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DEVELOPMENT, DEMONSTRATION, TESTING, AND EVALUATION EFFORTS ASSOCIATED WITH THE OAK RIDGE RESERVATION'S LAND DISPOSAL RESTRICTIONS FEDERAL FACILITY COMPLIANCE AGREEMENT

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On June 12, 1992, the U. S. Department of Energy Oak Ridge Operations Office and the U. S. Environmental Protection Agency (EPA) -Region IV signed a Federal Facility Compliance Agreement (FFCA) to regulate the treatment of wastes governed by the Land Disposal Restrictions (LDR) of the Resource Conservation and Recovery Act (RCRA).[1] Compliance Requirement 5 of the agreement states that " . . . DOE shall submit to EPA for review and approval a plan for the treatment of the LDR prohibited wastes identified in Appendices 1B, 2B, and 3B. This plan must identify the treatment strategy for such wastes to meet LDR treatment standards and must include a schedule, not to exceed two (2) years after the submittal of this plan (i.e., March 1995), for the evaluation and prioritization of treatment method options, treatability studies, if required, and technology development."[1] The FFCA divided the mixed wastes currently stored on the Oak Ridge Reservation (ORR) into two categories. Appendix A listed those wastes for which existing treatment methods and facilities exist. Appendix B listed wastes for which no identified treatment methods or facilities exist on the ORR.

As part of the FFCA, DOE was required to submit to EPA a plan that documents the strategies that will be used to treat Appendix B wastes generated and/or stored on the ORR. These strategies considered the evaluation, selection, and prioritization of treatment technologies and the identification and performance of treatability studies and technology development activities necessary to comply with the applicable regulatory standards. *The Strategic Plan for the Treatment of Appendix B Wastes* (TSP) was issued on February 12, 1993.[2]

Development efforts will be coordinated with the FFCA programs at the Paducah Gaseous Diffusion Plant (PGDP) and the Portsmouth Gaseous Diffusion Plant (PORTS). The low-level mixed wastes currently stored at PGDP and PORTS are similar to those on the ORR. When waste types permit similar treatment, the PGDP and PORTS wastes will be integrated into the ORR process development efforts.

This paper outlines the development, demonstration, testing, and evaluation (DDT&E) efforts necessary to identify treatment methods for all the waste listed in Appendix B of the ORR's LDR/FFCA as well as any new wastes which meet Appendix B criteria. To successfully identify a treatment method, at least a proof-of-principle level of understanding must be obtained: that is, the candidate processes must be demonstrated as effective in treating the wastes to the LDR; however, an optimized process is not required. Where applicable and deemed necessary and where the budgets will support them, pilot-scale demonstrations will be pursued. The overall strategy being adopted in this program will be composed of the following activities:

1. scoping of the study,
2. characterization,
3. development and screening of alternatives,
4. treatability investigations, and
5. detailed analysis of alternatives.

The strategic plan is the basis for the efforts described in this plan.

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DISCLAIMER

EVALUATION OF WASTE DATA

The strategic plan requires that an evaluation of all LDR wastes be made. The goal of this effort is to establish the necessary and sufficient information to effectively conduct treatability studies and technology development for mixed waste treatment. The Evaluate Waste Data project has the following four objectives:

- develop technology-based sufficiency criteria to determine the data type and level of detail needed;
- gather and evaluate data by collecting existing waste documentation and conducting generator interviews, as necessary, to categorize wastes into treatability study groups;
- identify wastes that will require sampling and analysis prior to conducting treatability studies and determine specific sampling and analysis needs; and
- establish pretreatment, primary treatment, and posttreatment requirements for all Appendix B waste.

The satisfactory accomplishment of these objectives will minimize the amount of characterization and the number of treatability studies required to develop treatment technologies for Appendix B mixed wastes. In addition, this evaluation may identify potential deficiencies with previous RCRA characterizations. The waste categories used are depicted in Figure 1, while the data evaluation methodology is presented in Figure 2.

ALTERNATIVES AND TREATABILITY INVESTIGATIONS

A wide range of possible candidate treatment technologies exists. These technologies are at various stages of development from conceptual design to commercial-scale facilities. Some of these technologies have been used to treat low-level mixed wastes, but a majority have not. The strategic plan was developed by the Energy Systems Waste Management Organization of Martin Marietta Energy Systems to place the Appendix B wastes into categories as defined by the DOE low-level mixed waste project (funded by EM-30) and to identify all appropriate treatment technologies for each of those categories. A prioritization analysis was performed to match the categorized wastes with a preferred treatment technology or technologies. (see Table 1). The resulting matrix is the planning foundation for the DDT&E Program. Sixteen National Plan subcategories were combined to form 11 treatability groups. These treatability groups were distributed among 11 treatment technologies: 4 chemical processes, 5 thermal processes, and 2 immobilization processes. The two immobilization processes and two of the thermal processes (glass and microwave melting) are addressed as part of the Final Waste Forms (FWF) Project. Only one of the thermal processes, low-temperature thermal desorption, will be pursued vigorously on the ORR. Thermal desorption is a mature, well-understood process which has the potential for treating the largest waste streams with a reasonably straightforward approach and thus will be emphasized in the DDT&E Program.

THERMAL DESORPTION

The removal of volatile RCRA and Toxic Substance Control Act constituents, in particular mercury, polychlorinated biphenyls, and chlorinated solvents, is essential to the development of a treatment method for many of the Appendix B wastes because of the widespread nature of these contaminants in ORR wastes.[2] The broad class of processes known as thermal desorption has been chosen to accomplish the removal of these volatile hazards. Thermal desorption is an ex situ means to physically separate volatile and semivolatile contaminants from soil, sediments, sludges, and filter cakes.[3] The data required to design an optimized processing facility (or facilities in the case of transportable units) will be obtained. This optimized process will include not only the parameters of the desorption unit itself but also the off-gas and front-end handling systems. The data will be acquired through bench-scale and pilot-scale experiments either on-site (on the ORR) or off-site (at other DOE facilities or at commercial vendors).

FINAL WASTE FORMS

The FFCA TSP identified four immobilization technologies for treatment of the Appendix B wastes: cementation, glass melting, microwave solidification, and polymer encapsulation. The FWF Project is chartered with providing the necessary data and process information to support development of these technologies. This section describes the activities comprising the FWF Project. This project will support the identification and selection of the TSP stabilization processes and, as funding permits, the design and operation of a stabilization facility.

The FWF Project has four fundamental goals:

- develop stabilization methods for specific FFCA Appendix B wastes,
- provide the technical information necessary to facilitate selection of the stabilization technology,

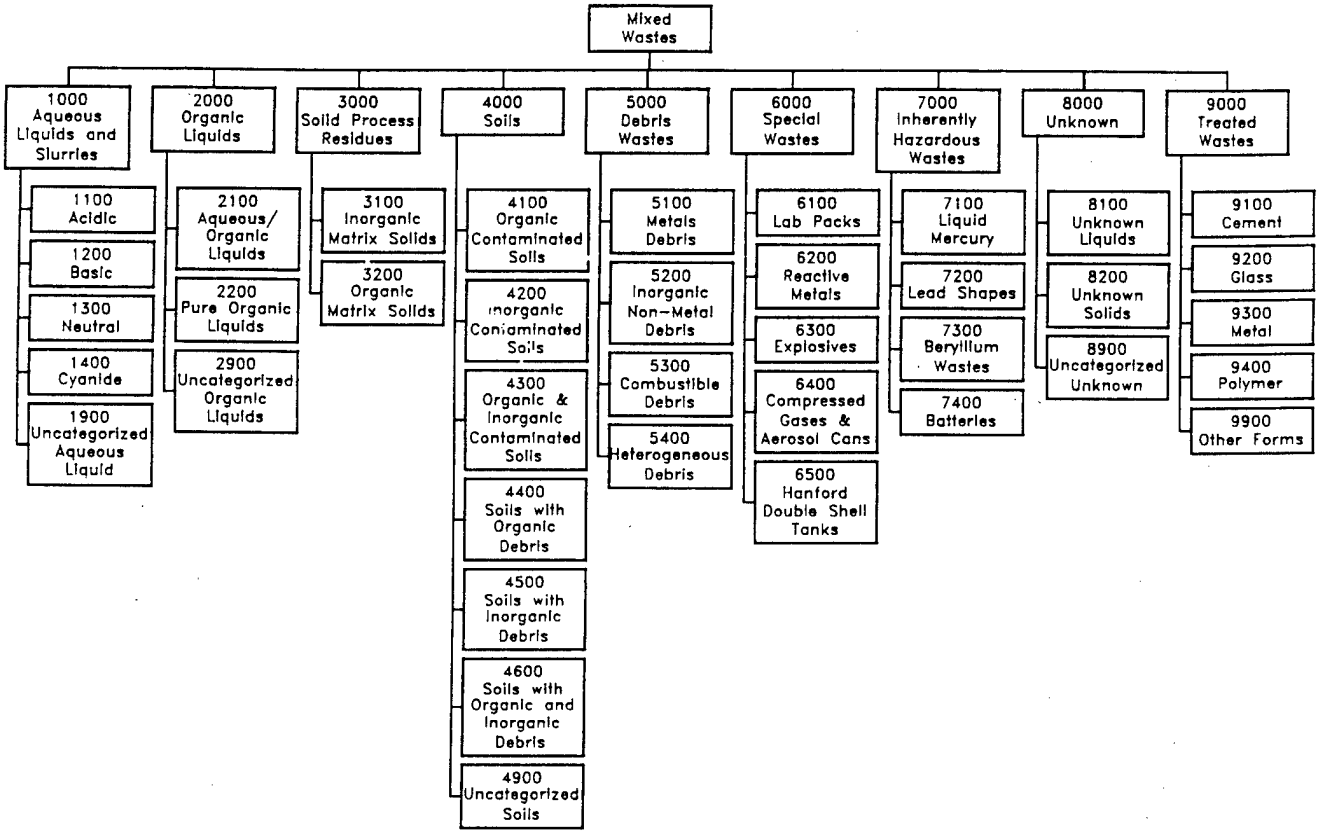

Figure 1. DOE National Plan Mixed Waste Classification System

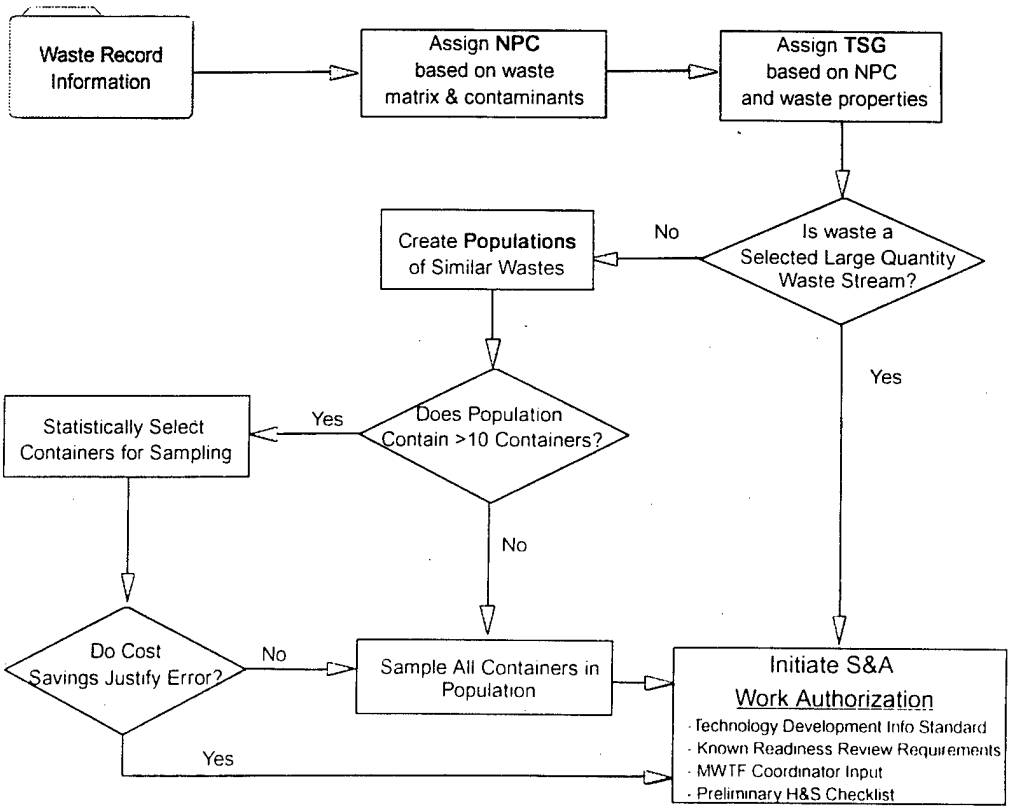

Figure 2. DDT&E Waste Evaluation Methodology

Table 1. Treatment Technologies Selected for Treatability Studies and Monitoring

National Plan Waste Category*	2000	3100 5200	3200	4100	4200	5100	5300 5410 5420	6100 6400	6200	7100	7200 7400
Perform Treatability Studies and Development											
Glass Melting (Vitrification)	x	x		x	x			x			
Microwave Melting		x		x	x						
Low-Temperature Thermal Desorption		x	x	x	x	x				x	
Cement Solidification		x		x	x	x					x
Rotary Kiln	x	x	x	x	x		x	x			
Integrate ORR Requirements											
Supercritical Fluid Extraction		x	x	x	x	x	x				
Polymer Solidification		x			x	x					x
Monitor Technology Development											
Acid Digestion	x		x				x				
Biological Treatment	x		x	x							
Chemical Oxidation	x		x						x		
Plasma Melting	x	x	x	x	x	x	x				

*See Figure 1 for category names.

- provide technical assistance for the design of the Mixed Waste Treatment Facility (MWTF), and
- provide the capability to evaluate future modifications to the MWTF and treatment options for miscellaneous small-quantity waste streams.

To accomplish these goals, four key activities are planned: Development of Stabilization Technologies, Development of Final Waste Form Performance Criteria, Development of a Waste Matrix Baseline, and Establishment of Potential Vendor Requirements. The stabilization technology development effort involves coordinating final waste form development activities with activities of other DDT&E projects as well as with the EM-50-funded Mixed Waste Integrated Program. Consequently, the FWF Project may be modified to reflect developmental and process knowledge gained from these projects.

AQUEOUS/ ORGANICS/ DECONTAMINATION

The technologies discussed so far will cover the treatment of 80 to 90% (by volume) of the mixed wastes on the ORR. The remaining 10 to 20% must also have viable treatment options for inclusion in the treatment methods plan due to the EPA in March 1995. These wastes can be divided into three classes: aqueous liquids, organic liquids, and debris. Of the treatment technologies listed for debris in Table 1, treatability studies will be performed for glass melting, microwave melting, thermal desorption, solidification, and rotary-kiln incineration. The aqueous and organics wastes must be either treated for discharge or pretreated prior to primary treatment in an existing waste treatment process. The TSP indicates that the pretreatment approach is to be pursued for the aqueous and organics wastes. The problematic characteristics for the treatment or pretreatment processes may be physical, such as particulate size distribution (micron-size particulates may blind filters in an off-gas treatment system) or chemical, such as the presence of chlorides, nitrates, and organics (creating problems for the final waste forms). The characteristics of concern, whether chemical or physical, must be delineated by the applicable regulations (e.g., the Clean Water Act, National Emission Standards for Hazardous Air Pollutants); the other projects within this DDT&E Program; and/or the Waste Acceptance Criteria of the existing treatment facility that would further process the wastes. The separation or elimination of these characteristics or the species that create them will be the focus of this project within the DDT&E Program. A listing of many of the chemical/physical separations technologies available can be found in Table 2.

REFERENCES

1. "Federal Facilities Compliance Agreement for Storage of Radioactive Mixed Waste Subject to Land Disposal Restriction for the Oak Ridge Reservation," U.S. Department of Energy, Oak Ridge, Tennessee, June 12, 1992.

2. U.S. Department of Energy, *Strategic Plan for the Treatment of Appendix B Wastes*, DOE/OR-1083, Rev. 0, U.S. Department of Energy, Oak Ridge, Tennessee, February 1993.

3. *Alternatives Evaluation of the Treatment, Storage, and Disposal Options for Low-Level Radioactive, RCRA/TSCA, and Mixed Waste at the Y-12 Plant*, Y/SUB/92-99069/1, Science Applications International Corporation, Oak Ridge, Tennessee, October 1992.

Table 2. Chemical/Physical Separation Technologies

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Solid/Liquid Separation Technologies
• Chemical Techniques
• Biological Processing
• Media Beds
• Membranes
• Electrolysis
• Electrokinetic Techniques
• Thermal
• Filtration
• Solvent Extraction
• Nitrate Destruction
• Mechanical Separation
Liquid/Liquid Separation Technologies
• Media Beds
• Distillation
• Steam Stripping
• Air Stripping
• Mechanical Techniques
• Membranes
Solid/Solid Separation Technologies
• Mechanical Techniques
• Electromagnetic Techniques

Source: C. H. Brown, Jr., and W. E. Schwinkendorf, *Technical Area Status Report for Chemical/Physical Treatment Volume 1,* DOE/MWIP-18, Martin Marietta Energy Systems, Inc., August 1993.

DoE