IMPACT OF INNOVATIVE DECONTAMINATION TECHNOLOGY COSTS ON WASTE DISPOSAL DECISIONS (LAUR-04-8409[a])

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ABSTRACT

Glovebox decontamination and size reduction data developed in the Los Alamos Large Scale Demonstration and Deployment Project (LSDDP) supports and reinforces the decision that the minimum waste management cost to DOE is on-site disposal of decontaminated large metal objects, as opposed to simple size reduction and disposal as transuranics waste. The LSDDP, in support of the US Department of Energy (DOE), identified and demonstrated technologies to reduce the cost and risk of management of transuranic (TRU) element contaminated large metal objects, i.e., gloveboxes. The Decontamination and Volume Reduction System (DVRS) at Los Alamos National Laboratory (LANL) was designed to process and repackage a crated glovebox line for disposal at the Low Level Waste (LLW) disposal area at LANL. Decontamination and size reduction data was developed by the LSDDP for five decontamination technologies and 4 metal cutting technologies to support the DVRS mission.

Cost estimates are developed for a reference glovebox processed at DVRS for disposal under three scenarios; as TRU waste for WIPP, as LLW processed by baseline technologies, and as LLW processed using the demonstrated lowest cost innovative technologies. The results show that the baseline process for glovebox treatment to LLW was more expensive than simple size reduction and shipment to WIPP – for LANL. Application of innovative technologies for decontamination, crate size reduction, glovebox cutting, and improved communications change the conclusion. Application of the innovative technologies makes it more cost effective for LANL to process the glovebox to LLW, separating the TRU contaminants for separate disposal. In addition, the estimate calculates a total cost to DOE, which includes an estimate of the shipping and disposal cost at WIPP. The high costs of preparation for and characterization for WIPP shipment makes it a clear advantage for DOE to treat this particular waste by decontamination to LLW.

INTRODUCTION

The LANL DVRS was designed and constructed to process LANL's large metal objects for disposal. A "large metal object" generally refers to gloveboxes and the associated ductwork that has been disposed of by the plutonium processing operations at LANL. Some of these large metal objects were crated in the 1970's and stored in above-ground berms. These crates have been retrieved and the contents must be processed for disposal. DVRS was constructed to process the gloveboxes to LLW, and dispose at the on-site burial ground, leaving a small volume of TRU waste. The DVRS processes include;

- Crate opening
- Glovebox window and lead shielding removal
- Decontamination to LLW (resulting in a small volume of TRU)
- Compaction of the metal in a shear/baler
- Packaging and certification of all wastes (LLW and TRU)

To improve the cost effectiveness and safety of DVRS, thirteen technology demonstrations were conducted using the LSDDP methodology; comparison of the innovative and conventional (baseline) technologies side-by-side in actual operational facilities. The demonstrations included technologies for crate characterization, crate cutting, material movement, glovebox cutting, glovebox decontamination, and personnel communication equipment. That data has been reported in numerous papers and published Innovative Technology Summary Reports (ITSRs).

RESULTS

To facilitate one-on-one comparison of the glovebox disposition options, a standard glovebox was defined and used in the calculation of costs. The data from the various technology evaluations was scaled to this “reference” glovebox, as the demonstrations were conducted on different sized gloveboxes. This reference glovebox generally follows the dimensions of a LANL three-station glovebox described as:

- Glovebox dimensions are 2.4 m long (8 ft.), by 0.7 m deep (28 inches), by 1.1 m high (45 inches).
- 316 stainless steel; 4.75 mm (3/16 inch) thickness
- Leaded glass windows
- Six 15 cm (6”) gloveports, three viewing windows, and three smaller windows that are located between the gloveports
- Alpha contamination level is 2 x 10^6 dpm/100 cm^2; The acceptable alpha contamination levels at the LANL LLW disposal site is 50,000 dpm/100cm^2

Estimates for LLW disposal at LANL were based on decontamination and size reduction using the LANL DVRS process. Both conventional DVRS processing as well as a cost for DVRS processing using improved technologies were estimated. For disposal as TRU waste at WIPP, the estimated includes cutting the glovebox into pieces and placement in a WIPP Standard Waste Box.

Table I is tabulates the cost elements for the first scenario; the LLW baseline case in which the waste is processed through the DVRS process using conventional technologies. The bases for the costing elements of this scenario are discussed below, with descriptions of how the same elements were costed in the other two scenarios; TRU waste disposal and LLW scenario using innovative technologies. Details of these latter scenarios are not presented here, only the results.

Table I. Basis for Cost Estimate for LLW Baseline Costs

Activity	***Site coordinator***	***Site RCT***	***Site Operators***	***Other Cost***	***Cost of activity***
Labor Rate	$89.63/hr	$48.45/hr	$58.25/hr		
	Labor Hours by Task				
Crate radiography	0.67	0.67	0.67	$483	$631
Crate assay	1.00	1.00	1.00		$196
Crate opening	4.00	4.00	8.00	$104	$1,068
Preparation for decontamination (LLW options)	2.00	4.00	8.00		$839
Decontamination				$31,049	$31,049
Pre-sizing for compaction (LLW options)	2.00	2.00	4.00		$509
Compaction	2.00	2.00	4.00	$104	$1,018
Packaging	1.00	4.00	4.00	$50	$566
Certification for disposal				$1,053	$1,053
LLW disposal	1.00	1.00	2.00		$305
Secondary waste disposal & packaging	1.00	1.00	1.00	$50	$246

The costing methodology is similar to that used in the LSDDP demonstrations. Cost elements were defined and the labor hours, labor rates, and non-labor costs for accomplishing each task were identified. Where cost data was available from LSDDP demonstrations, that data was scaled to this reference glovebox instead of labor estimates. For example, crate assay costs are based on a buildup of labor rates and hours, whereas decontamination costs are given as a total cost as taken from the applicable demonstration reference.

Crate radiography

Crate radiography was demonstrated using two alternative technologies for DVRS. The labor hours and equipment cost shown on Table I are taken from the LSDDP demonstration of the Mobile Characterization System’s large box “Real-Time Radiography” system.[1] In that analysis the cost estimates were based on a regular use of the MCS unit for two weeks, processing 12 crates per day. The values in Table I represent 1/120 of the costs of that analysis.

Crate Assay
Crate Assay estimates are based on experience from similar activities at the LANL.

Crate Opening
Crate opening labor estimates were taken experience gained in evaluation of crate cutting at a tool evaluation program at the Florida International University's Hemispheric Center for Environmental Technologies.[2] In that program several crate cutting tools were evaluated. These labor estimates are based on the Porter Cable saw evaluation in that program.

Preparation for Decontamination
Preparation estimates account for moving the uncrated glovebox from the opening area into a cell for decontamination. Ventilation equipment is connected to the glovebox to control airborne activity when the glovebox is open for decontamination.

Decontamination
In this LLW case the decontamination estimate was taken as the "baseline" cost used in evaluation of several decontamination alternatives as summarized in a previous conference. [3] The cost of the LSDDP decontamination demonstrations was compiled as unit costs for decontamination technologies ranging from $1,636 to $3,100 per square meter of glovebox. The reference glovebox used here has an area of 10.7 m^2. The cost tabulated is for the baseline technology, nitric acid. The cost of the improved technology decontamination process is that of cerium nitrate and $2,000 per square meter.

Note that decontamination costs were not included in the scenario for WIPP disposal. The lowest decontamination cost, that for cerium nitrate decontamination, was used in the scenario for LLW disposal using innovative technologies.

Pre-sizing for Compaction (LLW Option) and Compaction
Pre-sizing for compaction and compaction labor estimates account for the effort of moving the decontaminated glovebox into the compaction area of DVRS and the labor required to operate the shear-baler compaction system. These estimates are based on similar activities in the LANL waste disposal area. This activity is not required for the WIPP TRU disposal option.

Size Reduction for Packaging (TRU Scenario Disposal Step not included in Table I)
Size reduction for packaging in the TRU scenario accounts for the substantial effort associated with cutting the glovebox into shapes that fit into a WIPP Standard Waste Box (SWB). All pieces must be sized to less than 2 meters long and 1.3 meters wide. The effort includes stacking the material in the SWB. The size reduction costs for cutting the gloveboxes was taken from the ITSR for the Evolution 180 metal cutting saw.[4] In that ITSR a glovebox was prepared for disposal at a cost of $5749 using the baseline technology and $1833 using the Evolution 180. A later evaluation of a nibbler showed even greater savings.

For this analysis it was decided to use the cutting rate of the Evolution 180 saw for the reference glovebox. Since the baseline for the Evolution 180 glovebox demonstration was a die grinder that would not be used at DVRS and an even better technology has been identified, the Evolution 180 costs were used as representative of the "baseline" cost. The cost of size reduction for this small glovebox used in the Evolution 180 demonstration was scaled to the reference glovebox by ratios for length of cuts, metal thickness, and rounding technician time to half-day increments.

Packaging

Packaging costs account for the cost of the waste package. For this baseline case, the glovebox is compacted into two "pucks" which fit into one 55-gallon disposal drum. For the TRU disposal option, the costs reflect 1.3 SWBs, the volume required by the waste generated.

Certification Costs

All three scenarios involve certification of waste for disposal for either WIPP disposal, LANL disposal, or both. The decontamination scenarios result in LLW for disposal at LANL and a small volume of waste for TRU disposal. LANL waste certification costs are labor estimates. The cost for certification of a WIPP package, $3900 per waste container, is based on the National Academy of Sciences report on WIPP characterization costs.[5] Fractional costs of the waste packages were used for the small volumes of decontamination wastes and the partial SWB package resulting from the TRU waste cutting.

LLW Disposal

Disposal costs at LANL include labor for package placement in the disposal cells and the associated documentation.

Secondary Waste Disposal

This element accounts for the cost of disposal of LLW generated (PPE and other items) in DVRS operations.

TRU Disposal

DVRS was originally conceived recognizing the high cost to DOE. The National Academy of Sciences report provides data indicating WIPP TRU disposal costs as high as $\$90{,}000/m^3$.[5] This analysis uses $\$50{,}000/m^3$ which is a more commonly understood value.

Comparison of Costs Among Scenarios

The total cost of processing this reference glovebox to the LLW waste form (2 scenarios) and the TRU waste form was estimated using the cost elements discussed above and summarized on Table II. The costs shown in the third column (minimized TRU volume using innovative technologies) are those associated with maximized use of innovative cost savings technologies. The cost benefit of innovative technologies has been applied as described in the previous discussion of the baseline estimate. In addition, the labor estimates were reduced by 25% to reflect the experience gained in use of a communication system for technicians operating in full-face respirators. This benefit was identified in the demonstration of the Race Scan EarMic system and summarized in an ITSR.[6]

Table II. Comparison of Costs of TRU Glovebox Processing and Disposition

DVRS Activity	Decontamination & Minimized WIPP volume - Baseline	Treatment as TRU Waste	Decontamination and minimized WIPP disposal - Innovative
Crate radiography	$631	$631	$621
Crate assay	$196	$196	$182
Crate opening	$1,068	$1,068	$952
Preparation for decontamination	$839	NA	$723
Decontamination	$31,049	NA	$20,342
Pre-sizing for compaction (LLW option)	$509	NA	$451
Compaction	$1,018	NA	$902
Size reduction for packaging (TRU option)	NA	$15,582	NA
Packaging-LLW	$566	NA	$508
Packaging - TRU	NA	$5,058	NA
Certification for disposal	$1,053	$11,700	$741
LLW disposal	$305	NA	$275
Secondary waste disposal	$246	$246	$182
Total LANL Cost	$37,481	$34,481	$25,879
TRU disposal (CBFO costs)	$13,500	$230,769	$9,500
Total DOE Cost	$50,981	$265,251	$35,379

Comparable Data

For comparison and verification, data from Rocky Flats glovebox management cost was evaluated. Sanford et al presented glovebox management data on a volumetric basis. This data, when applied to the reference glovebox in this analysis results in a cost of $37,000.[7] A previous Rocky Flats report, the Facility Decommissioning Cost Model, compiled glovebox costs, including glovebox removal. This cost is $65,000 when applied to the reference glovebox used in this analysis.[8] These costs verify that the estimates developed for Los Alamos are similar to Rocky Flats costs. Since the Rocky Flats costs appear to include glovebox removal, the fact that they are higher is understandable.

CONCLUSION

The application of innovative technologies to the processing of large metal objects for disposal as either LLW or TRU is significantly impacted by the use of innovative technologies. Table II shows that the LANL cost for treatment and disposal as TRU waste favors treatment as TRU, using the baseline technologies from DVRS. If however, the demonstrated technologies from the LANL LSDDP are applied, then the costs for TRU disposal and LLW disposal are essentially equal. In that scenario, it is easily justified to process to the LLW form as the overall cost for

DOE are significantly reduced and the uncertainties of TRU waste certification and disposal are eliminated at LANL.

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FOOTNOTES

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