A STRATEGY FOR UNIQUE AND PROBLEMATIC MIXED WASTES

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ABSTRACT

The Department of Energy's (DOE) Mixed Waste Focus Area (MWFA) has prepared a Unique Waste Development Plan. The plan defines the needs and outlines the proposed technology development, demonstration, and deployment activities, as well as the support strategies, needed to initiate the resolution of the many problematic and orphan mixed waste issues existing throughout the DOE complex. Problematic, orphan, and/or unique waste needs are those issues involving low volume, less traditional mixed waste inventories (e.g. compressed gas cylinders, batteries) that have specific logistic, regulatory, and/or treatment capacity challenges.

The plan describes the issues associated with eight distinct unique mixed waste groups and provides generic as well as specific resolution strategies, where applicable. Resolutions to these unique waste challenges will be based on established requirements (e.g. waste acceptance criteria) and distinct, documented end user (DOE-Environmental Management 30/40/60) needs. Solutions to unique mixed waste needs, addressed through the technology-development activities and the national-program-support efforts, as presented in this paper, may increase the unique mixed waste treatment/disposal capacities and capabilities within the DOE complex. The result of this strategy may also reduce life-cycle costs for treating unique mixed waste with some assurance that waste treatment schedules, as identified by Site Treatment Plans (STPs) or other legal DOE commitments, will be met.

INTRODUCTION

The Department of Energy's (DOE's) Mixed Waste Focus Area (MWFA) is an EM-50 program that sponsors technology research and development to address the many mixed waste characterization, treatment, and disposal problems existing in the DOE complex. Since 1994, the MWFA has provided technology development resources to address those issues common and urgent to many of the larger DOE sites (e.g. the Idaho National Engineering and Environmental Laboratory/INEEL, the Oak Ridge National Laboratory/ORNL, Hanford, the Savannah River Site/SRS), as well as those issues associated with large volumes of common waste types (e.g. sludges, soils, debris, organic liquids). Support toward a particular technology development portfolio was based on an assessment, evaluation, and ranking of DOE complex wide needs and problems. Therefore issues tied to large waste inventories, pending deadlines, or complex and costly treatment systems received priority over the lower profile problems usually associated with relatively low volume waste inventories residing at smaller DOE sites. Even though this approach led to some success in resolving high priority, high profile, complex wide mixed waste challenges, it has neglected addressing those unique issues involving special case, problematic and orphan waste streams.

Traditionally, the MWFA had supported technology development efforts that addressed key issues in specific categories. Early on these categories were based on the basic mixed waste medium (i.e. wastewater, debris, organics, sludges, etc.). As of late, the categories have become more technology and process based, such as "stabilization", " transuranic (TRU) waste characterization", "off –gas treatment", and "material handling" [1]. However, neither of these two types of technology development categories were completely effective in addressing orphan, special case or unique waste inventories. These inventories comprise ~10-15% of the total mixed waste inventory. They consist of the less common types of waste streams, including, but not limited to, reactives (including uranium chips), batteries, compressed gas cylinders, and tritium-contaminated material. However, more common waste streams also make up the unique waste inventory for logistic or regulatory concerns associated with their disposition. Examples include small quantities of organics that can not be cost effectively incinerated, wastes containing classified and/or sensitive configurations, and wastes that are too radioactive for a low-level waste disposal site, but of insufficient curie level to be classified TRU, and therefore disposable at the Waste Isolation Pilot Plant (WIPP).

This Development Plan provides the MWFA current and out–year strategy for addressing the unique issues associated with the special case, problematic, and orphan mixed waste in the DOE complex. Various unique waste types and the issues and problems associated with them are identified from various sources and categorized based on

similar characteristics. A general strategy for all the unique waste issues and needs is presented. Where possible, specific strategies to address the technical, logistic, and/or radiological issues associated with each category are also provided.

SOURCES OF UNIQUE WASTE NEEDS

DOE complex wide needs associated with the unique mixed waste strategy were extracted from various sources. The majority of the needs and deficiencies were obtained from the various DOE Site Technology Coordination Groups (STCG) needs databases. Only those needs associated with orphan, unique, special case or problematic wastes were selected. Needs involving general and wide spread characterization, material handling, transuranic wastes, and off-gas monitoring issues were not included, but were assigned to other applicable MWFA product lines. In addition to the STCG needs, needs were extracted from a 1999 orphan wastes workshop sponsored by the INEEL Environmental Management and Integration (EMI) organization and the DOE Center of Excellence for Low-Level and Mixed Waste. At the workshop, various waste generators and cognizant technical representatives presented many issues concerning the characterization, treatment and disposal of orphan wastes, many of which are applicable for addressing in this MWFA unique waste strategy. In very few instances did these orphan waste issues coincide or cross walk with STCG needs. Another less significant source of unique needs evolved from a documented log of issues accumulated from various complex-wide interviews conducted by INEEL (EMI) personnel. The fourth source of needs resulted from a review of specific DOE updated Site Treatment Plans (STPs).

CATEGORIES OF UNIQUE WASTE NEEDS

Based on an extensive review of the needs and deficiencies associated with the 4 sources, a list of 143 separate unique waste issues corresponding to ~20 active and inactive DOE sites was prepared. These needs were separated and categorized into 8 groups based mostly on the physical characteristics of the mixed wastes associated with the need. Additional groups are also possible (e.g., groups involving sealed sources and non-defense TRU waste), but are not presently included in this plan as a consequence of their highly radioactive nature or lack of an identified final disposal option. The 8 grouping areas are necessary to establish appropriate technology development and support strategies that will benefit the DOE complex as a whole and leverage the available limited resources of the MWFA. A summary of the issues associated with each unique waste category is provided below. The summary is then followed by a description of the MWFA's proposed generic and specific strategies to be applied to each category.

Summary of Needs/Issues/Deficiencies

Problematic Organics

Many organic- based mixed wastes cannot be incinerated because of lack of timely access to or availability of existing DOE mixed waste incinerators, or the inability to use thermal treatments due to stakeholder concerns about off-gas emissions, including dioxin/furan formation. Specifically, the Toxic Substance Control Act (TSCA) incinerator at Oak Ridge is currently not accepting wastes from outside the state of Tennessee, severely limiting the complex's capability in treating mixed wastes, especially those containing polychlorinated biphenyls (PCBs). Additionally, organic-based mixed wastes containing mercury, tritium, and some actinides are difficult to thermally treat because these contaminants can lead to off gas treatment concerns. In particular, TRU wastes containing specific actinides (i.e Pu-238) and appreciable organic based materials cannot be easily incinerated, even though the organic source must be reduced to avoid the formation of the hydrogen generated via alpha radiolysis. The Department of Transportation (DOT) requires that TRU wastes destined to WIPP must demonstrate compliance with established hydrogen levels to mitigate pressurization or explosive issues during transportation. Presently, there are over 20 needs that are associated with problematic organic mixed waste that could be potentially resolvable with the deployment of alternative oxidation technologies (AOTs).

Alternative oxidation technologies (AOTs) employ relatively low temperature methods, such as digestive systems, strong redox chemistry, or catalysts to destroy organics. AOTs provide alternatives to free oxygen, open flame methods of combustion. Although not appropriate for all organic–based mixed wastes, the primary benefit of AOTs over traditional incineration is that they produce smaller off-gas volumes that may contain environmentally hazardous or radiological emissions, including dioxins and furans. Between 1992 and 1995, the MWFA and its EM-

50 predecessors sponsored the development and demonstration of various AOT technologies and advanced several of them short of full-scale mixed waste deployment. For example, these AOTs included Acid Digestion at Savannah River (SRS), Direct Chemical Oxidation at Lawrence Livermore National Laboratory (LLNL), Catalytic Chemical Oxidation at Lawrence Berkeley National Laboratory (LBNL), molten salt oxidation at Los Alamos National Laboratory (LANL), and two steam reforming technologies that are now commercially available for hazardous waste treatment. In addition several commercial companies are claiming methods suitable for mixed waste. Examples include Atomic Energy Agency's (AEA's) mediated electrochemical oxidation process, Commodore's solvated electron method, PermaFix's Direct Chemical Oxidation method (available through the Oak Ridge Broad Spectrum Procurement in fiscal year 2000), and Delphi Research's DETOX^{SM} system. The latter process is receiving MWFA support to demonstrate a small-scale system on PCB mixed waste at the Los Alamos National Laboratory.

Reactives (Including Uranium Chips and explosives)

Reactive wastes are highly energetic and unstable materials that are difficult to handle using conventional techniques and pose unique treatment barriers due to their relatively high safety risk in comparison to other less challenging waste streams. Specialized material handling requirements are usually associated with treating these highly energetic wastes. Many DOE sites possessing these reactive inventories are too small or have insufficient inventories to justify on-site facilities and deployment of appropriate technologies. Additionally, rare commercial treatment, when available, is usually too expensive. The types of reactive mixed wastes vary, but are best defined by the following four subcategories:

> *Water Reactive Wastes* include materials such as sodium, lithium hydride, and sodium potassium (NaK) metal.
> *Pyrophoric Wastes* include materials such as uranium chips and plutonium chips. Usually these chips have been stored in hazardous oil, making the treatment evermore challenging.
> *High Explosive Wastes* include materials such as triamino trinitrobenzene (TATB) contaminated with radionuclides, usually tritium. (A portion of this class of reactive waste is found at the ex-DOE weapons fabrication plant at Pantex, TX.) In 1997, the MWFA sponsored base- hydrolysis development and deployment as an alternative to open pit burning at Pantex, but additional methods are still needed.
> *Miscellaneous Energetic Wastes* include shock sensitive materials and other highly energetic substances that are not defined in the other subcategories.

Currently there are over 15 documented issues associated with highly reactive/ energetic waste streams at seven DOE sites. In some of these cases, specific treatability studies have been performed, but permitted and economical treatment options are currently not available.

Batteries

Spent batteries that were used in radioactive service may result in difficult treatment and disposal situations since they usually contain hazardous constituents resulting in a mixed waste classification. Examples include lead acid, cadmium and mercury batteries. Because recycle and reuse of these batteries has proven not to be cost effective in some scenarios, most mixed waste batteries are in expensive storage throughout the DOE complex awaiting the availability of economical treatment/disposal routes. For example, there are inventories of batteries at West Valley, Hanford, and the Sandia National Laboratory (SNL) that cannot be readily treated and/or disposed of for various reasons including, but not limited to: 1) the lack of commercially available and permitted recycling facilities, 2) the presence of other difficult contaminates with the batteries such as explosives and PCBs, and 3) the lack of available macroencapsulation capacity. There are currently at least 5 specific DOE site-wide needs in the battery category.

Compressed Gas Cylinders

This specific category includes mixed waste consisting of radiologically contaminated, pressurized gas cylinders, including aerosols. There are a few commercial facilities (e.g. International Technology (IT) Corporation and Nuclear Sources and Services Inc. (NSSI)) that have demonstrated storage and treatment of mixed waste compressed gas cylinders through treatability studies, but may not have full permits for continual treatment. Regardless, these commercial options may not be cost effective for the DOE sites, in light of the site's low volume

of compressed gas inventories. A gas recontainerization skid developed by Los Alamos is available at Oak Ridge, but the mobility and applicability of this skid needs to be assessed.

Mercury

Even though significant investment by the MWFA has been made toward the development and demonstration of technologies to amalgamate, stabilize and/or separate mercury in various mixed waste mediums, end-user specific needs involving this particular Resource Conservation and Recovery Act (RCRA) hazardous metal still exist complex wide. Based on currently documented DOE complex-wide needs, there are more than 16 mercury related mixed waste issues existing at 10 different sites. Most of these mixed waste mercury- related issues are at the smaller DOE sites, such as the Grand Junction Project Office (GJPO), the General Atomic (GA) Site in California, the Brookhaven National Laboratory (BNL), and the Lawrence Berkeley Laboratory (LBNL). In several cases the treatment of the mercury contaminated mixed waste at these sites is complicated by the presence of other troublesome constituents, such as tritium and organics.

Mercury's unique properties and the complex regulatory framework governing its treatment and disposal make mercury- based mixed waste management challenging and expensive for these smaller sites, since they cannot afford in-house, large- scale treatment or have too little inventory to justify commercial treatment at facilities such as Nuclear Fuel Services (NFS). As a result of the treatment flexibility now available because of proposed changes in RCRA regulations dealing with the stabilization of mixed wastes containing mercury greater than 260ppm, resolution of these issues may be possible through a combination of the following: 1) Use of other DOE facilities, and 2) Use of the Allied Technology Group (ATG), Waste Control Specialists (WCS), and/or the Materials and Energy Corporation (M&EC) via the Oak Ridge Broad Spectrum (BS) contact. However, the treatment schedule for these options may not always be compatible with meeting the end-user's commitment milestone associated with their mercury contaminated mixed wastes.

Waste Forms and Stabilization

Portland cement is the baseline low-temperature stabilization technology in use for much of the sludge, soils, and homogeneous solids that comprise the DOE's mixed low level waste inventory. However, experience has proven that cement is not always the most efficient method for many of these waste streams. There are over 25 issues associated with the adequacy of existing waste forms or stabilization methods and 9 DOE sites are seeking methods to ensure their wastes are stabilized to meet or exceed existing requirements. In particular, the waste streams produced as fly ash or scrubber blow down from the DOE's incinerators present unique problems because they contain salts, excessive heavy metals, unburned organics, and other nuisance substances.

Incinerator scrubber blow down and other high salt content waste streams, such as those from wastewater treatment facilities, are difficult to solidify with the available cementation technologies. These salts can cause the final waste form to degrade prematurely causing the leaching of undesired contaminants. Specific examples include the residues from a large effluent treatment facility at Hanford, and the spent off-gas scrub blow down from Savannah River's mixed waste incinerator.

Incinerator ash waste streams, which contain concentrations of heavy metals, salts, and unburned organics, are also difficult to solidify with the available cementation technologies. Currently, these problems are resolved in a similar manner to salt waste streams. Specific site-wide examples include the fly ash and bottom ash generated by both the INEEL and Savannah River mixed waste incinerators.

Multiple sites have also expressed a need for the encapsulation and immobilization of various mixed waste streams, such as debris, that may or may not contain the same troublesome components that exist in the salt and ash mixed waste streams. Examples include jacketed encapsulation at Fernald and the need for extruder encapsulation at LANL. The Sandia National Laboratory is seeking an in-house macro encapsulation process because a portion of their debris waste is classified.

A better understanding of the behavior of a given waste form over time is also needed to predict the disposed waste form's long term performance. The MWFA will recommend that the Environmental Management (EM) science program initiate research in this area.

Tritium

Due to tritium's volatility and value to defense programs, tritium-contaminated mixed waste is a problem for several sites. The wastes involved are also usually contaminated with other problem constituents such as mercury. In some cases, the tritium concentration is high enough that recovery and recycle of the tritium is the preferred treatment path. However, some have elected to "stack" or discharge the tritium to the atmosphere, and as a result are contracting commercial treatment for a portion of their inventory. The MWFA will track the progress of a SNL effort to stack tritium and, if successful, will assist other sites in leveraging the technology if appropriate. For pump oils and other organic matrices, if the tritium and potentially volatile heavy metals could be removed, the rest of the waste could be readily incinerated or treated via an AOT. The MWFA will evaluate the applicability of potential tritium removal technologies that have been developed by the EM-50 Efficient Separations crosscut program (ESP) and leverage that development where appropriate.

Commercial and DOE treatment technologies for tritium removal are nearing full-scale treatment capability, but require support for demonstrations at a larger scale to reduce the risk of the treatment methods at full- scale. However, one of the most advanced technologies, that which is being developed by Ontario Hydro of Canada and deployed by NSSI of Houston TX, cannot be used to recover tritium for defense applications per the NSSI license agreement.

Wastewater/Aqueous

Many wastewater streams generated through-out the DOE complex contain trace levels of RCRA heavy metals (e.g. mercury, cadmium), varying amounts of other potentially environmentally harmful contaminants (e.g.lithium, nitrates, organics), and radionuclides. Presently, the acceptable disposal route for many of these waste streams is to process them through an onsite treatment facility, which generates a concentrated residue, and discharge them to settling/ retention ponds, or directly to the environment as allowed under the sites' respective permits. Some sites, however, are treating their wastewaters or treatment concentrates through commercial facilities at an unfavorable cost, and are seeking more economical alternatives. In other instances, the sites are anticipating future requirements that will only allow discharge if the concentration of the contaminants is reduced to very low levels. These site end-users are requesting information on new separation technologies that will reduce contaminant levels to the part-per-billion (ppb) range as well as monitoring technologies for detecting the presence of very low levels of the contaminant. Other site end-users are requesting technologies to optimize, improve, and/or expand the applicability of their existing wastewater treatment facilities. Examples include technologies to increase the performance of filters, methods to remove biological foulant build-up, and the addition of systems to treat radiation standards. Currently, there are approximately 14 unique wastewater related needs associated with 9 DOE sites.

STRATEGIC APPROACHES

The MWFA has been and will be deploying various techniques and approaches in addressing the numerous and various unique waste issues. Where appropriate, these generic approaches as discussed will then be applied to the specific waste cases described above.

Generic Approaches

Assistance to Obtaining and/or Procuring Commercial Treatment and Disposal

In its relations with various DOE sites, disposal locations, and privatization efforts (e.g. the Oak Ridge Broad Spectrum (BS) Procurement), the MWFA has identified the existence of commercial mixed waste treatment options, of which only a limited number of DOE sites may be familiar due to the locality, visibility, and size of the commercial enterprise. In some instances these commercial treatment options, as well as treatment available through Broad Spectrum privatization contracts, were previously developed with partial sponsorship from EM-50 programs and transferred to the private sector. Examples include Sepradyne, which has developed a dioxin/ mercury treatment method through its Raduce technology, Nuclear Sources and Services (NSSI) in Houston TX which has limited tritium and gas cylinder treatment capability, and Allied Technology Group (ATG) in the Hanford area, which has a wide range of mixed waste treatment capabilities, including a melter system developed by EM-50 and now supplied by Integrated Environmental Technologies. Based on its broader knowledge, the MWFA will be in a

central position to recommend commercial options or Broad-Spectrum privatization efforts that may be viable for a particular end- user's unique waste issue. The position and objective of the MWFA in this role would be not to broker waste for the commercial entities, but to recover the investment of any past EM-50 sponsored development that has been commercialized.

Waste Consolidation

In many instances potential technology end-users and owners of unique waste have inventories of such insignificant volume, the use of commercially available facilities for treatment and disposal is not cost effective. In other cases the waste is too small in volume to justify a separate burn campaign at a DOE mixed waste incinerator. The initiation, hotel-load, one time fee at these commercial or DOE facilities is too excessive for a specific site's small problematic waste volumes, unless similar wastes from multiple sites are consolidated. Through the use of its extensive databases and working groups, the MWFA will take a lead role in initiating waste consolidations efforts among different DOE sites.

Treatability Studies

In many cases, a specific DOE site has evaluated, and as a result, has identified a potentially successful technology to resolve their need independent of any direct EM-50 efforts. However, the site lacks development funds to transition the technology from conception to an operational level. Frequently all that is needed is a simple treatability study or series of treatability studies involving real waste to validate the selected method. Since treatability studies are usually completed at costs less than $100k, the MWFA may choose to fund a specific treatability study to bridge the last gap between development and deployment. The MWFA would be more likely to support studies for applications where the chosen technology is innovative and has a potential to be deployed at additional sites.

Regulatory Variances

In limited cases, the problematic issue involving a unique or orphan mixed waste is a result of the existing regulations or criteria restricting viable treatment and/or disposal options. Even though most attempts are arduous and time consuming, efforts to alter the existing regulations or disposal site criteria may resolve the issues surrounding large mixed waste populations. Many disposal sites limit the type and amount of radionuclides present, only allow wastes generated from specific programs, or disallow wastes that have been pre-treated in specific ways. For example, the WIPP facility only accepts transuranic waste that has been generated as a result of Defense related programs. In another example, the State of Utah will not allow the commercial Envirocare disposal facility to accept waste that has been previously macroencapsulated. As a consequence, sites that must encapsulate classified/sensitive waste prior to shipment off-site are left with few final disposal options.

In the past the MWFA has had limited success in instigating regulation changes that expedite and improve the disposal of specific mixed wastes. For example, current RCRA regulations dictate that for wastes containing mercury at concentrations greater than 260 ppm a specific recommended method to recover mercury is required, such as retorting. The objective of the regulation was to ensure the recycling of mercury. This objective is sound for hazardous waste, but not practical for mixed wastes, since recycled radioactive mercury does not a have a broad market. The MWFA was successful in collaborating with the Environmental Protection Agency (EPA) to alter the existing regulation in a manner to allow direct disposal of mixed waste containing mercury greater than 260ppm, as long as the waste was treated to meet existing land disposal requirements. Additional attempts to modify existing regulations and criteria may be the appropriate approach for other unique waste issues.

Use of Subject-Matter-Experts (SMEs) and Working Groups

MWFA sponsored working groups involving representatives from multiple DOE sites possessing similar unique and/or orphan waste issues have been useful in identifying efficient technology development paths. By working together, these groups, such as the Mercury Work Group (HgWG) established in 1995 by the MWFA, have been able to effectively utilize the limited MWFA resources. Working groups allow the sites to collectively prioritize their specific issues and mutually determine the most optimum course for technology development, including any large-scale demonstrations and treatability studies. The work groups are also an ideal avenue for consolidating

various DOE site wastes that are similar, so that commercial treatment options become more economical. The addition of technology-based subject-matter experts (SME) to the work group is critical in ensuring its success. An unbiased SME provides key consultation on specific technology details and validates the decisions of the group. Dependent on out- year funding, the MWFA plans to utilize more working groups and subject-matter-experts for specific unique waste areas. The issue associated with the use of alternative oxidation technologies to address problematic organic-based mixed wastes is a prime candidate for a working group, inclusive of SMEs. Issues centered on reactive wastes and mixed waste containing tritium are also possible candidates for working groups.

Use of other Focus Areas and Crosscut Programs.

EM-50's other Focus Areas and Crosscut Programs may contain on-going or proposed development and demonstration efforts that could be leveraged toward specific problematic and/or orphan issues assigned to the MWFA. The Tanks, Subsurface Contamination and Nuclear Materials Focus Areas may have stabilization methods suitable for the problematic and unique mixed wastes. Additionally, the Efficient Separations Crosscut Program (ESP) may have development activities that could be utilized to address the tritium, mercury, or waste water treatment issues. Presently, the MWFA is managing two programs funded through the ESP to address issues involving the removal of mercury from organic media.

Throughout fiscal year 2000 and beyond, the MWFA will continue to review the development and demonstration projects of the other Focus Area programs and Crosscuts, and leverage any activities as they are applicable to the MWFA unique waste issues.

Use of the DOE Mixed and Low-Level Waste Center of Excellence.

The mission of the Center of Excellence for Low-Level and Mixed Low-Level Waste is to analyze critical waste management issues, formulate effective solutions, and assist DOE Headquarters in creating policies that are put into practice. As a consequence, the Center will be frequently consulted to better understand the issues and develop efficient resolution strategies.

Since the Center was established to provide technical support to DOE's national LLW and MLLW programs at the DOE Headquarters and the field level, the MWFA will interface with the Center on a continual basis. This interfacing will allow the MWFA to resolve issues more effectively and provide funding recommendations to the Center for the purpose of addressing short falls in MWFA resources.

Specific Approaches

Problematic Organics

Since significant development has already been completed on various AOTs to address the problematic organic-based mixed wastes, the best approach for the MWFA is to form an AOT Working Group to collectively define the path-forward strategies for the DOE complex.

The proposed AOT working group will be composed of DOE waste owners from across the entire complex. These individuals will be very knowledgeable of the waste issues at their respective sites and the relation of AOTs in regard to addressing the issues. Based on the needs associated with this category, representatives from LANL, LLNL, SRS, and Hanford will be required. Waste owners and potential end- users from the Ohio, and Albuquerque field office sites are also a possibility. The working group would also include 2-3 MWFA personnel representing both technical and regulatory expertise. State and Federal regulators would be asked to also participate in specific group meetings. The work group would also include subject matter expects (SMEs) in regard to the technical details and use of AOTs that have or have not been developed with MWFA support.

The objective of the work group will be to develop mutual strategies for addressing the mixed waste issues that may be resolvable via continued development, demonstration and deployment of AOT methods. Particular emphasis will be placed on those organic-based mixed wastes containing PCBs and the new regulations governing their land disposal. Cost savings will be realized since group-developed strategies will eliminate site specific activities and

allow end users at one site to leverage the activities of another. The group will analyze the existing AOT needs and recommend specific strategies that may include, but not be limited to the following:

1. Continued demonstration and deployment of previously developed AOT methods.
2. Use of available commercialization options.
3. Treatability studies.
4. Preparation of proposals for collective treatment

The MWFA requested a budget for the AOT work group in FY-2000 and has sought financial support from the DOE-ID Center of Excellence for Mixed and Low Level Waste.

Specifically, the Savannah River Site (SRS) has a Site Technology Coordination Group (STCG) need for an AOT process that will destroy the organic component of a combustible-debris mixed waste stream known as "job control" wastes. This waste stream includes personal protective equipment, rags, plastics, and wood contaminated with sub-micron plutonium-238 particles. Shipment of the waste to the WIPP requires destruction of the organic fraction to minimize or eliminate the radiolytic generation of hydrogen or repackaging, which would be prohibitively expensive.

The MWFA has worked and will continue to work with personnel at the Savannah River Site to develop a scope of work for the SRS Pu-238 job control waste. The work scope will define technical performance requirements for the alternative oxidation technology, selection criteria, and specific work activities to be incorporated in the Federal Energy Technology Center's (FETC) Request for Proposals (RFP) to be initiated in fiscal year 2000. The project is estimated to take four years from the date of award.

In addition to the Working Group and the SRS demonstration, the MWFA will also continue to support development of the Delphi Detox AOT at the Los Alamos National Laboratory to treat a small inventory of PCB mixed waste. In fiscal year 1999 LANL agreed to a DOE –HQ request to develop, design, install, and deploy a small-scale 5-gallon Delphi DETOX ^{TM} system after a larger scale Delphi demonstration was terminated at Savannah River for lack of a definite end-user. Since LANL plans to design and construct the small-scale unit in a manner that is transportable, Delphi may be in a position to commercialize themselves, use the process to approach potential markets, and treat other DOE mixed wastes after the LANL demonstration is complete. To reduce costs, the LANL Delphi effort will utilize applicable equipment being dismantled at Savannah River.

The schedule to complete the demonstration and actual waste treatment is March of 2001 with a surrogate study to validate the Delphi process in March of next year. Validation will be accomplished with cold testing using surrogates of the LANL PCB waste stream. The MWFA will be working with LANL to identify other surrogate compositions in order to assess the Delphi process for other waste streams in the DOE complex.

Reactives (Including Uranium Chips)

As a consequence of the limited DOE-HQ budget, there is presently no dedicated fiscal year 2000 MWFA funds specifically for those needs concerning unique waste that are reactive or highly energetic. However, the MWFA will continue to seek resources for specific reactive waste related issues, and may leverage funding for the AOT working group if provided. If resources are located, a test bed to evaluate technologies for reactive uranium chips treatment is available at the Hanford site. In fiscal year 1999, the MWFA funded a vitrification stabilization demonstration on a representative sample of the Hanford uranium chip inventory and, if complex wide interest and funding is made available, demonstrations of other technologies are possible.

Batteries

Contingent on available out year funding, the MWFA plans to gather information from across the various DOE sites regarding the quantities and types of mixed waste batteries. The information will supplement the existing mixed waste battery issues as indicated by the 5 STCG needs currently documented. Each year, the DOE Mound facility in Ohio funds a Large-Scale Demonstration Project involving specific wastes. Several battery decontamination methods may be available for testing through a similar program, if initiated and supported by the MWFA.

Dependent on available funding, the MWFA will co-sponsor a demonstration with a selected site to test the proposed battery decontamination system. If the demonstration proves successful, the MWFA will contact permitted treatment facilities to promote the deployment of the process.

Compressed Gas Cylinders

Oak Ridge presently has a LANL designed skid to recontainerize compressed gases to prepare them for disposal. The MWFA will contact Oak Ridge to determine whether Tennessee will accept gas cylinders from the rest of the complex for treatment. If Oak Ridge will not treat cylinders from outside the state, the MWFA will work with a commercial vendor to establish similar capability. The MWFA may have the resources to support the first production run of the deployed system and in the process eliminate as much of the mixed waste gas cylinder inventory as possible.

Mercury

For mixed waste classified as elemental mercury, Brookhaven National Laboratory (BNL) has developed, with MWFA resources, the Sulfur Polymer Stabilization System (SPSS) to treat their own inventory. BNL is in the process of licensing the SPSS to Envirocare of Utah for use on elemental mercury wastes from retorting and on other mercury wastes sent by other DOE sites. Dependent on available out year EM-50 funding, the MWFA will continue to support this technology transfer.

In addition, two commercial vendors, Nuclear Fuel Services (NFS) and ADA Technologies, have successfully demonstrated their elemental-mercury amalgamation technologies on DOE waste. Under MWFA sponsorship, elemental mercury from several DOE sites was treated by these vendors and will soon be disposed at Envirocare. These vendors have marketed their technology to treatment companies who hold the Oak Ridge Broad-Spectrum (BS) contracts. The BS contract to treat elemental mercury was awarded to the Allied Technology Group (ATG), who has recently obtained a treatment permit. NFS and ADA are marketing their technologies to ATG, competing for the contract; therefore ADA may be deploying their MWFA sponsored developed technology at ATG's facility to treat the BS contract mercury. Additionally, the Material and Energy Corporation (M&EC) has contracted with NFS to use the DeHg^{TM} process to treat elemental and other mercury–contaminated waste.

The MWFA plans to make effective use of the Broad-Spectrum contract by providing technical assistance and coordination to the sites to put together a large-scale treatment campaign. The Center of Excellence for Low Level and Mixed Low Level Waste at DOE-ID is interested in providing financial support to working groups that integrate the efforts of the DOE complex toward waste treatment. As such, the Center may supplement the limited MWFA funding available to support this effort.

For mixed wastes consisting of mercury- contaminated organic liquids, the MWFA, along with the EM-50 Efficient Separations Crosscut Program (ESP), will support a large-scale fiscal year 2000 demonstration of a technology utilizing the Self-Assembled Monolayer on Mesoporous Support (SAMMS) material. Given that the demonstration is successful, the MWFA will work toward deploying the technology at a treatment facility that also has the capacity to remove tritium from organic liquids. The MWFA will then coordinate with those DOE sites that have both mercury and /or tritium contaminated liquids to get those wastes treated.

The MWFA has demonstrated commercial capability in treating mercury-contaminated wastes with less than 260-ppm mercury. Three vendors, Nuclear Fuel Services (NFS), GTS Duratek, and Allied Technology Group (ATG) participated in demonstrations on actual DOE waste. These vendors are now permitted to treat waste or are teamed with others who have treatment permits. Innovative Technology Summary Reports (ITSRs) describing the companies' capabilities have been issued to the applicable DOE sites. The mercury-working group will contact waste managers at the sites to promote a unified effort to make use of these technologies and reduce treatment and disposal costs.

For mixed wastes containing mercury at concentration levels of greater than 260 ppm, the MWFA is conducting demonstrations of four technologies on the Chemical Hole Waste at Brookhaven National Laboratory (BNL). Sepradyne/Raduce is demonstrating their low-temperature vacuum retort system on the Chemical Hole Waste to serve as the baseline technology. Sepradyne will also treat other BNL wastes while on site to perform the initial

demonstration. BNL has demonstrated the sulfur polymer stabilization system (SPSS) on the same waste and will have the final waste form analyzed along with that of the other three participants to determine its behavior in a disposal facility. ATG and NFS are treating samples of the Chemical Hole Waste to demonstrate that their processes are also capable of treating >260 ppm waste and of reaching the required disposal requirement. BNL will deploy the SPSS at Envirocare of Utah. The MWFA will issue an ITSR to inform the DOE complex of this technology's capabilities and work with the sites to make use of the deployed technology. The MWFA will also issue ITSRs describing the performance of the other three technologies on the Chemical Hole Waste and will work with the EPA to obtain Determinations of Equivalent Treatment for NFS, ATG, and the SPSS to allow treatment of >260 ppm mercury wastes.

For addressing mixed mercury waste in water, the MWFA is sponsoring ADA Technologies to deploy their mercury-extracting water filter on sump discharges at the Oak Ridge Y-12 site. Depending on the performance of the deployed unit and requirements established by the State of Tennessee, a larger unit may be deployed to treat the water in Oak Ridge's East Fork Poplar Creek.

For mixed waste classified as mercury-contaminated debris, the Polymer Filtration Technology (PFT) will be tested at the Los Alamos National Laboratory. The test will be conducted at sufficient scale to prove its feasibility and obtain data to support scale up. The EPA is considering elimination of macroencapsulation as an acceptable treatment for mercury-contaminated debris, leaving PFT as the only available non-thermal technology to prepare mercury-contaminated debris for disposal. The MWFA will then support Los Alamos and their commercial partners in deploying the technology in fiscal year 2002.

Waste Forms and Stabilization

The MWFA will provide end-users and waste managers across the complex with the necessary information to select those technology solutions potentially suited for their specific waste form and stabilization issues, whether it involves troublesome salt, and/or ash concerns, or a need for a specific encapsulation technique. Over the past three years, the MWFA and other EM organizations have developed and demonstrated new stabilization materials based on innovative chemistries (such as ceramics and polymers) to increase waste loading and improve final waste form performance. Among these materials are polyester, phosphate bonded ceramics, enhanced cements, polysiloxane, sintered ceramics, polyethylene, sulfur polymer cement, iron phosphate ceramics, and sol-gels. Innovative Technology Summary Reports (ITSRs) have been written for most of these technologies

Depending on the specifics of an end- user's particular need, the MWFA will provide waste managers data obtained during the development of the above technologies as well as information on commercial technologies and/or technologies not developed with MWFA support. (Starting in fiscal year 2000, the MWFA will begin efforts to consolidate much of the extensive stabilized waste form data into a single document). Based on their evaluation of the data, end-users will chose those technologies to be further developed through treatability studies and/or demonstrations to ensure deployment. No new starts involving untested new low-temperature stabilization technologies will be initiated based on the numerous developments in this area the last 10 years, but depending on funding available in the out-years the MWFA may support specific small-scale treatability studies. This same strategy will be utilized for existing and anticipated needs involving encapsulation.

The following site-specific development efforts have been and may continue to be supported by the MWFA for the purpose of providing solutions to specific stabilization-based needs as identified. The MWFA has recommended an out-year budget to continue support in two of the following areas, as well as for the area of general encapsulation. The MWFA has also recommended an out-year budget to address any new needs associated with this area, or to address needs not solved as planned in fiscal year 2000.

1. The Hanford site has recently completed a treatability study with a specific vendor's phosphate-based, low temperature stabilization process. The study was performed with actual salt-dryer residues from their Effluent Treatment Facility. These residues are not anticipated to meet disposal requirements in the near future.

2. The Savannah River Site is conducting treatability studies on two processes (e.g. phosphate bonded ceramics, Adtech's Super Cement) with the purpose of validating an efficient stabilization process for both the ash and the salt blow down from their Consolidated Incineration Facility. The project started in fiscal year 1998, and work

will continue through fiscal year 2000. The second phase of the project addresses the need for studies to ensure stabilization equipment is compatible to the process chosen as well as efficient for the incinerator environment.

3. The MWFA is currently managing two EM-50 sponsored Accelerated Site Technology Deployment (ASTD) programs involved with stabilization. One is the stabilization of various Rocky Flats waste water treatment sludges using a commercial low-temperature method involving phosphate chemistry, the other a macroencapsulation process using a commercially provided polyethylene overpack system. The system will macroencapsulate debris waste from Oak Ridge. Based on the successful completion of these 2 ASTD projects, the MWFA will promote subsequent deployments of the same methods at other DOE sites to resolve other outstanding needs in this category.

4. At INEEL efforts are underway to demonstrate a fly ash stabilization process at full-scale. The mixed waste fly ash is generated by INEEL's mixed waste incinerator and has been difficult to effectively stabilize with simple cements. Past MWFA sponsored development efforts have included treatability studies with enhanced concretes, sintered ceramics, and phosphate bonded ceramics. The current schedule indicates demonstrating the chosen technology at full-scale in fiscal year 2000.

Tritium

The MWFA presently is not devoting any funding to specifically solve the tritium treatment problem, except for the side issue of removing the mercury from organic liquids as a preparatory step to tritium removal. Commercial capacities must be thoroughly investigated to determine if the private sector can provide the treatment. The wastes must also be inventoried and examined to determine the full extent of the problem and to find out if any of the wastes are of a classified nature that would exclude them from treatment by the private sector. If the commercial sector falls short, the MWFA may then support the continued development of any DOE developed technologies to ensure that the needs can be met.

Wastewater/Aqueous

In the past year, the MWFA was able to address a limited number of issues associated with the treatment of mixed wastewater. For example, the MWFA sponsored the development and deployment of a chemical redox method to denitrify effluent wastewaters. The batch process is currently in place at LANL and is treating mixed wastewater on a continual basis. The technology will be recommended to other potential DOE site end-users that have similar denitrification needs.

Even without dedicated funding, the MWFA will continue to assist end-users in their unique mixed wastewater needs by identifying commercial options, leveraging past development, or utilizing developments being completed by other Focus Areas. A key part of the out-year strategy will be to utilize available resources or applicable research being conducted by both the EM science program and the Crosscuts. The EM science program in particular has completed research on several innovative metal removal processes for waste water and the MWFA may recommend the work be elevated to the Focus Area level.

REFERENCES

1. *Mixed Waste Focus Area Integrated Technical Baseline Report*, Phase 2, Volumes 1 and 2 DOE/ID –10524, Revision 1, Idaho National Engineering and Environmental Laboratory, Idaho Falls, ID, April 1997