

SUCCESSFUL MIXED WASTE DEPLOYMENTS THROUGH TECHNOLOGY TRANSFERS – PAST, PRESENT, AND FUTURE

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ABSTRACT

The U. S. Department of Energy (DOE) Environmental Management Office of Science and Technology has developed the Mixed Waste Program to address and resolve technology needs associated with disposition of “mixed waste” (i.e. waste materials that contain both radioactive and hazardous contaminants). The Mixed Waste Program is comprised of the Environmental Management Science Program, Mixed Waste Focus Area, Accelerated Site Technology Deployment Program, Industry Programs, and various Crosscut Programs. Collectively, these individual elements provide a technology life-cycle continuum that offers a balanced portfolio ranging from basic research to technology development through deployment. Although deployment seems to be the most elusive phase in this continuum, the Mixed Waste Program has experienced success in this area due to various technology commercialization, site-to-site transfer, and industrial partnership efforts.

Commercialization involves transfer of a DOE-developed technology to the private sector for use in DOE or commercial applications. The primary purpose of this type of transfer is to allow widespread use of a needed technology, without requiring multiple system installations. Site-to-Site transfers involve deployment, at one DOE site, of a specific treatment system or equipment that was obtained from another DOE site. The technology involved can be either DOE-developed or commercially available. The primary purpose of this type of transfer is to provide cost savings or expedite disposition schedules. Site-specific deployments involve development, demonstration, and deployment of a specific technology intended to address a specific need at a specific site. Industrial Partnerships involve either joint development of a technology between DOE and an industrial partner; or joint demonstration of a commercial technology for general DOE application.

Throughout the last few years, the combined efforts of the Mixed Waste Program elements have resulted in deployment of several technologies. Examples include polymer macroencapsulation, extrusion polymer microencapsulation, kinetic mixer polymer microencapsulation, chemically bonded phosphate ceramics, sulfur polymer cement stabilization, gas recontainerization technology, portable water treatment unit, direct chemical oxidation, active and passive computed tomography, and combined thermal/epithermal neutron assay. In addition, several more technologies, which were developed or tested by DOE, are presently being evaluated for deployment at DOE sites including molten salt oxidation, twin-screw polymer microencapsulation, electro-thermal plasma stabilization, and uranium chip treatment technology.

Deployment of these technologies, in conjunction with existing DOE and commercial capabilities, will provide a suite of technologies that can address approximately 90% of the DOE mixed waste inventory. The remaining 10% is comprised of “unique” waste streams, which include problematic organic waste streams [i.e. tritiated polychlorinated biphenyls, transuranic

(TRU) polychlorinated biphenyls], highly energetic waste streams (i.e. water reactives, pyrophorics, high explosives), and miscellaneous problematic waste streams (i.e. batteries, cylinders, activated lead, non-defense TRU waste). Opportunities for future deployments will most likely be realized through dispositioning these unique waste streams.

This paper focuses on the past deployments achieved by the Mixed Waste Focus Area component of the Mixed Waste Program, through various technology transfer activities. It also discusses the potential future technology deployments related to dispositioning the unique waste in the DOE mixed waste inventory.

INTRODUCTION

The U. S. Department of Energy (DOE) currently has about 165,000 m³ of “mixed waste” in inventory. (Mixed waste is defined as waste materials that contain both radioactive and hazardous contaminants.) Significant additional quantities will most likely be generated as a result of the planned remedial actions throughout the weapons complex. The DOE Office of Environmental Management (DOE-EM) has established the Mixed Waste Program to address and resolve the technology deficiencies associated with the disposition of existing and projected inventories, in accordance with Atomic Energy Act (AEA) and Resource Conservation and Recovery Act (RCRA) requirements. The Mixed Waste Program is comprised of several elements including the Low-Level/Mixed Low-Level Waste Center of Excellence, the EM Science Program (EMSP), the Mixed Waste Focus Area (MWFA), the Accelerated Site Technology Deployment (ASTD) Program, as well as various Crosscut Programs.

Historically, the focus of the Mixed Waste Program has been on technology development and demonstration. As the program has matured, its focus has shifted to deployment, as illustrated by implementation of the ASTD program. Technology development and demonstration will continue to be a part of the Mixed Waste Program, but the majority of future efforts will, increasingly, be aimed at *deployment of technologies*.

A key component of the Mixed Waste Program is the MWFA. Although the primary emphasis of the MWFA has been on technology development and demonstration, the program has also been successful at deploying several DOE-developed technologies. This deployment success has been the result of various activities including commercialization, site-to-site transfers, site-specific deployments, and industrial partnerships.

The term “deployment”, as used in this paper, refers to any instance in which a characterization, treatment, or packaging technology is directly or indirectly used to actually reduce the DOE mixed waste inventory. This definition is consistent with the clarification issued in the August 18, 1998 letter from Gerald Boyd, Acting Deputy Assistant Secretary of Science and Technology, to all Operations Office Managers [Subject: Clarification of the Term “Deployment”] (1), in which deployment is defined as:

“...the use of a technology or technology system toward accomplishment of one or more site-specific DOE Environmental Management program cleanup objectives as applied to the actual waste requiring management at the site.”

The letter indicates that this definition of deployment is “consistent with contributing to the accomplishment of EM’s performance measures (e.g., completion of release site or facility assessments or cleanup; storage, treatment, or disposal of hazardous, radioactive, or mixed wastes) [through] application of technology to actual site wastes and cleanup.”

BACKGROUND

The MWFA established a technical baseline in fiscal year 1995 (FY1995). This was done through direct interface with site representatives from throughout the DOE complex. The technical baseline defined and prioritized the science and technology needs relative to disposition of the DOE mixed waste inventory. The activities initiated as a result of this baselining effort generally involved long-term development and demonstration projects. Over the last several years, the MWFA has continued to advance these activities along the technology life-cycle continuum, directing them toward deployment. Several DOE-developed technologies have been deployed at commercial and DOE facilities. Examples are discussed in more detail below.

The status of mixed waste treatment technology capabilities has improved dramatically over the last few years, both commercially and within DOE. Companies like Envirocare of Utah, Waste Control Specialist, Perma-Fix, Geo-Safe, Diversified Scientific Services, Inc., Applied Technologies Group, Materials and Energy Corporation, British Nuclear Fuels, and others have continued to expand and improve their mixed waste treatment services, in part due to DOE support. The combination of existing DOE and commercial technologies provides a suite of treatment, storage, and disposal capabilities that can address approximately 90% of the DOE mixed waste inventory. The remaining 10% is identified as “unique” or problematic. These waste streams include those materials that, for some reason, cannot be dispositioned using existing or planned capabilities. These have been generally grouped in the following categories, as defined in the draft FY1999 MWFA Multi-Year Program Plan (2):

Problematic Organic Waste Streams: this category includes waste streams such as tritiated polychlorinated biphenyls (PCBs), PCBs with TRU contaminants, tritiated combustible debris that exceeds incinerator waste acceptance criteria, etc.

Highly Energetic Waste Streams: this category includes waste streams such as water reactives (i.e. sodium, lithium hydride, NaK), pyrophorics (i.e. uranium chips), high explosives, and shock sensitive materials.

Radioactive Sources: this category includes radioactive sources that no longer have a useful life. For some of these items, the need no longer exists; for others, the source has decayed below a useful level. These sources may include TRU or non-TRU alpha emitters packaged in hydrochloric acid, in liquid form, or in solid form.

Miscellaneous Problematic Waste Streams: this category includes other miscellaneous problematic waste streams such as non-defense TRU waste, non-TRU alpha contaminated materials, highly tritiated materials, small quantity waste streams, batteries, gas cylinders, and activated lead.

Disposition of these waste streams will require highly specialized solutions that will be strategically implemented through various approaches including site-specific deployments, multiple site collaborations, and national initiatives. This will be a primary source of future deployments within the Mixed Waste Program.

PAST AND PRESENT TECHNOLOGY DEPLOYMENTS

The MWFA has been, or is, involved in several successful technology deployment activities. The MWFA deployment projects can be loosely grouped into the following categories: a) commercialization, b) site-to-site transfers, c) site-specific deployments, and d) industrial partnerships; although, these categories often overlap. The description of each category, as used in this paper, follows:

Commercialization involves transfer of a DOE-developed technology to the private sector for use in DOE or commercial applications. The primary purpose of this type of transfer is to allow widespread use of a needed technology, without requiring multiple system installations.

Site-to-Site Transfers involve deployment, at one DOE site, of a specific treatment system or equipment that was obtained from another DOE site. The technology involved can be either DOE-developed or commercially available. The primary purpose of this type of transfer is to provide cost savings or expedite disposition schedules.

Site-Specific Deployments involve development, demonstration, and deployment of a specific technology intended to address a specific need at a specific site or sites. Typically these are long term projects that involve only DOE scientists and resources; however, the activities are often co-funded by the Office of Science and Technology (EM-50) and operations offices such as Waste Management (EM-30) or Environmental Restoration (EM-40).

Industrial Partnerships involve either joint development of a technology between DOE and an industrial partner; or joint demonstration and deployment of a commercial technology for DOE applications.

Examples of specific deployment projects in each of these categories are presented below.

Commercialization

The MWFA completed successful commercialization of polymer macroencapsulation at Envirocare of Utah during FY1996. Polymer macroencapsulation was developed at Brookhaven National Laboratory (BNL). In this process, drums or B-12 boxes are placed in overpack molds and molten low-density polyethylene (LDPE) is poured into and around the waste container. A specially formulated multi-viscosity LDPE is used to control cracking and shrinking, while maintaining acceptable pour characteristics. The result is a monolithic waste form that meets the definition of macroencapsulation, as provided in RCRA. A cooperative agreement was established between the DOE Idaho Operations Office (DOE-ID) and Envirocare (Instrument No. DE-FC07-95ID13372) (3) that governed this technology transfer. The terms of the cooperative agreement, which provided for in-kind support from both participants, included payment of \$960,000 to Envirocare by DOE. In return, Envirocare procured and installed

equipment, established operating and safety procedures, and treated and disposed of 500,000 lbs. of mixed waste lead and debris, at an estimated cost to Envirocare of \$890,000. Participation in the cooperative agreement was offered to the entire DOE complex. Participating sites were obligated to pay all profiling, packaging, and shipping costs. Over 2,000,000 lbs. of waste was identified for inclusion in the cooperative agreement. After negotiations with the sites, allocations were finalized and 500,000 lbs. of waste from 23 sites (including seven Navy sites) were treated and disposed. In many cases, entire waste streams were eliminated from the DOE mixed waste inventory. For the Pinellas Site, the entire mixed waste inventory, as identified in their Site Treatment Plan, was eliminated. Multiple DOE sites now routinely use polymer macroencapsulation to treat and dispose mixed waste lead and debris.

Other DOE-developed technologies are currently in the process of being commercialized. These include extrusion polymer microencapsulation, and chemically bonded phosphate ceramics (CBPC). Negotiations for these technology transfer efforts were initiated in early 1998. In addition, new negotiations have recently begun for commercialization of a sulfur polymer stabilization system for application to mercury contaminated mixed waste.

The CBPC stabilization technology was developed at Argonne National Laboratory - East (ANL-E). In this process, calcined magnesium oxide is mixed with phosphoric acid to form an acid phosphate paste. This is then mixed with waste (i.e. ash, soil, blowdown salts, sludges, finely divided solids) for 20 minutes to 30 minutes and allowed to cure for approximately 2 hours in a slightly exothermic (approximately 80°C) process. CBPC is a batch process, and the primary operating equipment is a drum-scale double-planetary mixer. Extensive testing of CBPC has been completed on several different waste matrices, including ash, soils, and salts. The resulting analyses show that the CBPC process is capable of stabilizing various matrices (with waste loadings exceeding 75 wt% in some instances) to meet or exceed RCRA Land Disposal Restrictions (LDRs). The CBPC process has been patented by ANL-E. Envirocare has procured and installed the equipment for this process and is currently testing the technology on various DOE mixed waste streams.

The polymer microencapsulation process was also developed at BNL. In this process, waste materials and LDPE are continuously fed from individual loss-in-weight hoppers (AccuRate/Merrick) into a Davis-Standard 4.5 in. single-screw extruder. Due to friction and some external heating, the temperature in the extruder exceeds the melting point of the polymer (120°C), and the action of the screw thoroughly mixes the waste and polymer. Upon cooling, this results in a monolith that is capable of meeting the RCRA LDRs for hazardous metals. The polymer microencapsulation process has been demonstrated on dry ash, soils, and salts. Water-wet waste streams must be pretreated by drying to less than 2 wt% water. Waste loadings of 50 wt% are common for most waste materials tested. The polymer microencapsulation process has been patented by BNL. Envirocare is currently leasing a Davis-Standard 4.5 in. single screw extruder system from BNL, while in the process of procuring their own equipment. The unit has been installed and testing is ongoing for several DOE waste streams.

Recently, Envirocare has expressed a strong interest in commercializing the sulfur polymer stabilization system (SPSS), demonstrated at BNL, for treatment of mixed waste mercury waste streams. The U. S. Bureau of Mines originally developed sulfur polymer cement (SPC) as a low-

cost, corrosion-resistant construction material. BNL adapted this technology to stabilization of mixed waste in the SPSS, and was issued a U.S. Patent in November 1997. SPSS is a two-phase treatment process that effectively stabilizes mercury in a final waste form that meets the RCRA LDRs. In Phase I, finely ground SPC (a mixture of 95% sulfur and 5% organic modifiers) is combined with the waste material, at room temperature, in a commercial agitated mixer to form mercuric sulfide (HgS). In Phase II, the SPC/HgS mixture is heated, to approximately 130°C to a thermoplastic range, forming a molded, leach-resistant, monolithic waste form that meets RCRA LDRs for mercury. The equipment and chemicals required for this process are commercially available, and relatively inexpensive. The MWFA is working with Envirocare to ensure successful commercialization of this technology.

Direct Chemical Oxidation (DCO) is a non-thermal organic destruction process that was developed by scientists at Lawrence Livermore National Laboratory (LLNL). The DCO technology is an ambient pressure process that uses acidified ammonium peroxydisulfate solution, an aggressive oxidant, to destroy both liquid and solid organics, while maintaining an operating temperature below 100°C. Broad categories of organic mixed wastes [i.e. neat organics, solvents, polyvinyl chloride (PVC), rubber, etc.] can be converted to carbon dioxide, water, and inorganic residues derived from the wastes. The DCO process has been successfully demonstrated on several waste matrices including contaminated soils, Trimsol, amino pyridine chloride, pentachlorophenol, hard PVC, and hard rubber. Materials and Energy Corporation (M&EC) was recently awarded a significant portion of the Broad Spectrum Procurement, which provides for DOE complex-wide treatment and disposal of several mixed waste matrices. M&EC identified the DCO process as the technology chosen to process organic waste streams treated under the Broad Spectrum Procurement. In addition, LLNL deployed the DCO process for treatment of some unique organic waste streams that contain thousands of curies of tritium, and are not acceptable at existing or planned commercial treatment facilities.

Site-to-Site Transfers

DOE has amassed a significant inventory of unused equipment and technology systems due to various reasons. Facilities get closed, programs shut down, projects are completed, and system upgrades are implemented. These types of activities leave a legacy of operational equipment, pilot-scale treatment systems, partially constructed systems, and other useful materiel available for deployment at other DOE sites. The Mixed Waste Program periodically identifies opportunities to transfer unused equipment and systems from one DOE site to another.

The Oak Ridge site identified a need for the capability to treat certain mixed waste compressed gas cylinders that could not be certified for shipment under Department of Transportation (DOT) requirements. This need was communicated to the MWFA in a proposal that was received in response to the Quick Win Program call for proposals. Through site interface, the MWFA was aware that Los Alamos National Laboratory (LANL) had previously designed and partially constructed a skid mounted unit for processing compressed gas cylinders. This work was conducted under the LANL mobile treatment unit (MTU) program. A programmatic decision was made to pursue offsite treatment for all of the LANL mixed waste inventory; consequently, the Gas Recontainerization Skid was left 90% completed. The MWFA (EM-50) and Oak Ridge (EM-30) co-funded completion, transfer, and installation of the skid. Oak Ridge subsequently treated its inventory of compressed gas cylinders.

A portable water treatment unit (PWTU) from the Idaho National Engineering and Environmental Laboratory (INEEL) was transferred to the Fernald Site in FY1997 to treat process waste waters, in support of the site cleanup and closure schedule. The PWTU, which included basic ion exchange and carbon bed filtering, had been effectively used to complete the task at the INEEL for which it was constructed, and had been placed in storage. Fernald identified an unexpected need for waste water treatment capability and identified this problem to the MWFA. This issue developed because the onsite facility identified to treat the residual waste waters, which were expected to be generated from a planned mixed waste treatment process, was decontaminated and dismantled ahead of schedule. The PWTU was transferred to Fernald, with support from the MWFA, which provided a critical need while minimizing costs to DOE.

LANL also designed and began construction of a Uranium Chips Treatment Skid; however, for the same reasons discussed above, the unit was never completed. The MWFA became aware in FY1998, through support of the EM Integration program, that LLNL is planning to build a process system for oxidizing uranium chips. Uranium chips often exhibit pyrophoricity, as defined by RCRA, and must be oxidized or stabilized to mitigate this characteristic. Preliminary designs of the LLNL system are based on some form of bleaching (i.e. sodium hypochlorite, peroxide) to chemically oxidize the uranium chips, with plans for significant development and testing. The LANL skid was designed to chemically oxidize uranium chips using sodium hypochlorite, and has been successfully demonstrated. Project engineers from both sites are now in contact and negotiations are ongoing to transfer all, or portions of, the LANL Uranium Chips Skid to LLNL. This will save DOE significant expense in system design, development, and testing since these tasks have already been completed at LANL and the data will be provided to LLNL engineers.

The RMI Titanium Ashtabula site is taking this deployment concept to new heights. Ashtabula has identified a suite of five technologies that, jointly, will be able to treat the site's entire mixed waste inventory for disposal, with potential application to other DOE sites. The selected technologies include twin-screw polymer microencapsulation, single-screw polymer macroencapsulation, molten salt oxidation, compression forming stabilization, and electro-thermal plasma treatment. These five treatment systems, which are already at the Ashtabula site, were identified and procured through the DOE excess material system. Each of the technologies has previously been successfully demonstrated at other DOE facilities. The technologies are generally pilot-scale systems, but are more than adequate to address the Ashtabula treatment needs.

Site-Specific Deployments

The computed thermal/epithermal neutron (CTEN) assay system is an improved non-destructive assay (NDA) technology for characterizing drums of TRU waste. This technology was developed and is currently being deployed at LANL. The CTEN method is a differential die-away technique (DDT) passive active neutron (PAN) method, but interrogates the sample with both thermal and epithermal neutrons. Because epithermal neutrons are more penetrating in fissile material than thermal neutrons, the differential response can be analyzed to detect the occurrence of self-shielding by fissile material and measure the size of the effect. The accuracy of TRU waste assay using the active DDT technique depends upon significant corrections to

compensate for the effects of the matrix material in which the TRU waste is located. The CTEN has been designed to improve on PAN capabilities to better correct for the matrix and source effects on the measurement. Experimental results have shown that for some matrices, corrections for position dependent effects within the matrix are possible.

The DCO process described above was also a site-specific deployment. The technology was developed, demonstrated, and deployed at LLNL to address and resolve a site-specific need to treat highly tritiated organic waste streams that are not acceptable to existing commercial or DOE treatment facilities.

Industrial Partnerships

The kinetic mixer polymer microencapsulation process for stabilizing mixed waste was developed and demonstrated by BNL, through a Cooperative Research and Development Agreement (CRADA) with EcoLex, a commercial plastics and equipment manufacturer. In this process, waste materials and LDPE are batch fed from loss-in-weight hoppers into the fluxing chamber of a kinetic mixer, which was originally designed for processing recycled plastics. The high-speed mixing action of the equipment completely homogenizes the waste and polymer mixture in seconds, volatilizing water and other organic compounds, which are then condensed and separated for additional treatment. This process is referred to as “fluxing”, because, during this short mixing cycle, the polymer becomes molten. The kinetic mixer system, as a stand-alone process, results in a monolith that meets or exceeds the RCRA LDRs for hazardous metals. The advantage of the kinetic mixer process over polymer microencapsulation using an extruder is that, generally, waste streams with water and/or organics in excess of 2 wt% cannot be treated without being dried in an evaporator or other similar process. Using the kinetic mixer, the waste is dried and stabilized in one step. Waste streams with up to 25 wt% moisture have been successfully processed. Waste loadings of 50 wt% are common for most waste materials tested. Envirocare has established licensing and royalty agreements with BNL and EcoLex, procured the equipment, and installed it for full operations. Testing of several DOE waste streams is currently being conducted. The technology has already been successfully used to treat a commercial ash waste stream that was particularly difficult to stabilize due to high concentrations of selenium.

Scientists at LLNL, in partnership with Bioimaging Research Inc. (BIR), developed an automated gamma-ray active and passive computed tomography (A&PCT) technique for NDA of closed 55-gallon drums. The A&PCT technology uses two separate gamma-ray measurements during operation to accommodate measurement complications. The first is an active density mapping of the waste drum matrix by an external radioactive source(s) and the second is a passive measurement of the gamma-emitting radioactive source(s). The “passive” component of the A&PCT system uses a high purity germanium (HPGe) detector to quantitatively identify, with high precision, gamma-emitting nuclides in sludge, glass, combustibles and metal matrices. This technology can also be applied to other waste forms. The existing gamma-ray nondestructive assay technology (e.g., segmented gamma-ray scanner) cannot accurately measure TRU or low-level radioactive wastes that contain heterogeneous radioactive source distribution or attenuation caused by heterogeneous matrices. The matrix and radioactive material spatial information determined from the computed tomography reconstruction process is used to arrive at a gamma attenuation corrected assay. The A&PCT system can accurately and precisely characterize TRU waste drums for shipment to the Waste Isolation Pilot Plant (WIPP)

in Carlsbad, New Mexico. This technology could potentially be modified, by extending its sensitivity, and used to differentiate between TRU and low-level radioactive waste categories, which would provide significant cost savings to DOE. Nevada Test Site (NTS) has deployed the A&PCT system for certification of their TRU waste drums for shipment to WIPP.

FUTURE DEPLOYMENTS

The DOE Mixed Waste Program will continue to support the technology development required to address the needs of the DOE sites. Ongoing development and test programs for non-destructive assay and examination of contact-handled and remote-handled (RH) TRU waste will lead to deployments of technologies throughout the DOE complex. Likewise, ongoing and planned activities addressing material handling and packaging deficiencies associated with RH materials (i.e. HANDS-55 system) will result in deployment of major technology systems. However, evaluation of the DOE mixed waste inventory, and the planned strategies to disposition the various waste matrices, indicates that multiple, near-term deployments will be required to address and resolve the "unique" problematic waste streams. This concept is not new. Several of the deployments discussed in this paper (e.g. SPC, Gas Recontainerization Skid, kinetic mixer, and DCO) were a direct result of the MWFA Quick Win Program, which was active during FY1996 and FY1997. The Quick Win Program was directed at end-users, rather than principal investigators, and specifically targeted unique, problematic waste streams that could be dispositioned with a near term deployment.

The DOE unique waste inventory, which represents approximately 10% of the total DOE mixed waste inventory, includes: a) problematic organic wastes streams, b) highly energetic waste, c) radioactive sources, and d) other miscellaneous unique waste. Waste streams that are grouped into these classifications are considered problematic because they cannot be dispositioned using the available, or planned, DOE or commercial capabilities. The particular characteristics of waste streams that render them "unique" are as varied and diverse as the waste streams themselves. Generally, the issues are not due to technology deficiencies, but rather site-specific, logistical, and regulatory limitations. Disposition of these waste streams will require highly specialized solutions that will be strategically implemented through various approaches including site-specific deployments, multiple site collaborations, and national initiative efforts. A thorough understanding of the problematic characteristics of unique waste streams will be key to successful deployments and final disposition. In all cases, the Mixed Waste Program will work closely with the end-users to develop integrated approaches that use commercial and DOE capabilities, as necessary, to disposition the unique waste inventory.

The following sections describe the general categories included in the unique mixed waste inventory and a brief explanation of the characteristics that make the materials problematic.

Problematic Organic Waste Streams

This waste category includes organic waste streams that cannot be processed using conventional technologies (i.e. incineration) due to technical, facility, or regulatory limitations. For example, certain PCB waste streams contain problematic co-contaminants that render them unacceptable to existing and planned treatment capabilities (i.e. Toxic Substance Control Act Incinerator and Broad Spectrum Procurement, respectively). For example, PCB waste streams with materials

such as high explosives and mercury have been identified. Other problematic waste streams include combustible organic debris with high chlorine, non-compliant articles, or tritium concentrations that exclude them from treatment in the existing DOE incinerators. Another class of unique organics includes TRU waste with PCBs.

High Energetic Waste Streams

This waste category includes such materials as water reactives, pyrophorics, and high explosives. Materials such as sodium, lithium hydride, and NaK exist at several DOE sites for which a treatment option is not available. Capabilities exist within DOE (i.e. Argonne National Laboratory-West Sodium Processing Facility) and the private sector [i.e. British Nuclear Fuels, Ltd.(BNFL), Waste Control Specialist (WCS), Commodore Inc.), but these systems are either regulatorily restricted to onsite waste or not permitted under RCRA. Pyrophorics and high explosive waste streams have been identified at several DOE sites. The MWFA is supporting an ongoing collaborative effort between Rocky Flats Environmental Technology Site (RFETS) and Hanford Site to identify, evaluate, and deploy a system for treating and disposing uranium chips contaminated with PCBs, spent solvents, and RCRA metals.

Radioactive Sources

This waste category includes radioactive sources that no longer have a useful life. In some cases the need no longer exists, and in other instances the source has decayed to the point that it is no longer usable. The sources may be non-defense TRU material or non-TRU alpha-emitters, packaged in hydrochloric acid, in liquid form, or in solid form. Some of these materials will be mixed and will require treatment in accordance with the RCRA LDRs prior to disposition.

Miscellaneous Problematic Waste Streams

This waste category includes all the “cats and dogs” not addressed in the other categories. Several example problematic waste streams that have been identified by the DOE sites include: non-defense TRU/non-TRU alpha contaminated material (i.e. waste that is not acceptable at WIPP, but exceeds commercial and DOE capabilities); non-compliant material (i.e. waste streams that exceed the acceptance criteria of available commercial and DOE treatment and disposal facilities such as high tritium waste streams); small quantity waste streams (i.e. materials, such as some sludges, debris, and elemental mercury, that cannot be cost-effectively treated at commercial facilities due to the small volume); and unique bulk materials (i.e. radioactive batteries, activated lead, very large lead pieces, gas cylinders, etc.). Each of these waste streams offers a potential near-term deployment opportunity, and the resulting inventory reduction.

CONCLUSION

The Mixed Waste Program has experienced some successes in deploying technologies that actually reduced the DOE mixed waste inventory, and others are on the horizon. However, the Mixed Waste Program would like to increase the frequency and effectiveness of deployments. Through close coordination and interaction with the sites and end-users, Mixed Waste Program will be able to effectively identify, plan, and support site-specific deployments, multiple site collaborations, and national initiative activities, as appropriate, to address the unique waste streams. Likewise, the Mixed Waste Program will be better able to direct technology development and demonstration activities, such that the sites needs are thoroughly understood,

incorporated into the planning, and fully addressed. If this approach is followed, the end result will be effective deployments of technologies and technology systems that directly support site-specific cleanup objectives.

REFERENCES

1. Gerald G. Boyd, *Letter to Operations Office Managers, Subject: Clarification of the Term "Deployment"* (August 18, 1998)
2. U. S. Department of Energy Idaho Operations Office, *Mixed Waste Focus Area Multi-Year Program Plan Fiscal Year 1999 DRAFT*, DOE/ID-10659 (September 1998)
3. U. S. Department of Energy Idaho Operations Office, *Notice of Financial Assistance to Envirocare of Utah, Inc., Cooperative Agreement*, Instrument No. DE-FC07-95ID13372 (August 1995)