CONVERTING MIXED LOW LEVEL WASTE INTO TRANSURANIC WASTE FOR GEOLOGIC DISPOSAL AT WIPP: A COST COMPARISON

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ABSTRACT

The Department of Energy (DOE) has approximately 43,000 cubic meters of mixed-low-level waste (MLLW) with alpha emitting concentrations of 10 to 100 nanocuries per gram (nCi/g) generated from the nations defense programs requiring radioactive waste disposal [1]. DOE has decided to commingle MLLW containers with transuranic (TRU) waste containers in larger containers such that the average concentration in the larger container would qualify as TRU waste for deep geologic disposal at the Waste Isolation Pilot Plant (WIPP). Since Congress has exempted the WIPP mixed TRU waste from the Resource Conservation and Recovery Act (RCRA) [2] requirement to treat the waste prior to disposal [3], the MLLW would not require treatment prior to disposal. The MLLW comprises about 25% of the total WIPP waste disposal volume authorized by Congress.

The purpose of this paper is to examine some of the costs associated with the decision to dispose of these alpha emitting MLLW as TRU waste at WIPP in comparison to the costs for TRU waste, examine some of the costs of low-level waste (LLW) shallow land disposal, address the potential for delay if treated to comply with the Environmental Protection Agency (EPA) hazardous waste Land Disposal Restrictions and to provide some cost comparisons and recommendations for the disposal of additional MLLW in the future resulting from environmental remediation programs and decommissioning and dismantling activities at DOE generating sites. Additionally, the conversion of a less toxic material to meet the more stringent regulatory requirements of a more toxic material is somewhat unique and bears examination.

INTRODUCTION

In 1970 the Atomic Energy Commission (AEC) recognized that the disposal of defense transuranic waste with concentrations of alpha emitters greater than 10 nanocuries per gram (nCi/g) posed greater hazards than the disposal of low-level waste (LLW) and began storing the material rather than continue with shallow land burial [4]. In 1982, DOE raised the threshold of TRU waste to 100 nCi/g [5]. The question arises what to do with the remaining LLW with alpha-emitting radionuclides in concentrations between 10 and 100 nCi/g, also known as alpha LLW. If it were commercial waste, the Nuclear Regulatory Commission (NRC) defined such material as Class C Low Level Waste [6]. DOE estimated that 95% of the 65,000 m^3 waste being processed at the Idaho National Engineering and Environmental Laboratory (INEEL) for WIPP qualified as mixed waste [7] and would be subject to the EPA regulations for hazardous waste disposal issued under RCRA [2]. Since 25,000 m^3 of LLW are included in this total [7], it is assumed that 95% of the LLW is also mixed. Congress exempted the DOE TRU waste slated to go to WIPP from the RCRA hazardous waste requirements to treat the waste to comply with the Land Disposal Regulations and also for the agency to file a No Migration Variance Petition [3]. DOE estimated there are about 43,000 cubic meters of alpha emitting MLLW at the DOE generator sites [1]. DOE has chosen to deal with these defense wastes in the following three ways.

In one approach, DOE has chosen to take drums containing less than 100 nCi/g MLLW and place them in a Ten Drum Overpack (TDOP) together with one or more drums containing TRU waste and to then dispose of the large Overpack containing 10 drums. The mean concentration of TRU waste in the first 21,000 drums disposed at WIPP was observed to be 16,000 nCi/g and the median 3,220 nCi/g [8]. Although individual drums must all be measured, note that placing nine MLLW drums without any measurable long-lived alpha emitters with one drum of average TRU waste would have an average concentration in excess of 100 nCi/g, thus qualifying the TDOP disposal container as TRU waste. But EPA, however, has said that the individual drums must have detectable alpha activity to qualify for WIPP [9]. If the minimum detectable activity (MDA) of equipment to measure alpha emitting radionuclides at a generating site is 100 nCi/g, drums of wastes that have no detectable activity (e.g. concentrations less than 100 nCi/g) cannot be brought to WIPP [9].

A second approach for some of the MLLW undergoing supercompaction at the Advanced Mixed Waste Treatment Facility (AMWTF) at INEEL is to place the supercompacted material in larger containers for shipment to WIPP. Since the process does not change the concentration of alpha emitters per unit weight, it does not convert LLW into TRU waste. Hence it is necessary to select compacted materials such that the average concentration in the larger container exceeds the threshold concentration for TRU waste.

A third approach would be to dispose of the alpha emitting MLLW at a LLW site. The question arises whether the costs to treat MLLW and dispose of it at a LLW site would exceed the costs to dispose of the MLLW as TRU waste in WIPP. In a 1995 Settlement Agreement and Consent Order, DOE and the State of Idaho have jointly defined the supercompaction of MLLW as "treatment" to satisfy the RCRA requirements for disposal of MLLW [10]. While such supercompacted waste would then be eligible for disposal in Idaho, the Agreement specifically precluded any disposal in Idaho and required the material to be sent out of state to either WIPP or elsewhere. The Record of Decision of the DOE in 2000 announced that treatment of MLLW would occur at Hanford, INEEL, Oak Ridge National Laboratory (ORNL) and Savannah River Site (SRS) and disposal of the product at the Hanford site and Nevada Test Site [11]. A 2001 Report of the DOE Inspector General urged DOE not to bring Idaho's MLLW to WIPP due to cost, capacity of the repository, and reiterated the previous commitment for treatment and disposal of the MLLW [12]. In November 2003, Hanford announced that they would segregate TRU waste for shipment to WIPP from the LLW and MLLW which would be disposed at Hanford [13]. Therefore it appears that DOE plans to have a capability to treat MLLW as well as dispose of MLLW at a LLW facility.

EXAMINATION OF STANDARDS, WASTE VOLUME AT WIPP, AND COSTS

Standards

TRU waste was defined by DOE in their 1988 Order 5820.2A as waste exceeding 100nCi/g at the time of assay [14]. Since the mission of WIPP is limited to TRU waste, LLW is not eligible for disposal at WIPP. In 1999, DOE issued DOE Order 435.1 which superceded 5820.2A and changed the definition of TRU waste by deleting the phrase "at the time of assay [15]." DOE could do this under their authorities and responsibilities to self-regulate and EPA noted that this was legal [9]. Adherence to standards more rigorous than those that are required is somewhat unusual and generally not done since it is usually more expensive.

Effect on Volume of Waste to Be Disposed at WIPP

The conversion and disposal at WIPP of 43,000 m^3 of MLLW to CH-TRU waste may result in exceeding the authorized disposal volume of 175,000 m^3. The Advanced Mixed Waste Treatment Facility at INEEL is scheduled to reduce the 65,000 m^3 of waste 65% to 22,750 m^3 [7]. However, the 2003 Audit Report by the DOE Inspector General estimates that the supercompaction of 65,000 m^3 at the AMWTF at INEEL

will only result in a net volume reduction of 6% [16]. For the 25,000 m^3 of MLLW to be processed at AMWTF, this would only result in a volume reduction of 1500 m^3 to 23,500 m^3. If all the 10 to 100 nCi/g MLLW identified by DOE were to be shipped to WIPP, it would contribute 41,500 m^3 to the total.

According to DOE, the total volume of each disposed container is counted as waste, regardless of the extent that it is filled. So a 55 gallon drum with a volume of 0.21 m^3 is credited as having contributed 0.21 m^3 of TRU waste to WIPP, whether filled or not. Similarly, a TDOP is credited with 4.7 m^3 of waste. Emplacing 9 drums of MLLW in a Ten Drum Overpack at 0.21 m^3 /drum amounts to 1.89 m^3 of waste volume. But the DOE takes credit for 9/10 of the 4.7 m^3 TDOP volume. This results in a volume penalty for the MLLW of

$$(0.9) \times (4.7) / 1.89 = 2.24 \quad \text{(Eq. 1)}$$

A similar penalty of 2.24 occurs when 3 MLLW drums and one TRU waste drum are shipped in a 1.88 m^3 Standard Waste Box. Excluding the 25,000 m^3 of MLLW to be supercompacted at INEEL, disposal of all the remaining MLLW in TDOP's and SWB's will account for a TRU waste disposal volume of 63,800 m^3. That amounts to 36 % of the total authorized volume. While this approach enables reporting more waste as disposed, it may be changed as the waste emplaced in the repository begins to approach the limit.

The 1997 DOE Supplemental Final Environmental Impact Statement (FEIS) states that the expected volume of TRU waste will be 193,000 m^3 [17] and the National TRU Waste Management Plan estimates quantities requiring disposal will be 186,614 m^3 [18]. While estimates are always being revised, even without the additional alpha emitting MLLW, the volume appears to be greater than the amount authorized.

It is to be recognized that there are considerable uncertainties in the predicted future quantities of radioactive wastes. As an example, estimates by DOE of the quantities of RH-TRU at Hanford ranged from 29,200 cubic meters to 1,482 cubic meters [19].

Costs

Cost data were obtained from various sources for characterization, transportation, treatment and disposal.

Characterization

The average cost for the characterization of 55 gallon CH-TRU waste drums was estimated by the DOE as $ 3,900 per 55 gallon drum [20]. The total cost for characterization of 850,000 CH- TRU drums is $ 3.3 billion. MLLW drums undergo identical characterization as the TRU drums. However, the MLLW is then emplaced in a Ten Drum Overpack costing from $ 2,500 to $ 4,000 which increases the cost of MLLW characterization of $300 per drum to $ 4,200 per drum. Total characterization costs for 41,500 m^3 (199,500 drum equivalents) would be $ 838 million.

Transportation

With respect to truck transportation, DOE estimated the total cost to transport 850,000 drum equivalents of CH-TRU to be $1,260 million which averages $ 1,480 per drum [21] [17]. For the alpha MLLW, each TRUPACT containing a Ten Drum Overpack can only carry 10 of the drums of MLLW and TRU versus 14 drums of TRU waste. There is a payload penalty requiring 40% more shipments. Due to highway weight limitations, note that there may be fewer than 14 TRU waste drums per TRUPACT. While a similar weight distribution may exist for drums of MLLW carried in a TDOP in a TRUPACT, the

payload penalty for the MLLW is greater due to the added weight of the TDOP. Despite this penalty, we assumed the average cost to ship the MLLW in a TDOP in a TRUPACT is only

1.4 x $ 1480 = $ 2,070 (Eqn. 2)

per MLLW drum. Transportation of the 199,500 drum equivalents amounts to $ 413 million.

Treatment

Congress exempted Mixed TRU waste for WIPP from the RCRA requirement to treat the waste prior to disposal. Most of the waste is mixed. For example, DOE estimated that 95% of the 65,000 cubic meters of waste being processed at INEEL for WIPP is Mixed Waste [7]. Hence, converting MLLW to Mixed TRU would eliminate any requirement to treat the waste.

It is interesting to note that DOE and the State of Idaho have agreed that the compaction of MLLW slated to go to WIPP would constitute "treatment" of the waste to satisfy RCRA requirements. Compaction does not change the alpha emitting concentration per unit weight to qualify as TRU. Other than the AMWTF at INEEL, there are no other facilities currently available to treat MLLW for shallow land disposal. Because the required treatment is uncertain for different MLLW streams, it is not possible to obtain estimates of the treatment costs.

Disposal

Costs for disposal of 850,000 drums were estimated by DOE [17] to be $ 4,200 million at an average cost of $ 4,940 per drum. Costs for the disposal of MLLW are higher. While regular TRU waste can be placed in a 21 drum stack in the mine, the overpacked MLLW is placed in a maximum configuration of 17 drums per stack consisting of one TDOP with a 7 pack placed on top. Some of the MLLW may be in four 55 gal drums enclosed in a Standard Waste Box. The amounts make it difficult to estimate. It may be less than a 23.5 % space penalty. Let us assume it is 20%. Therefore,

1.2 x $ 4,940 = $ 5,925 (Eqn. 3)

per drum. The disposal costs for the drums containing MLLW amounts to $ 1,180 million. Consider the following two tables. Table I summarizes the estimated alpha emitting MLLW volumes while Table II summarizes the costs of the different stages.

Table I Estimated MLLW Volumes having Alpha Emitting Radionuclides between 10 and 100 nCi/g through FY 2001 [1]

Site	Cubic Meters (m^3) of Waste
Idaho National Engineering and Environmental Laboratory (INEEL)	26,653
Savannah River Site (SRS)	3,060
Rocky Flats (RFP)	10,769
Nevada Test Site (NTS)	261
Mound Plant	101
Los Alamos National Laboratory (LANL)	27
Lawrence Livermore National Laboratory (LLNL)	2,208
Hanford Reservation	5
TOTAL	43,084

Table II Average Costs for the Disposal of TRU and MLLW Drum Equivalents at WIPP

Stage	Cost per drum of CH-TRU ($)	Cost per drum of MLLW ($)	Total Costs to process MLLW for WIPP (million $)
Characterization	3,900	4,200	838
Transportation	1,480	2,070	413
Treatment	Not required	Not required	Not applicable
Disposal	4,940	5,930	1,180
TOTAL	10,320	12,200	2,431

Characterization of MLLW for disposal does not require the same spectrum of measurements of that required for TRU. Transportation as LLW is cheaper, as is disposal. The financial issue is whether the costs of treatment as MLLW would exceed the costs of processing and disposing of these materials as TRU waste. It is important to emphasize that LLW is not authorized for disposal at WIPP. It is necessary to emplace the MLLW drums and boxes in larger containers such that the average concentration in the container to be discarded exceeds 100 nCi/g, thus qualifying as TRU waste. While RCRA requires treatment of the MLLW, LLW does not require treatment since RCRA does not apply to LLW. DOE estimated that 95 % of the 65,000 m^3 of waste being processed at INEEL for WIPP is Mixed Waste. Hence, most of the less than 100 nCi/g waste is MLLW.

DISCUSSION

The question arises "Why is DOE is bringing such waste to the WIPP since LLW was never authorized for WIPP?" The reasons are straightforward. DOE maintains there are no currently licensed facilities to dispose of treated alpha MLLW. Additionally, since WIPP has been shown to meet the standards for the disposal of TRU waste, it should not be a problem for the less toxic MLLW.

DOE has determined that it makes more sense to process the MLLW thru the TRU process on the basis that it has been managed that way since storage began in 1970. The argument is made that the MLLW is processed as a waste stream with TRU waste streams and to break out the MLLW from the TRU waste stream would be inefficient and disruptive of the operations. This does not appear to be a valid argument since each drum undergoes a non invasive assay procedure near the beginning of the characterization process to measure the radioactive content and then weighed. One can immediately calculate the radioactivity per unit weight. If it is less than100 nCi/g it is LLW. The TRU waste already disposed at WIPP has a mean concentration of 16,000 nCi/g and the alpha emitting MLLW drums can easily be isolated from the TRU waste drums. Hence it is not a continuous waste stream flow process but is a batch process.

There are a number of factors warranting reconsideration of the conversion of MLLW to TRU.

1. It appears to be more expensive to dispose of MLLW as TRU waste at WIPP than to dispose of TRU waste at WIPP.

2. Since the DOE and the State of Idaho have agreed in a Consent Order that supercompaction of the 25,000 m^3 of MLLW at INEEL satisfies the requirement of "treatment" to meet RCRA (10), disposal as Mixed LLW is a viable option. In Sept 2001, the DOE Inspector General noted that the disposal of Idaho's MLLW in WIPP would cost $119 million more than necessary and also needlessly add additional waste volumes to WIPP. The IG recommended that the MLLW be disposed in either Hanford or the Nevada Test Site [12]. A subsequent analysis by the DOE IG in 2003 estimated the increase in cost for WIPP would be $ 205 million since the supercompaction would not reduce the volume 65%, but only 6% [16]. The processing requires some of that waste to be subsequently emplaced in 3 different drums; all disposed at WIPP.

3. Unilaterally changing the threshold definition of 100 nCi/g for TRU waste in DOE Orders by deleting the requirement "at the time of assay," which permits alpha emitting MLLW disposal at WIPP, does not enhance public confidence.

4. The increase in volume for the repository may require a Congressional Amendment to the Land Withdrawal Act since it appears the statutory limit may be exceeded.

5. Because EPA will not permit LLW with concentrations less than the lower limit of detectability, to be brought to WIPP, DOE will have to tackle the problem of their disposal as well as other large quantities of LLW on their hands and the sooner the issue is confronted, the quicker the solution can be obtained.

CONCLUSIONS

1. The MLLW, about 25% of the total waste authorized for WIPP, reduces the available volume for TRU in WIPP by twice that amount due to the method of calculating volumes of waste emplaced.

2. The operations of characterization (additional cost of a TDOP and increased time for radioassay), transportation (reduced payload) and disposal (increased volume in the mine) of MLLW with alpha concentrations of 10 to 100 nCi/g are each more expensive on a per drum basis than the TRU waste slated for WIPP.

3. Transportation of 41,500 m^3 of MLLW at an average rate of 30 drums per shipment in lieu of 42 could require about 1,900 additional shipment to WIPP.

4. Knowledge of the MLLW streams is incomplete and so varied that it is not clear what treatment would be required for the 539 individual TRU waste streams identified by DOE to meet the hazardous waste RCRA Land Disposal Regulations.

5. Even if the waste were to be treated to meet the RCRA Land Disposal Restrictions, there is no disposal site in the U S currently accepting such waste classified as Class C LLW although Hanford announced in October 2003 [12] that they will dispose of their LLW and MLLW at the Hanford facilities.

6. DOE expects considerable amounts of LLW to be produced that will require disposal.

RECOMMENDATIONS

1. DOE should publish detailed cost estimates of MLLW treatment to see if there is an overall cost saving for surface disposal since the costs of processing as TRU appear to be expensive. The emplacement of 41,000 m^3 of MLLW in WIPP at $12,200 per drum equivalent increases the costs by $ 2.4 billion.

2. Because DOE has a considerable inventory of stored LLW as well as a considerable amount expected to be generated from Environmental Restoration projects and the D&D of various facilities, the Department should determine the fraction that is mixed and begin planning now for the ultimate disposition; whether to treat the material for shallow land burial or obtain an exemption from Congress for deep geologic disposal.

3. DOE should investigate alternatives to the future disposing of LLW, MLLW and alpha bearing MLLW in shallow land burial rather than the expensive requirements for characterization, transportation and disposal in deep geologic formations. Some of these wastes may be excellent candidates for treatment and disposal in less expensive shallow burial.

4. For each volume of MLLW commingled for emplacement as TRU waste in WIPP, the TRU waste volume must correspondingly be reduced. If buried TRU waste is exhumed for disposal at WIPP and future Environmental Restoration and D&D activities produce more TRU waste, under the current design there will be no place for it at WIPP. Estimates of the required volumes for disposal should be prepared now.

5. Of the 65,000 m^3 of waste being processed at the AMWTF in Idaho, 25,000 m^3 are LLW (and 95% of that is mixed). DOE should consider shipping the remaining 19,000 m^3 (91,000 drum equivalents) located elsewhere to the AMWTF for similar supercompaction to satisfy the requirement for treatment as Mixed LLW.

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FOOTNOTES

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