# RE-ENGINEERING THE PIPELINE: A TRU WASTE SITE INITIATIVE TO OPTIMIZE WIPP SHIPMENTS

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## ABSTRACT

After opening the Waste Isolation Pilot Plant (WIPP) for the permanent disposal of transuranic (TRU) waste on March 26, 1999, the Department of Energy (DOE) Carlsbad Field Office (CBFO) and DOE Headquarters launched a major initiative to assess and recommend modifications to the national transuranic waste system. The purpose of these recommendations was to identify ways to address the WIPP's prescriptive regulatory framework and to accommodate the transuranic waste generator sites' many needs and requirements.

Three teams, composed of representatives of all the transuranic waste generator sites, focused on issues related to characterization, transportation, and disposal. In addition, an executive team of DOE representatives from each of the sites developed broad recommendations that crossed several areas and were more general in scope.

Although the CBFO initiated and supported the re-engineering initiative, the sites led the effort, eliciting ideas and recommendations from the individuals responsible for managing, characterizing, certifying, and packaging TRU waste for shipment.

This paper presents the technical recommendations and implementation status of these far-reaching recommendations.

## INTRODUCTION

On March 26, 1999, the Waste Isolation Pilot Plant (WIPP) opened for the permanent disposal of transuranic waste resulting from weapons research and production. The WIPP's opening resolved a number of scientific, engineering, regulatory, and political challenges, but issuance of the Hazardous Waste Facility Permit for the WIPP brought a new set of challenges *and* opportunities for the CBFO. The permit, effective November 26, 1999, required the CBFO and the TRU waste sites to work within a new structure for site and waste certification, to test and prove the transportation system, and to establish and exercise revised disposal procedures. As operations were changed to meet permit requirements, participants quickly realized that some of these requirements and protocols were counterproductive to efficient system management. In particular, the TRU waste generator sites found that many requirements for characterization and certification were costly, time-consuming, and in some cases, they actually increased potential risk to workers. These challenges with respect to characterization and certification, transportation, and disposal activities included:

- **Characterization and certification:** adequate and cost-effective waste characterization according to prescribed procedures and certification that the contents of every container to be disposed of at the WIPP meets the waste acceptance criteria.
- **Transportation:** obtaining Nuclear Regulatory Commission-approved shipping containers to meet differing needs; retaining highly competent carriers to transport the waste; training emergency responders across the nation; and correctly packaging, loading, scheduling, coordinating, and shipping the waste to the WIPP in compliance with federal and state laws. Developing transportation schedules for the disposal of transuranic waste requires balancing cleanup agreements, timetables, and commitments that individual states and the federal government have made presented many competing priorities.
- **Disposal:** anticipating disposal quantities and timetables, ensuring adequate assets for waste receipt and emplacement, maintaining mine readiness, mining new panels and rooms to ensure availability of adequate disposal volume, preparing for closure, and sealing the panels as they are filled.

These tasks are overlain by preparations to receive remote-handled waste by 2002, which will entail additional and significant procedural and technical requirements. In addition, the coordination of all of these activities, including the evolving requirements, necessitates clear communication among all the transuranic waste generator sites and with the CBFO.

Recognizing the enormity of this task, the CBFO (which manages the WIPP) and DOE Headquarters launched a major initiative to assess and modify as necessary the waste system to accommodate the many needs and requirements. In launching this effort, the CBFO Manager and DOE Deputy Assistant Secretary, who had been the Headquarters WIPP lead for many years, wrote,

> " . . .the time has come to re-examine how we are doing business and to take a holistic, system-wide view to re-engineer the TRU waste program. . . ." (1)

Responding to this need, DOE formed four teams – an Executive Team, a Characterization Team, a Transportation Team, and a Disposal Team – from representatives of all the transuranic waste generator sites and the CBFO to undertake this effort. The CBFO established an aggressive schedule to develop recommendations to re-engineer the TRU waste program in phases:

- **Phase 1:** recommendations for activities that could be implemented within 6 months
- **Phase 2:** recommendations that require additional paper study for justification or additional lead time for implementation within 18 months
- **Phase 3:** recommendations that require technology development activities for implementation within 36 months.)

The four re-engineering teams, composed of more than 100 members, met in late October 1999 to begin this task. Out of that initial meeting, the teams developed drafts of their Phase 1 recommendations. The team leaders met in late November to review, finalize, and prioritize the Phase 1

recommendations, which they presented to the DOE Assistant Secretary for Environmental Management, EM-1, and the DOE CBFO Manager on November 17. Their response was positive.

The individual teams continued weekly conference calls throughout the winter and early spring, working simultaneously on Phase 2 and 3 recommendations. The team leaders met again March 14-16, 2000 to review, finalize, and prioritize these recommendations; develop cost estimates for implementation of the recommendations; estimate cost savings through recommendation implementation; and present the results of their work to the DOE CBFO Manager.

This paper summarizes the recommendations, the cost and schedule estimates, and the CBFO's response to the recommendations.

## OVERARCHING THEMES

A primary goal of the re-engineering effort was to get key transuranic waste managers to lead the six-month effort so that the recommendations would reflect the experience of the individuals and organizations working in the transuranic waste system. The result of the effort was dramatic: issues crystallized, paths forward emerged, and the teams produced 59 recommendations. Several themes recurred in the teams' recommendations, including:

- **Excessive requirements:** The recommendations referred frequently to requirements in the WIPP Hazardous Waste Facility Permit that are not prescribed by law and do not contribute to the protection of workers, human health, or the environment. At the same time, the teams noted, these requirements not only significantly increased the cost of and time required for characterization, transportation, and disposal, but sometimes the risk of doing so.
- **Orphan TRU waste:** The teams recommended addressing existing orphan waste (i.e., TRU waste without a disposal path) and developing standard definitions to avoid generation of new orphan waste.
- **Standardization:** Several teams identified issues related to inconsistencies in how the work is done and the need for standardization. The inconsistencies included differences across the sites in characterization procedures and equipment; methods of estimating total TRU waste disposal costs; software for data reporting; formats for data recording, certification, and quality assurance documents; and procurement of common items. The teams recommended standardization of formats, software, procedures, and equipment to address these inconsistencies and achieve efficiencies.
- **Remote-handled waste:** The team identified different issues the CBFO needed to address to initiate disposal of remote-handled TRU waste. The recommendations covered a range of needs including development of:

    - A remote-handled waste regulatory strategy that addresses internal documentation and management needs and external regulatory processes and communications
    - Mobile remote-handled waste characterization equipment

  - Model certification documents (to promote standardization for this immature program) and alternate shipping casks and packages
  - Alternate disposal configurations to mitigate lost panel space.

- **Communications:** All the teams cited a need for better communication. They recommended holding workshops, establishing a site liaison, fostering more effective communications with the regulators, improving the information exchange between the CBFO and the sites, clarifying requirements, implementing an electronic version of the TRAMPAC, and providing the remote-handled (RH) design basis to the sites.
- **Flexibility:** The teams cited a need for greater flexibility that would allow use of new technologies and new or different shipping packages. They said that experience will provide new understandings of what is needed to demonstrate compliance with the requirements and that as they demonstrate the efficacy of alternate procedures, the regulators should allow use of these new procedures. They identified the permit modification process as the vehicle to achieve these efficiencies and encouraged the CBFO to submit modifications and clarifications as soon as possible.

The teams made a total of 59 recommendations, which fall into at least one of the following emphasis areas:

- Eliminate waste characterization requirements that lack a legal or safety basis.
- Evaluate the gas generation assumptions and develop realistic models.
- Evaluate the current packaging configuration and recommend improvements for larger packages, alternative packages, or package improvements.
- Create efficiencies in characterization procedures.
- Develop a path forward for wastes hat have no disposition path.
- Develop alternatives for shipping waste from small quantity sites to the WIPP.
- Develop RH procedures, permit requirements, and technologies to enable timely initiation of RH operations
- Develop waste handling system improvements to improve efficiency.

## CBFO Response Status

The CBFO reviewed and analyzed the recommendations and developed a path forward for each. Table I summarizes the implementation status of the recommendations. Twenty-two recommendations have been fully implemented. The 31 recommendations that are in progress are mostly those that require permit modifications or clarifications. More than 70 clarifications have been written, forwarded to the New Mexico Environment Department (NMED), and placed on the re-engineering web site for the waste generator sites' information. Class 1 and Class 2 permit modifications that respond to the recommendations have been written, and some of these have been submitted to the NMED. Some are still being written. Recommendations in the "in-progress category" have some aspects that may be implemented, but others that are still being worked out. The six recommendations that are pending are

of lower priority and will be implemented later. They require additional study or analysis and are currently being actively addressed by the CBFO and its contractors.

Table I. Implementation Status of Recommendations

| | Implemented | In Progress | Pending | **Total** |
|---|---|---|---|---|
| Executive | 5 | 1 | 0 | **6** |
| Characterization | 11 | 15 | 5 | **31** |
| Transportation | 3 | 12 | 0 | **15** |
| Disposal | 3 | 3 | 1 | **7** |
| **Total** | **22** | **31** | **6** | **59** |

The recommendations are being addressed in several ways: through permit modifications and clarifications, engineering studies, longer-term technology development efforts, and organizational changes. An overview of how these mechanisms were applied is shown in table II.

Table II. Categories of Recommendations

| **Recommendation type** | **Number** |
|---|---|
| Permit-affecting recommendations | 32 |
| Recommendations requiring engineering studies | 22 |
| Recommendations requiring research and development | 2 |
| Recommendations requiring organizational changes | 10 |

## THE CBFO'S RESPONSE TO THE RE-ENGINEERING RECOMMENDATIONS

The CBFO has reviewed, analyzed, and responded to each of the recommendations, as shown in table III.

Table III. Status of Re-engineering Recommendations

| **No.** | **Recommendation** | **Status** |
|---|---|---|
| **Executive Recommendations** | | |
| E-1 | Approve permit clarifications and submit proposed permit modifications | Completed |
| E-2 | Conduct characterization workshops | Completed |
| E-3 | Identify a WIPP liaison | Completed |
| E-4 | Facilitate regulator meetings | Completed |
| E-5 | Working group to develop cost models | Completed |
| E-6 | Develop a strategy for disposal of waste that is currently unacceptable at the WIPP | In Progress |
| **Characterization Recommendations** | | |
| C-1 | Write RH Waste Analysis Plan (WAP) | Completed |
| C-2 | Improve information exchange | Completed |
| C-3 | Provide model software for reporting | Completed |
| C-4 | Remove requirements for quarterly review of data | In Progress |
| C-5 | Identify and eliminate redundant requirements | Completed |

| No. | Recommendation | Status |
|---|---|---|
| C-6 | Dispose of previously characterized waste | Completed |
| C-7 | Change WAP to transportation-based drum age criteria | In Progress |
| C-8 | Determine total measurement uncertainty requirement | Pending |
| C-9 | Eliminate the gas chromatography/mass spectroscopy quality control sample to verify Fourier transform infrared spectroscopy (FTIRS) | Pending |
| C-10 | Standardize reporting formats | Completed |
| C-11 | Standardize the methodology for segregating TRU and low-level waste | In Progress |
| C-12 | Identify the minimum data management requirements | In Progress |
| C-13 | Re-evaluate quality assurance objectives (QAO's) and program required quantitation limits (PQRL's) | In Progress |
| C-14 | Reduce prescriptive headspace gas sampling and analysis requirements | In Progress |
| C-15 | Reduce headspace gas sampling and analysis to statistical sampling only | Pending |
| C-16 | Reduce headspace gas sampling for non-mixed waste streams | Completed |
| C-17 | Obtain approval of alternative sampling devices and methods | Completed |
| C-18 | Modify the leak test for FTIRS | In Progress |
| C-19 | Establish a minimum threshold for adding tentatively identified compounds (TIC's) as target analytes | In Progress |
| C-20 | Basis for detailed breakdown of waste matrix codes | Pending |
| C-21 | Develop nondestructive assay policy for a large container Performance Demonstration Program (PDP) | Pending |
| C-22 | Develop a path forward to characterize and certify large containers, shielded containers, canisters, and neutron sources | In Progress |
| C-23 | Eliminate the visual examination (VE) requirement that verifies radiography | In Progress |
| C-24 | Clarify the requirements for nondestructive examination (NDE) of lead-lined containers and sludge-filled drums | In Progress |
| C-25 | Develop a policy and path forward for certification of CH waste with inadequate acceptable knowledge (AK) | In Progress |
| C-26 | Reduce homogenous waste sampling and analysis requirements | In Progress |
| C-27 | Evaluate mobile RH-TRU waste characterization equipment | In Progress |
| C-28 | Develop remote-handled permit strategy | Completed |
| C-29 | Prepare a robust RH regulatory strategy for involving regulatory and oversight agencies | Completed |
| C-30 | Prepare an alternative RCRA compliance strategy | In Progress |
| C-31 | Prepare model RH waste program documents | Completed |
| **Transportation Recommendations** | | |
| T-1 | Ensure acquisition of the balance of the TRUPACT-II fleet | In Progress |
| T-2 | Evaluate small quantity sites' alternatives to baseline | Complete |
| T-3 | Develop hydrogen getter for use in TRUPACT-II | In Progress |
| T-4 | Standardize TRUPACT-II operations and maintenance procedures | Completed |
| T-5 | Qualify TRUPACT-II shielded pipe components | In Progress |
| T-6 | Standardize procurement of common items | In Progress |
| T-7 | Automate shipping schedule planning | Completed |

| No. | Recommendation | Status |
|---|---|---|
| T-8 | Initiate a user group to facilitate WIPP Waste Information System (WWIS) changes | Completed |
| T-9 | Implement e-TRAMPAC at all sites | In Progress |
| T-10 | Participate in the development of TRANSCOM 2000 | In Progress |
| T-11 | Perform transportation system analysis | Pending |
| T-12 | Evaluate alternative Type B packaging for CH-TRU waste | In Progress |
| T-13 | Evaluate alternative Type B packaging for RH-TRU waste | In Progress |
| T-14 | Evaluate TRUPACT-II payload expansion | In Progress |
| T-15 | Increase fissile gram equivalent (FGE) limits for standard waste boxes (SWB's) and TRUPACT-II | Pending |
| **Disposal Recommendations** | | |
| D-1 | Evaluate different approaches to engineered barriers | In Progress |
| D-2 | Provide the RH design basis to the sites | Completed |
| D-3 | Evaluate CH handling system redundancy | Completed |
| D-4 | Evaluate site receipt of RH waste in CNS 10-160B casks | In Progress |
| D-5 | Evaluate ways to provide hoisting redundancy | Completed |
| D-6 | Evaluate four-drum-high waste stacking | In Progress |
| D-7 | Evaluate emplacement alternatives for RH waste | Pending |

## COST AND SCHEDULE ANALYSIS

The CBFO tasked a team of independent cost estimators to evaluate the potential cost savings, the cost to implement, the return on investment, the programmatic risk, and potential schedule impact of each recommendation. The return on investment was calculated based on the potential cost savings vs. the implementation cost. For this analysis, the following definitions were used:

### Cost to Evaluate and Implement

- High: Cost is greater than $500,000
- Medium: Cost is between $100,000 and $500,000
- Low: Cost is less than $100,000 to implement

**Schedule Impact** (compared to the current baseline)

- High: Greater than 20% schedule improvement
- Medium: 5-20% schedule improvement
- Low: Less than 5% schedule improvement

**Programmatic Risk** (compared to the current baseline)

- High: Difficult technology, long lead times, Class 3 modification
- Medium: Medium difficulty or time to develop, Class 2 modification

- Low: Easy technology or short lead time to develop

**Projected Cost Savings** (compared to the current baseline)

- High: Savings greater than $100 million over the life of the WIPP
- Medium: Savings expected to be between $10 and $100 million
- Low: Expected savings less than $10 million over the life of the WIPP

The summation of the total projected life-cycle cost savings for all the recommendations slightly exceeded $1 billion. Tables IV – VI present the estimates for each of these categories.

Table IV. Phase 2/3 Characterization Cost Matrix

| **Characterization Recommendation** | **Implementation Cost** | **Net Cost Savings** | **ROI Ratio** | **Programmatic Risk** | **Schedule Impact** |
|---|---|---|---|---|---|
| Standardize reporting formats | High | Low | 6 | Low | Low |
| Standardize methodology for segregating TRU and low-level TRU | Medium | NQ | NQ | Low | Low |
| Identify the minimum data management requirements | Medium | Low | 23 | Medium | Medium |
| Re-evaluate QAO's and PRQL's | High | Medium | 111 | Medium | Low |
| Reduce prescriptive headspace gas sampling and analysis requirements | Medium | Medium | 189 | Low | Low |
| Reduce headspace gas sampling to statistical sampling only | High | High | 374 | High | High |
| Reduce headspace gas sampling for nonmixed waste streams | High | Medium | 82 | Medium | Medium |
| Obtain approval of alternative sampling devices and methods | Medium | Medium | 51 | Medium | Low |
| Modify leak-test requirements for FTIRS | High | Medium | 2 or 37 | Low | Low[4] |
| Establish minimum threshold for adding TIC's as target analytes | High | Medium | 14 | Medium | Low |
| Simplify the waste stream classification system and go to summary category level | Medium | Medium | 171 | Medium | Low |
| Develop a policy for a large container PDP[2] | Low | N/A | N/A | Medium | N/A |
| Develop path forward to characterize large containers, shielded canisters, and neutron sources | High | High | 242 | High | High |
| Eliminate the VE requirement | High | Low | 3 | High | Medium |

| Characterization Recommendation | Implementation Cost | Net Cost Savings | ROI Ratio | Programmatic Risk | Schedule Impact |
|---|---|---|---|---|---|
| that verifies radiography or develop an alternative verification process | | | | | |
| Clarify the requirements for NDE of lead-lined containers and sludge-filled drums | Low | Low | 11 | Low | Low |
| Develop policy and path forward for CH waste with inadequate AK | Low | NQ | NQ[3] | Medium | NQ[3] |
| Reduce homogeneous waste sampling and analysis | High | High | 130 | High | Medium |
| Evaluate mobile RH-TRU waste characterization equipment | Low | NQ | NQ | High | Unknown |
| Develop remote-handled permit strategy | Low | NQ | NQ | Low | Medium |
| Prepare robust RH strategy for involving regulatory and oversight agencies | Low | NQ | NQ | Low | High |
| Prepare a strategy to evaluate commercial approaches to meeting WIPP RCRA requirements | Medium | NQ | NQ | Medium | Medium |
| Prepare model RH-TRU waste program documents | Medium | Low | 6 | Low | Saves 4-6 months per site |

**Legend**

NQ means not quantifiable
N/A means not applicable
ROI means return on investment, which is the gross savings divided by the cost to implement.

**Notes**

1. Savings to the TRU Waste Program offset by increased cost to sites to dispose non-TRU low-level and low-level mixed waste.
2. PDP decision only leads to potential to use large container characterization.
3. Cannot be quantified until quantity of potential orphan waste is identified.
4. This could significantly impact waste characterization rate. Baseline assumes this will be successful.

Table V. Phase 2/3 Transportation Cost Matrix

| **Transportation Recommendation** | **Implementation Cost** | **Net Cost Saving** | **ROI Ratio** | **Programmatic Risk** | **Schedule Impact** |
|---|---|---|---|---|---|
| Evaluate and develop a new Type B packaging design for large boxes of CH waste and other containers not presently shippable in TRUPACT-II or HalfPACT | High | Low | 2.6 | Medium | Medium |
| Evaluate alternative Type B packaging for RH-TRU waste | High | High | NQ | Medium[1] | High |
| Evaluate TRUPACT-II payload expansion options [2] | Medium | High[3] | 453.0 | Medium | High |
| Increase FGE limits for SWB and TRUPACT-II | Already funded | NQ | NQ | Low | Low |

**Legend**

NQ means not quantifiable
ROI means return on investment, which is the gross savings divided by the cost to implement.

**Notes**

1. Assumes the WIPP will be permitted and operationally ready to receive RH waste (by ???).
2. Recommendations T-3 and T-4 were already funded for a total of $942,000.
3. Savings for Savannah River Site alone; other sites would be additional savings.

Table VI. Phase 2/3 Disposal Cost Matrix

| **Disposal Recommendation** | **Implementation Cost** | **Net Cost Savings** | **ROI Ratio** | **Programmatic Risk** | **Schedule Impact** |
|---|---|---|---|---|---|
| Evaluate ways to provide hoisting redundancy for waste and salt handling | High | NQ | NQ | High[1] | High |
| Evaluate four-drum-high waste stacking | Medium | Low | 6.2 | Medium | Low |
| Evaluate emplacement alternatives for RH waste | High | NQ | NQ | Medium | Low |

**Legend**

NQ means not quantifiable
ROI means return on investment, which is the gross savings divided by the cost to implement.

**Notes**

1. High risk because it is a high cost capital project

## CONCLUSIONS AND NEXT STEPS

The re-engineering effort has established a framework for the next steps in managing the National TRU Waste Program for the characterization, transportation, and disposal of transuranic waste. As the CBFO moves forward to optimize the TRU waste system, the re-engineering effort recommendations play a significant role. The CBFO plans to implement each re-engineering recommendation and refine the priorities for implementing them, based on evaluation and analysis established in the National TRU Waste Optimization Plan. Through the re-engineering process, the teams developed several major conclusions:

- The TRU waste characterization and certification program is overburdened by excessive quality assurance paperwork required by the RCRA permit. The quality assurance program should ensure that waste characterization for disposal protects workers, the public, and the environment. Often, however, the permit requires the TRU waste generator sites to expend significant cost and effort while far *exceeding* regulatory mandates that have no legal or safety basis. To achieve significant cost savings, the permit should be modified to comply with – but not excessively exceed – legal requirements.
- The DOE sites are expending a significant portion of their waste certification costs to characterize the RCRA constituents of the waste, which pose less hazard to the worker, the environment and the public than the radioactive components. An Environmental Evaluation Group (EEG) study (2), documents that the hazardous constituents of the waste represent one ten-thousandth of the risk posed by the radioactive constituents. Ideally, the program's characterization requirements should focus resources on characterizing that portion of the waste that poses the greatest risks to the worker, environment, and public.
- Part of the re-engineering teams' charter was to identify options to significantly reduce the overall cost of the TRU waste disposal program, with its estimated total life-cycle cost of $22 billion. However, the total estimated cost savings from all recommendations only slightly exceed one billion dollars, less than a five percent reduction. While implementation of each recommendation is projected to reduce the cost of disposal and make it easier for the sites to process waste, the results of the re-engineering effort strongly suggest that the only approach for significant cost reduction is through a major regulatory and/or programmatic change, such as the proposed CBFO central certification facility. An incremental approach to modify regulatory requirements may be effective in the short term, but in the long term, it will not result in a major reduction in the life-cycle costs.

Nevertheless, the CBFO is pleased with the recommendations and has initiated efforts to implement all of them. It has submitted permit modifications, drafted policy papers, and held workshops. In addition to describing the re-engineering process and results, this paper provides a status of the CBFO's progress on each. The CBFO and the sites have made a long-term commitment to carry through with

implementation of the resulting new protocols that will be established. However, true progress calls for a coordinated effort among the CBFO, its regulators, the TRU waste sites, and the public. This effort must apply the lessons learned from our experiences at the WIPP to establish a regulatory framework that protects workers, the public, and the environment while focusing on the proportional risks. At the same time, it maps out a path that reduces the financial burden for cleanup of the DOE complex.

## REFERENCES

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2. J. Channel, R. Neill, "A Comparison of the Risk from the Hazerdous Waste and Radioactive Waste Portions of the Waste Isolation Pilot Plant Inventory", Environmental Evaluation Group-72, July 1999.