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Title: PROPOSED TECHNOLOGIES FOR USE IN THE
NATIONAL TRU WASTE SYSTEM OPTIMIZATION


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EXTENDED SUMMARY

Proposed Technologies for Use in the National TRU Waste System Optimization

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1. Introduction

Technology deployments planned for the National TRU Waste System Optimization Project are aimed at using appropriate cost-effective technologies to drive the national TRU waste system to a performance-driven certification system that is based on administrative and operational requirements with a sound safety and/or technical basis. Appropriate technology deployments are determined by first identifying technology needs; selecting promising technologies; and overseeing the development of operating procedures, personnel training, testing, and startup and operations to ensure that the resulting operations function correctly and meet the TRU waste certification requirements.

Technology deployments (1) provide support to the Optimization Project Planning, Implementation and Control (PPIC) function in scheduling the implementation of new technologies for system optimization; (2) support regulatory change planning by identifying and prioritizing technology needs in those areas in which technology is the only available solution or in which technology must be deployed if regulatory relief cannot be justified on a safety or legal basis. New technology deployments generally require engineering modifications to meet site-

specific operating needs. Therefore, they always require the development of operating procedures, personnel training, testing, and startup and operational support to ensure that their deployment fulfills the TRU waste certification requirements; and (3) interact closely with RD&D through the classic research, development, demonstration, and deployment process. Technology deployment provides focus for the RD&D activities (the "Pull"), while RD&D identifies new technology (the "Push").

Technology deployment and RD&D ensure that state-of-the-art technologies are available to support a performance-based waste management system and to ensure a sound, well understood scientific basis for the performance-based system. As such, technological investments for the National TRU Waste Program necessarily span the gap from basic science research to deployment/implementation of existing technologies.

This paper briefly describes those technologies that will help achieve the TRU waste system's desired end state and provide the technical and scientific basis to support future WIPP Hazardous Waste Facility Permit modifications.

2. Results, Conclusions, and Discussion

The following provides an overview of the high-priority technology deployment activities for the National TRU Waste System Optimization Project.

A. Automated Data Management

Data management is a major cost element in the characterization and certification of TRU waste. For example, certification cost estimates run as high as \$4,000 per drum at RFETS. Accordingly, an electronic data reporting system is needed that will generate WIPP-compliant characterization data packages and automatically review, verify, validate, and reconcile the data quality objectives, quality assurance objectives, quality control criteria, and calibration

requirements. Deployment of such a system will significantly reduce both the time and expense of generating data packages and will allow sites to increase shipments. An automated data review and validation capability can be performed more efficiently and accurately than a review performed by one person with a spreadsheet, the current practice at most sites.

B. Packaging

Three packaging deployments have been identified. The following two are of primary interest.

1. Mobile System for RH Loading. Many sites with RH TRU waste need equipment for loading the waste. A mobile system of specialized equipment can perform efficient and cost-effective loading of high-activity waste. The mobile system must be capable of performing all operations in either a horizontal or vertical position in appropriate facilities at the various sites. An RH mobile loader has been designed.
3. Reduction of Inner Layers of Confinement. Technology is needed to rupture all waste-containing bags within a TRU waste drum to meet TRUPACT-II wattage limit criteria with regard to gas-generation issues. This technology in and of itself will not make all high-wattage waste shippable, but is closely tied to development of hydrogen getters.

C. NDE Technology

Deployment of a digital radiography system in a hot cell for RH TRU waste analysis would readily demonstrate background corrections and resolution in a high-radiation field environment. Radiography of RH TRU waste containers may likely be required in those cases where process knowledge of the waste is limited. In addition, deployment of a system to image inside a shielded container may be advantageous.

D. NDA Technology

Four NDA technology deployments have been identified; the following one is considered a high priority.

1. NDA Deployment for RH TRU Waste in Hot Cell. Existing NDA systems are to be evaluated for use in a hot cell and measurement limitations determined. This deployment will be essential to shipment of RH waste that has limited AK. Furthermore, criticality concerns may dictate that NDA measurements be made on RH TRU waste.

E. Transportation

One transportation deployment, which is high priority, has been identified.

1. At-Drum System for Headspace Gas Analysis. The Optimization Project proposes to replace the WIPP-certified headspace gas sampling and analysis with a direct measurement of repository VOC emissions. As this occurs and Revision 19 of the TRUPACT-II SARP has been approved (which will allow for increases in the concentration of flammables to the lower flammability limit), the need for a rapid headspace gas screening tool will become critical. To facilitate shipping, software should be incorporated into the system that will automatically calculate the composite lower flammability limit in the container being measured.

The Role of RD&D in TRU Waste Optimization.

Research, Development and demonstration (RD&D) focuses on ensuring that regulatory change requests are based on accurate scientific and technical information. The RD&D area interacts strongly with technology deployment by providing guidance (“Push”) to define the technical information needed for proof-of-concept and process development.

The need for basic research is driven by gaps in information or technology requirements for which no identified solutions are available. Basic science expands the fundamental understanding of the physicochemical properties of TRU waste materials existing under a variety of conditions as they are treated, stabilized, packaged, characterized, and stored in the WIPP repository. A well-managed basic scientific research program provides the technical basis for understanding safe TRU waste operations and, very importantly, also provides a cadre of trained and knowledgeable scientists and engineers who are available to solve scientific and engineering problems associated with TRU waste treatment, characterization, packaging, and storage as they emerge.

The RD&D required for a new technology may take from three to five years to develop to the point of demonstration and deployment. Basic research for developing cutting-edge technologies may extend that time from seven to ten years.

The following presents a summary of high priority RD&D activities for the Optimization Project.

A. Waste Drum and Drum Vent Corrosion

Wastes containing high concentrations of chlorinated VOCs are subject to extensive corrosion from HCl generated by radiolysis. The acid corrosion can, over time, plug the vent filter and breach the metal waste container. Most of the DOE waste management sites list a significant quantity of their total TRU waste stream as probably containing chlorinated VOCs.

Research needs include (1) understanding the underlying chemistry associated with HCl formation by radiolysis and the solid-gas chemistry of corrosion in various parts of the waste drum, including the filter; (2) developing a noninvasive corrosion sensor that will allow simple and fast determination of the extent of corrosion inside drums; and (3) developing noncorrosive drum vent filters. This would be a three-year fundamental/applied research project.

B. Advanced VOC Analysis Methods

The desired end state for VOC measurements on individual waste drums is elimination of those measurements and reliance on monitoring VOCs in the WIPP repository itself. Accordingly, an applied R&D program may need to be established to develop sensors for detecting and measuring VOC concentrations in the WIPP repository air flows.

C. Alternative RCRA Metal Analysis Technique Development

New sampling and analytical techniques that are noninvasive or semi-invasive need to be developed for RCRA metal analysis in sludge and other homogeneous waste. The current coring and chemical analysis process for sampling RCRA metals is expensive, hazardous, and difficult to perform. Although the desired end state is

- Radiography
- Nondestructive Analysis
- Headspace Gas Analysis
- Visual Examination
- Data Management
- Auditing
- Load Preparation
- Homogeneous Waste Sampling and Analysis (Coring, Sampling, and Analysis)
- Repackaging
- Waste with No Disposal Path

While these initiatives are interrelated, the first four—the CCP, the CCF, the MMDP, and Transportation Optimization—are major NTP projects that will form the foundation for future optimization efforts.

It is expected that these efforts will result in enormous cost savings to the DOE. The estimated cost savings to the National TRU Waste System resulting from the combined efforts of the Optimization Project and the implementation of best business practices are expected to be over \$7B. This estimate reflects only those savings that will result if the NTP vision of WIPP as a repository for TRU waste is completed ten years early. For example, deploying integrated mobile/modular characterization systems is expected to significantly increase TRU waste characterization throughput and accelerate the schedule for shipping waste to WIPP, saving an estimated \$3.3B. Successful implementation of a Central Confirmation Facility (CCF) at WIPP would preclude the need for certain audit and certification costs at many waste generator/storage sites, saving an estimated \$315M. Development of NDA capability to support direct shipment and

disposal of waste in large containers could save several hundred million dollars in repackaging costs alone for the current inventory and produce additional significant savings during deactivation and decommissioning operations. Similarly, instituting repository monitoring of volatile organic compounds (VOCs) could obviate the requirement for headspace gas sampling and analysis, which could save about 40% of the characterization and certification costs for TRU waste and also reduce drum costs for data management, saving an estimated \$300M or more over the life of WIPP.

3. Results, Conclusions and Discussion

This section summarizes the cost savings estimates for the various projects, tasks, and activities that are being proposed under the National TRU Waste System Optimization Project. These cost savings are based on planning/feasibility study (order of magnitude) cost estimates and thus are considered to be accurate to -50%/+100%.^(3,4) The bases for these estimates are the TRU waste generator/storage site cost analyses,⁽⁵⁾ TRU waste drum inventory estimates, preliminary engineering design estimates for deployment of four mobile/modular systems,⁽⁶⁾ various preliminary cost/benefit analyses,⁽⁷⁾ and expert opinion. The accuracy of the preliminary cost savings estimates will be updated as more specific information becomes available concerning actual implementation of the various optimization action plans. Additional information concerning site-specific and mobile vendor TRU waste characterization costs is also being developed.

Table 1 presents the pertinent cost savings estimates and shows that implementing the various optimization options discussed in this plan would result in estimated cost savings of approximately \$7.1B for the National TRU Waste Program. This savings is

compared to the total estimated life-cycle cost (budget planning level, -30%/+70% level of accuracy) for the NTP of \$16B. ⁽¹⁾

By far, the most significant costs savings (\$3.3B) are associated with deployment of mobile/modular characterization systems to expedite shipping of waste drums to WIPP resulting in an estimated 10-year early mission completion of the NTWP. This is considered a conservative cost savings estimate because (1) associated mortgage savings from early closure of numerous waste generator/storage sites are not included in the estimate, and (2) costs savings for a 10-year early completion of the NTWP presented in the MMDP section of this plan are conservatively underestimated by about \$1B .

As a general confirmation of the cost savings derived from deploying mobile systems to the waste generator sites, a Net Present Value (NPV) calculation was performed to estimate a Return on Investment (ROI) for deploying this capability. The following assumptions were used in the calculation:

- Discount Rate: 5.8%
- Inflation Rate: 3%
- Equipment lifetime: 5 years
- Cost to characterize one CH TRU debris drum using current mobile characterization technology: \$6,900
- Cost to characterize one CH TRU debris waste drum using an optimized mobile/modular system: \$2,585
- 24,000 drums per year are processed over a 10-year period.
- Four systems are used to process the 24,000 drums/year
- Initial capital and start-up costs, and operating costs are those presented in the Mobile/Modular Section of the Optimization Plan ⁽⁶⁾

Table 1. Summary of Estimated Cost Savings for Implementing an Optimized Performance-driven TRU Waste Characterization System

System	Estimated Cost Savings (\$M)	Comments
CCF	315	Savings in SQS and LQS site certification costs
Mobile/Modular	3,300	Four units; 240,000 CH TRU debris drums over 10 years
AK	23	30% cost reduction in developing AK packages for 500,000 drums
Radiography	13	MPW eliminated. Cost savings of \$500k/year for 25 years
NDA	200	Repackaging cost savings for implementing NDA for oversized waste packages
HSG	300	Savings from implementing performance-driven repository monitoring of VOCs (150,000 drums @ \$2,150/drum)
VE	50	Savings from replacing VE with DR/CT to confirm RTR
Data Management	92	Savings from implementation of automated data reports
Auditing	-----	Savings due to elimination of LQs and SQs from audit program. Included in CCF cost savings estimates.
Load Preparation	125	Savings of \$50M/year for 25 years for implementing efficiencies in drum selection and drum management
Homogeneous Waste Sampling & Analysis	39	WAP revised to eliminate metals and organics analysis
	55	Total elimination of coring, sampling, and analysis of RCRA metals and organics
Repackaging	125	Mobile repack units deployed to SQSs. Savings of \$5M/year for 25 years. <i>NOTE:</i> Repack module is NOT included in Mobile/Modular Deployment Project estimates
Waste with No Disposal Path	-----	NO ESTIMATES AVAILABLE
Transportation CH TRU	1,000	Avoidance of repackaging size-limited items if TRUPACT-III is deployed
	1,500	Avoidance of repackaging high-wattage waste if TRUPACT-III is deployed
RH TRU	33	Payload expansion – mobile loader deployed
	13	Alternative Type B container deployed (\$500k/year for 25 years)
TOTAL COST BENEFIT	\$7.1B	Estimated Uncertainty: -50% / +100%