS-10-99	Fundamental Improvements to Soil Clean-up and Segregation Technology	2.397	1.978
SCFA	SS-11-99	Validation, Verification & Long-Term Monitoring of Containment & Treatment	2.178	5.784
TFA	WT-07-01	Product Acceptance Criteria & Canister Storage	3.225	4.073
			47.477	60.967