THE DETOX^{SM} DEMONSTRATION PROJECT A REVISED APPROACH TO DEMONSTRATION & DEPLOYMENT

Terry W. Rogers and Scott D. Goldblatt,
Delphi Research Inc., Albuquerque, N.M.

ABSTRACT

EM-50 has terminated the effort to develop a full-scale low level mixed waste (LLMW) DETOX^{SM} treatment unit at the U.S. Department of Energy's Savannah River Site, primarily due to reduction in the demand for large-scale, LLMW treatment facilities at selected DOE sites. The demonstration has refocused on small volume, problematic waste types found at many DOE facilities and sites. These wastes are costly to store and have no readily available treatment options on-site. Therefore, the demonstration effort has been redirected to design and construct a mobile treatment unit capable of treating such wastes. The project has been reassigned to Los Alamos National Laboratory (LANL) and is planned to test the effectiveness of the process in treating radioactive contaminated TSCA wastes. A comparison is made of the full scale and mobile treatment demonstration programs at the two DOE sites, identifying the common characteristics and differences. Special note will be made of the emphasis on the LANL demonstration plan elements that will greatly improve deployment and commercialization of the technology.

INTRODUCTION

Delphi Research, Inc. has been involved in the technology development programs sponsored by EM-50 over the period 1992 to 1999 for the development and demonstration of a full-scale waste treatment system designed for application to low level mixed wastes. Delphi managed the effort to design, fabricate, install, and operate a 25kg/hour DETOX^{SM} demonstration unit at DOE's Savannah River Site in South Carolina. In the course of this effort, Delphi has prepared documentation and procedures required to meet federal, state and site requirements for permitting, safety, and operations of a full scale treatment facility. Having passed scrutiny of the Gate Four Review (1.), ASME Peer Review (2.), SRS Operational Readiness Review (3.), and an EM-50 Special Review Team Evaluation (4.), the technology has consistently been found to be technically sound and offer advantages over existing technologies in treating low level mixed waste. In order to demonstrate the technical performance of the process on LLMW and determine the economic advantages it might provide, the demonstration project has been redefined as a small (1 kg/hr), transportable treatment unit capable of treating small volume, problematic waste streams. Key elements of a demonstration project are discussed with comparisons noted between full-scale and small-scale demonstrations. Suggested improvements in design of demonstration projects are noted.

SELECTING APPROPRIATE DEMONSTRATION ELEMENTS

Los Alamos National Laboratory has assumed management of the project with the IT-Oakridge facility selected as the host site. The waste chosen for demonstration is a PCB/oil mixture contaminated with Plutonium. Of interest to the U.S.E.PA. is the inclusion of Hg contaminated materials in the test agenda in order to evaluate the effectiveness of DETOX^{SM} in treating and stabilizing such wastes. A comparison major demonstration elements of the small scale unit (LANL/IT Oakridge) with those used in the full scale demonstration at Savannah River Site (SRS) provides some meaningful insight as to those elements of demonstration common to each project and those which need to be modified with the scope of the effort (See Table I).

Table I. Demonstration Elements at SRS and LANL/IT Oakridge

Description	**SRS**	**LANL/IT Oakridge**
	Demonstration Test Plan	Project Plan
Stakeholders	Technology Developer, Sponsoring Agency (EM-50), Host Sites, Design and Fabrication Firm, Regulatory Agencies, and Potential Customers	Technology Developer, Sponsoring Agency (EM-50), LANL, and Host Site, U.S. EPA.
Host Site	DOE-SR and M&O Contractor – no vested interest in success.	IT/Oakridge, partner in demonstration. Potential Strategic Partner for commercialization.
Demonstration Scale	25 kg/ hr	1 kg/hr
Potential Applications	Solid waste, liquid, and sludge Plastics, paper, latex Chlorinated solvents Chlorinated oils Non-chlorinated solvents Non-chlorinated oils Tri-butyl phosphate	Liquids only PCB's w/ Pu PCB's w/ Pu & Hg
Permitting Requirements	NPDES- Waste Water Treatment Facility Air Quality Exemption Status	Treatability Study with pathway to full Part B RCRA, TSCA permits possible.
Permitting Jurisdiction	South Carolina, New Mexico	Tennessee
Stabilization of residues	Treatability Study – New Mexico	Stabilization integrated into process design. To be performed in Tennessee.
Testing Objectives	1. Verify oxidation rate 2. Verify Throughput capacity 3. Evaluate operating controls 4. Determine destruction efficiencies 5. Verify materials compatibility 6. Validate procedures and data	1. Verify oxidation rate 2. Verify throughput capacity 3. Optimization of operating controls 4. Determine destruction efficiencies 5. Verify materials compatibility during operating conditions 6. Validate data

Site Requirements	1. Integrated Safety Management System 2. Readiness Review 3. HAZOP 4. Hazards Assessment Document 5. Process Hazards Review 6. Safety Walkdown 7. ASME-B-31.3 Certification 8. Pressure Vessels – Certification 9. Document Control System 10. Safety Review 11. Restricted Use of Support personnel per site agreement 12. CRADA with site contractor 13. Site specific training 14. Site Preparation – major installation issues, building, utilities, waste water treatment 15. Equipment to meet NFPA standards 16. Validation Plan 17. Sampling and Analysis Plan 18. Experimental Plan 19. Maintenance Plan 20. Spill Prevention and Control Countermeasures 21. Conduct of Operations – DOE Order– 5480.19	1. Readiness Review 2. HAZOP 3. ASME B31.3 Certification 4. Pressure Vessel Certification 5. Rad. Worker Training 6. Permacon 7. Sampling and Analysis Plan 8. Experimental Plan
Deployment Path	Transition from demonstration host for LLMW to User	Deployment Plan to be developed by Technology Developer.
Quality Assurance Plan	QA Plan integrated into project plan by Technology Developer.	Formal QA plan integrated into project plan by LANL
Decontamination & Transport of Radioactive Contaminated Equipment.	No decontamination and transport plan developed.	Plan included in Closeout Task.

Each of the above factors marks significant changes in the approach to demonstration and deployment of a waste treatment technology. Whether the revised model will address all issues encountered during demonstration remains to be seen; however, having experienced first-hand the shortcomings and success of a full-scale demonstration effort, the strategy resulting in this new approach to demonstration requires further explanation. Key parameters used to define this project are discussed in detail as follows:

Stakeholders

Of primary importance in the demonstration is the location of the actual equipment. In the full-scale demonstration at SRS, the term stakeholder was applied to many participants in the demonstration process; however, the scope of communication management was overwhelming in seeking approvals and in-put from a list of 60 or more stakeholders including DOE, regulators and key participants. The stakeholders in the LANL managed demonstration has been redefined to include those immediately involved in the project and its outcome and therefore, has eliminated much of the formality and extensive communications requirements imposed on the full-scale demonstration. This smaller stakeholder list is better focussed and will simplify decision-making and participation in the project as it progresses.

Host Site

The host for the demonstration is a key participant in the process. When demonstration is performed on a DOE site, not only do all site requirements come to bear on the project, but the management philosophy in applying site standards can impose significant cost and delays to what is otherwise an already difficult and complex process – technology demonstration. Performing simple tasks, such as repairs, maintenance, minor modifications, or changes in operating procedures can become a significant event requiring reviews and approval and months to implement. The change in demonstration sites from a DOE-Site to an off-site testing facility operated by a private contractor offers significant advantages regarding documentation, training, authorizations, and the use of subcontract organizations to accomplish the necessary tasks associated with design, fabrication, assembly, testing, operation, decontamination and preparation for transport. All of this translates to cost savings in securing the fundamental element required for technology demonstration and deployment – validated data.

Demonstration Scale

The unit design addresses not only the process considerations, but also the customers demands and wishes as well. The full-scale demonstration unit was designed to accommodate a throughput maximum of 25 kilograms per hour of dry weight organic. This throughput was based upon inventoried wastes available at multiple DOE sites in 1995. Since that time, reported LLMW's in inventory at DOE facilities have varied substantially with regard to volume of waste requiring treatment versus waste with identified treatment methods. Such variable data was used to make pivotal programmatic decisions in the full-scale demonstration at SRS and therefore made any plans for deployment and stakeholder involvement impossible to achieve. The current 1 kg/ hr capacity DETOX^{SM} treatment unit is designed to meet the needs of inventoried wastes at many DOE facilities. These wastes are considered small in volume, yet problematic in that disposal options are lacking or very expensive. Among the small-volume items common to almost every DOE site are PCB contaminated oils and solvents, that contain radionuclides and/or mercury. Thus, the 5-gallon unit is directly responsive to specific PCB/Plutonium wastes on hand at LANL and other DOE sites. In addition, the inclusion of mercury contaminated wastes to the test agenda is in response to an U.S. EPA evaluation of technologies that are an alternative to incineration. Data verified as meeting the destruction efficiency criteria while containing and stabilizing the radionuclides and heavy metals will qualify the DETOX^{SM} process for Best Developed Alternative Technology status for mercury contaminated organic wastes.

Potential Applications

While the process lends itself to a broad range of applications, the full-scale approach to demonstration was too inclusive of all potential applications and therefore complicated the process of demonstration, as well as elevated the cost of testing. The LANL demonstration project is designed to focus on liquid waste streams. However, contingency has been incorporated in the design for the addition of solids feed system later pending the successful outcome of liquid-feed tests. The LANL demonstration is focused on TSCA materials contaminated with plutonium and mercury. Such wastes constitute the most difficult disposal problems for waste managers because of the regulatory constraints and the lack of disposal options.

Permitting Options & Jurisdiction

The full-scale demonstration was constrained to regulatory requirements imposed by the State of South Carolina. Despite appeals to operate under a RD&D permit, the State of South Carolina classified the process as a waste treatment unit. Such a permitting option would not satisfy mixed waste applications in other states where RCRA and TSCA waste types would be treated. The LANL demonstration offers the RCRA pathway, beginning with the treatability permit notification to the State of Tennessee. Once data is obtained advanced testing can be continued under a RD&D application and ultimately a full Part B permit for commercial treatment. Such a plan meets the objectives of potential customers in providing evidence that the process is permittable under RCRA.

Stabilization of Residues

The process has been promoted as an "end to end" process from the outset of the demonstration program with DOE-FETC. That is to say, that little or no pretreatment of waste forms is required and the process produces a stabilized, disposable form as its final residue of radioactive material. The Argonne National Laboratory Chemically Bonded Phosphate Ceramic (CBPC) has been the selected method of stabilization for DETOX^{SM} solid residues. While the large scale demonstration at Savannah River did not allow for stabilization of residues on-site at SRS, a portion of the mercury contaminated residues was scheduled to be shipped to Delphi's laboratory in Albuquerque to be stabilized under a separate treatability study permit in the State of New Mexico. In the LANL demonstration, stabilization of process residues is fully integrated into the design and fabrication of the unit. Thus, the solution residues containing the metal contaminants will be converted to oxide form and then stabilized using the CBPC method. Previous testing of DETOX^{SM} solids stabilized using CBPC have been shown to demonstrate significant reduction in leachable metals well within the acceptable limits of EPA's TCLP requirements.

Testing Objectives

The testing objectives remain fixed for both large-scale and small-scale demonstrations with the exception of a relaxed validation effort regarding procedures. In place of a formal third party validator verifying that operating and sampling procedures were adhered to during demonstration, LANL will now perform this function. This change in the validation saves substantial costs while providing potential customers that a recognized scientific organization has reviewed operations, sample and data analysis to verify that the reported results are valid as claimed.

Site Requirements

The extensive list of requirements noted for the demonstration of the full scale unit at SRS serve to demonstrate the operational and safety compliance work that has been established on the equipment and documentation required for operation on a DOE site. However, the development and implementation of such an extensive list of requirements was obtained at a very high price in terms of time and cost. Having established the documentation and acquired the operational experience necessary for deployment on a DOE site, the cost of demonstration on a small scale can be significantly reduced by performing the test off-site of a government installation. While ES&H operational requirements will meet all regulatory standards, applying commercial standards to the small-scale demonstration will shorten the time required for demonstration, thus saving money, without compromising safety.

Deployment Path

Deployment of developed technology is an integral part of the success criteria for EM 50 sponsored programs. Therefore, all EM-50 sponsored technology demonstration projects should have an identified path for utilization of the technology beyond demonstration. In the SRS full-scale demonstration, potential users were identified as secondary or tertiary stakeholders in the demonstration, giving them an opportunity to follow the development and participate in the successful conclusion of the demonstration. Host sites were chosen based upon candidate LLMW in inventory, which could be treated after successful demonstration. The logistics in obtaining long-term commitments for demonstration as well as waste treatment in a project with relatively high risk are difficult to define and control. To overcome this conundrum, the deployment plan in the LANL project is left to the technology developer assisted by a market survey and economic assessment to be conducted by LANL during demonstration.

Quality Assurance Plan

The large-scale demonstration at SRS did not identify a specific QA/QC objective in the form of a plan to be developed and adhered to throughout the development program. Such a plan was developed over time by Delphi in an effort to implement QA measures into operations. However, the omission of a QA/QC plan during a critical phase of the project was manifested in the restricted budget allocated for design and fabrication of the process equipment. Such an omission resulted in significant shortcomings in quality that ultimately made continued operation of the full-scale unit too costly. To avoid repeating this error in the LANL project, a practical and appropriate QA/QC plan will be developed by an independent contractor. Such a plan will be used to shape and control the design and assembly of equipment, as well as the development of all documentation, procedures, ES&H activities and operations.

Decontamination & Transportation of Radioactive Contaminated Equipment

The issue of decontamination and transport of equipment was not fully addressed in the full-scale demonstration. The reasoning being that continued operation at the LLMW Host Site would transition to long-term waste treatment at that site. Although the full-scale unit was designed to be modular and transportable, it was only with considerable time and expense that relocation of the unit could be achieved. As mentioned in "Potential Applications" above, the DOE market for DETOX^{SM} applications has changed since a site survey was conducted in 1994. In 1999 and the projections for 2000-2005, it is the small, problematic waste types which can best be addressed as the niche application for DETOX^{SM}. Thus, the LANL project has integrated into the design, procedure development, and closeout of the unit, the issues of decontamination and transportability. The inclusion of these issues will address federal and state regulatory requirements, and DOE orders, thus, meeting the project objective of making the small-scale DETOX^{SM} treatment system transportable.

CONCLUSIONS

The demonstration elements presented herein for large and small-scale demonstrations of a waste treatment process illustrate the fact that no fixed model exists for demonstration projects. Further the need for flexibility in designing technology demonstration is dictated by the variations in the perceived markets, applications, and regulatory and site requirements. Experience gained from full-scale waste treatment demonstration, indicates that smaller is better, a vested interest by the host site is essential, and the relevancy of the chosen permitting pathway to end-users is essential. Assuming that the technical goals of the project are attainable, the goal of deployment to DOE and industrial applications can be greatly enhanced by proving the efficacy of the process off-site before making the large capital investment to operate on a DOE site.

ACKNOWLEDGMENTS

The authors would like to thank EM-50, and in particular Gerald Boyd, John Wengle, and Jeff Walker, for their support and assistance in making this project possible. We would like to acknowledge the assistance and support provided by LANL and in particular Bruce Erdal, Leon Borduin, Tom Spatz, Jeremy Boak, and the project team. We would also like to acknowledge the help and assistance we have obtained from the IT Corporation, John McFee. This work is being performed under the review of the Department of Energy's Mixed Waste Focus Area.

REFERENCES

1. "Development Studies for a Novel Wet Oxidation Process" (Gate 4 Review), Rev. 3, U.S. Dept. of Energy, Federal Energy Technology Center, Environmental and Waste Management Division, September 25, 1997.
2. "Consensus Report of the Review Panel for DETOX^{SM}, Review Panel: Daman, E.L., Gerstein, N.J., Kohout,R., Orth, D.A., Welty, J., Wittle, J.K., American Society of Mechanical Engineers, Columbia, Maryland, January 21-23, 1998.
3. "Delphi DETOX^{SM} Demonstration Project Compliance and Performance Based Readiness Review Plan", Savannah River Site, Multipurpose Pilot Plant Facility (TNX), Westinghouse Savannah River Company, Fachada, M.A., June 25, 1997.
4. "Treatment of Special Wastes by DETOX^{SM}", A Review by the Special Review Team, U.S. Department of Energy, Office of Environmental Management, Office of Technology Development, December, 1998.