ASSIGNMENT OF HAZARDOUS WASTE TREATMENT STUDY GROUPS AND PROCESS SCHEMES USING WASTE CHARACTERIZATION DATA

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Introduction

The Federal Facilities Compliance Agreement (FFCA) between the Environmental Protection Agency (EPA) and the Department of Energy (DOE) identifies Land Disposal Restriction (LDR) hazardous wastes on the Oak Ridge Reservation (ORR) without existing or identified treatment methods or facilities to allow disposal in accordance with the Resource Conservation and Recovery Act (RCRA). The ORR includes the Oak Ridge National Laboratory (ORNL), the Y-12 Plant, and the K-25 Site. The FFCA requires submittal to EPA of treatment plans for the LDR wastes at these sites. The wastes are divided into two categories: wastes for which existing treatment methods and facilities exist on the ORR, or "Appendix A" wastes; and, wastes for which existing treatment methods and facilities do not exist or have not been identified, or "Appendix B" wastes. The ORR Appendix B wastes consist of mixed (radioactive/hazardous) wastes (both characteristic and listed) that must be treated to meet LDR standards according to 40 CFR § 268.41 before ultimate disposal.

The Development, Demonstration, Testing, and Evaluation (DDT&E) program was established by Martin Marietta Energy Systems, Inc. to identify treatment methods for all ORR Appendix B wastes; the treatment focus is on removal/stabilization of hazardous components rather than on radionuclide removal. The DDT&E program will use results from treatability studies (proof-of-principle up to pilot-scale studies) in

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evaluating potential treatment technologies. Potential treatment methods for which these treatability studies will be conducted were prioritized in "The Strategic Plan for the Treatment of Appendix B Wastes" [1]; the prioritized technologies are given in Table 1. Currently, the focus of treatability studies at the ORR is for:

- final waste form development (cementation and glass vitrification) for solids contaminated with RCRA metals (except mercury);
- thermal desorption of soils and sludges contaminated with volatile and semi-volatile organics, polychlorinated biphenyls (PCBs), and mercury;
- pretreatment of aqueous waste to meet existing treatment facility waste acceptance criteria;
- where possible, organic liquid pretreatment to meet waste acceptance criteria of the Toxic Substances Control Act (TSCA) incinerator at the K-25 Site.

Also, results from treatability studies at other DOE sites will be monitored and results integrated where possible. Waste characterization information and waste categorization needed to support the DDT&E treatment technology development efforts are being provided by the Evaluation of Waste Data (EWD) project.

Evaluation of Waste Data

Collection of Characterization Data

A primary focus of the EWD project is to collect characterization information for Appendix B wastes stored on the ORR. This information is collected from:

- Site hazardous waste tracking databases.
- Request for Disposals (RFDs).
- Analytical data.
- Generation process information.
- Previous treatability study results as well as data from other special reports.
- Generator interview information.

During these data collection efforts, special emphasis has been placed on obtaining information for the large quantity waste streams that represent a significant fraction of the LDR wastes present on the ORR. After collection, information is entered into a relational database (EWD Interim System) which has the ability to include analytical data and other information in the waste records as well as perform database sorts on specific parameters such as RCRA contaminant concentrations, PCB concentrations, waste matrix composition, etc. Quality assurance activities in accordance with DOE Order 5700.6C (*Quality Assurance*) are being performed during data collection to ensure correctness and completeness of the information obtained.

Waste Categorization and Evaluation

Figure 1 shows a schematic of the waste categorization and evaluation process. Based on collected characterization information, each Appendix B waste is placed into a National Plan Category (NPC). The NPCs are categories developed by DOE to allow grouping of similar wastes based on waste matrix and contaminants; the NPCs are shown in Figure 2. Each waste is also placed into a treatability study group (TSG). The TSGs are treatment process schemes that were formulated to reflect the various waste matrices, waste contaminants, and potential treatment technologies listed in the Strategic Plan [1]. The 16

process schemes are given in Figure 3. NPCs in combination with contaminant and/or matrix information are used to assign each waste to the appropriate TSG according to the logic diagram given in Figure 4. Figure 5 shows the distribution of ORR wastes in each TSG. The majority of the wastes have TSGs for which the treatment technology is immobilization or thermal desorption, which are being emphasized in technology development efforts.

Figure 1 also shows that, except for large quantity waste streams (since a large quantity stream is considered its own population), discrete waste populations are also formed. Waste populations represent waste streams judged to be sufficiently similar in matrix, contaminants, and properties to be grouped together for the purposes of statistical sampling to obtain analytical data for the population and to obtain a statistically representative composite sample that can be used for the performance of treatability studies. Statistically sampling waste populations for analytical data may, depending on desired data confidence limits, lead to substantial savings in characterization costs and would allow determination of the range of contaminants with which, if necessary, to spike the treatability study composite sample. It also allows the prioritization of wastes on which to conduct treatability studies: treatability studies conducted on the large quantity wastes streams and the larger quantity waste populations will ensure that development efforts will be representative of the majority of wastes in a particular TSG. Composite samples will also be reflective of waste blending that will occur during full-scale treatment. Figure 6 shows an example of the soil and sludge waste populations requiring thermal desorption at the Y-12 Plant[2]; it indicates that over 50% of the wastes are contained in only two waste populations (A and B). Thus, for the 50 containers represented by the two populations, only two treatability studies on the statistically sampled populations will be required (as opposed to potentially up to 50 different studies that might have been required if each container was considered individually for treatability studies).

[2]Large quantity waste piles at the Y-12 Plant are not reflected in this figure.

Waste Characterization Requirements

Waste characterization requirements (information standards) necessary to conduct treatment technology development efforts were formulated with input from ORR technology developers, literature reviews, technology vendors, and technical experts within and outside the DOE complex. As indicated in Figure 1, these requirements, given in Table 2, provide general guidance concerning the types of analytes and analytical methods specified for waste characterization when sampling and analysis plans for the waste populations are formulated. Analytical data needed to satisfy health and safety, quality assurance, and off-site shipment readiness review requirements are also identified and included in the sampling and analysis plans for the waste populations. As Table 2 indicates, these characterization information needs are typically much more demanding compared to the analytical data needed to only determine compliance and storage requirements. Also, special analytical or preparatory techniques (e.g. harsh digestion conditions for soil or sludge matrix analyses) are sometimes necessary in order to obtain data that can be more fully utilized in technology development efforts.

Characterization Data Applications

Existing characterization data and that obtained as the result of sampling and analysis activities, including averages, ranges, and standard deviations of contaminants, process interferences, and matrices for each waste population and composite sample will be provided to the technology developers. All data will be thoroughly reviewed to ensure each waste is placed in the appropriate NPC, TSG, and waste population. In addition, information will be used to identify wastes that may be non-hazardous (and so do not require treatment) and to verify RCRA EPA code (i.e., contaminants) assignments to wastes. Also, existing treatment facility waste acceptance criteria will be compared to waste characteristics to identify those for which treatment is available on-site. Data will be used to support readiness review efforts for off-site shipment of wastes to vendors to perform treatability studies. Finally, the characterization data that is collected will also be used to support the information needs of the ORR's proposed Mixed Waste Treatment Facility (MWTF), its Site Treatment Plans (STPs), its Mixed Waste Inventory Reports (MWIR), and waste

stream treatment privatization efforts.

Conclusions

Upon completion of sampling and analysis activities, the EWD project will result in a database containing waste characterization information necessary for development of treatment technologies for ORR Appendix B wastes. Currently, each waste has been assigned to a matrix and contaminant-based NPC, a treatment technology-based TSG, and a waste population. The performance of treatability studies on these statistically sampled waste populations and on large quantity waste streams will ensure technology development efforts have covered the majority of wastes stored on the ORR.

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References

1. "The Strategic Plan for the Treatment of Appendix B Wastes", *DOE/OR-1083 Rev. 0*, February 12, 1993.

Table 1. Prioritized Treatment Technologies [1].		
Neutralization	Cementation	Glass Vitrification
Polymer Encapsulation	Microwave Solidification	Thermal Desorption
Steam Cleaning	Electrochemical Metal	Supercritical Fluid
Incineration	Removal	Extraction
Mercury Amalgamation	Precipitation	Filtration
Ion Exchange	Evaporation	Chelation
Carbon Adsorption	Chemical Extraction	Chemical Oxidation
Aerosol Can Puncture and Release		

Table 2. Treatment Technology Characterization Requirements.

Characterization Parameter	Organic Liquid Treatment	Aqueous Liquid Treatment[1]	Thermal Desorption	Immobilization[2]	Surface Decontamination[3]
Radioanalysis and Screening[9]	X	X	X	X	X
Host Matrix Material Composition	X	X	X	X	X
RCRA Contaminant Concentrations	X	X	X	X[8]	X
PCBs	X	X	X	X	X
Solution pH	X	X		X[6,7]	
Dissolved Solids Species and Concentrations	X	X		X[7]	
Suspended Solids Concentration	X	X		X[7]	
Complexing and Chelating Agents Present	X	X			
Moisture Concentration	X		X	X	X
Halides and Nitrate Concentrations				X	
Sulfur and Phosphorus Compound Concentrations				X	
Total Organic Carbon (TOC) Concentration		X	X	X	
Oil and Grease Content		X	X	X	X
Bulk Combustible Content	X[4]		X[4]	X[4]	X[4]
Particle Size Fractions	X			X	
Metal Pieces Content			X[4]	X[4]	X[4]
Bulk Physical Shape and Size			X[4]	X[4,5]	X[4]
Surface Characteristics (Clean, Painted, Oily, Cracked, etc.)				X[4,5]	X[4]

Table 2. Treatment Technology Characterization Requirements (continued).

[1]Aqueous liquid treatment technologies are precipitation, ion exchange, filtration, carbon adsorption, chemical extraction, and chelation.

[2]Immobilization technologies include cementation, glass vitrification, polymer encapsulation, and microwave solidification.

[3]Surface decontamination technologies include thermal desorption, steam cleaning, electrochemical metal removal, and supercritical fluid extraction.

[4]Determined by inspection.

[5]Applicable only for macroencapsulation by cementation or polymer encapsulation.

[6]Liquid phase pH.

[7]Needed only for liquids (<40% solids).

[8]Toxicity Characteristic Leaching Procedure (TCLP) analysis for RCRA contaminants also needed.

[9]As necessary to account for gross radionuclide levels.