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United States Government | Department of Energy

memorandum

Richland Operations Office

DATE: APR 29 1996

REPLY TO ATTN OF: WDD:WJT 96-WDD-011

SUBJECT: INDEPENDENT REVIEW OF HANFORD HIGH LEVEL WASTE VOLUME

TO: Distribution List

An independent review was commissioned to assess the high-level waste volume, resulting from the enhanced sludge washing treatment and immobilization of Hanford tank waste. The report of this independent review is attached.

The results of this review are accepted and will be used for planning purposes by DOE.

If you have any questions on this, please call me at (509) 372-3864 or Ken Lang at (301) 903-7453.

William J. Taylor, Director
Waste Disposal Division

Kenneth T Lang, Team Leader
Hanford Office
Office of Tank Waste Remediation System

Attachment

6c

7.4.6.2

96-WDD-011

Dist. List

w/attach:
D. Button, WDD
N. Brown, WDD
P. Certa, WHC
P. Colten, PNNL
R. Gilbert, WDD
C. Haass, MSD
L. Holton, PNNL
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M. Hunemuller, DOE-HQ
M. Johnson, WHC
M. Kupfer, WHC
C. Mylar, DOE-HQ
R. Orme, WHC
D. Pepson, DOE-HQ
J. Plodinec, WSRC
D. Strachan, ANL
C. Sohn, MSD
H. Sutter, SAIC
W. Taylor, WDD
D. Washenfelder, WHC

INDEPENDENT REVIEW TEAM REPORT

INTRODUCTION AND SUMMARY

The EIS leading to decisions about the fate of the waste in the HLW tanks at Hanford is scheduled to be released for public comment in March, 1996. It is important that the information in the EIS have a firm technical foundation so that sound decisions about the fate of the waste can be made. The Independent Review Team (IRT) was empaneled to examine the technical bases of one of the more important facets of the EIS - the number of canisters of HLW glass which would be produced from the waste in the Hanford tanks (The membership of the IRT is contained in Attachment 1; the Statement of Work in Attachment 2).

The goal of the IRT was to ensure that the number of canisters projected in the EIS:

• Adequately reflected the uncertainties associated with the current understanding of the inventory and especially the chemistry (degree of blending which will be achieved, separation factors in pretreatment processes, and vitrification process limits) of Hanford HLW. The IRT interpreted this as ensuring that the range of possible canister production values provided adequate upper and lower bounds for decision-making.

• Provided an appropriate median case (a sort of "expectation value") for detailed analysis and planning.

The IRT accomplished this through a series of briefings and discussions with cognizant Hanford Site personnel, and examinations of key documents (The list of briefings is contained in Attachment 3, and the documents provided to the IRT is contained in Attachment 4).

The IRT has concluded that the current range, and median value, of the number of canisters which will be produced from Hanford HLW contained in the EIS (13800 to 70000, and 33400, respectively) are conservative. However, the Hanford site has made significant progress in better defining key input since the EIS values were originally developed. Based on this progress, the IRT has concluded that a range of 13800 to 50000 canisters better reflects the current state of understanding, and that a value of 23000 canisters provides a more representative case for policy decision making.

The IRT recognizes that selection of the values in the EIS has been controversial and contentious. The IRT has concluded that this is due to a fundamental misunderstanding of the bases of the current calculations. Improved clarity in the presentation of the bases, coupled with better communications, would help to avoid this sort of problem in the future. In this report, we have attempted to provide a clearer exposition of the bases of the calculations.

EIS CANISTER PRODUCTION VALUES

Calculation

Canister production values are calculated in the following manner. The total inventory of waste on a mass basis is partitioned into soluble ("salt cake") and insoluble ("sludge") portions. The insoluble portion is assumed to undergo water-washing during which residual soluble material is removed by dilution. The resulting solids then undergo caustic leaching during which additional material in the "sludge," most notably aluminum, is dissolved. It is assumed that there is perfect blending of the "sludge" material.

It is assumed that 1% of the soluble material remains with the insolubles. The rest of the soluble material undergoes ion exchange, and the separated cesium is combined with the insoluble material at the high-level waste processing plant. Glass-forming additives are blended with the waste mixture and then vitrified. The amount of additives is selected so that the minimum volume of glass is produced, consistent with constraints on the solubility of waste components (e.g., Cr) in the glass.

For the EIS,[1] a total inventory dating back to the 1977 EIS (with periodic subsequent updates) was used as the starting point (This is referred to as the EIS inventory). This was partitioned into the soluble and insoluble portions, called "salt cake" and "sludge," based on the judgement of experienced personnel. It is important to note that this partition was somewhat artificial, in that it did not necessarily represent actual salt cake or sludge. If an element was not assigned to the soluble fraction, i.e. "salt cake," it was assumed to be contained only in the "sludge." Thus, the small portion of sludge which is found in actual salt cake was not included in the "salt cake" used for the EIS calculations. It was assumed that the "sludge" and "salt cake" were each perfectly blended.

The "sludge" and "salt cake" were then cascaded through the process (via the flowsheet model), using values for water-washing and caustic-leaching efficiencies reflecting the state of understanding up to 1994. The amount of glass-forming additives used to produce glass was the minimum amount necessary to ensure that the glass satisfied solubility limits for waste oxides such as Cr, Al, and Fe (These limits approximated plant operating limits rather than the true solubilities, and thus were representative of what might be achieved in operations). This led to an estimate of 13800 canisters, which is presented in the EIS as a lower bound on the number of canisters, since perfect blending of the waste is not possible.

To develop a "planning case" for the number of canisters, a nominal waste oxide loading of 20 wt% (= actual waste loading less Na and Si contained in the waste) was assumed. In this case, the actual waste loading was about 31 wt%.[2] The EIS waste inventory was used and a blending factor of 1.5 was assumed (The blending factor reflects the additional glass produced because of imperfect blending). This led to a projection of 33800 canisters. A maximum upper bound to the number of canisters was obtained by applying a blending factor of 5 to the lower bound case. This was based on subjective assessments of the possible effectiveness of blending. This latter figure led to a canister count of 70000, which is presented in the EIS as an upper bound.

Sources of Uncertainty

There are five major sources of uncertainty in the calculations described above. The IRT considered each of these in evaluating the canister production values in the EIS.

• Inventory. Both the total mass of oxides, and the partitioning of materials into soluble and insoluble fractions, can affect the accuracy of the calculations. Over the last few years, LANL has been reconstructing the total inventory. Agnew (LANL) has utilized the information used to develop the EIS inventory, as well as other information from nuclear materials production and

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[1] Throughout this document, when an Environmental Impact Statement is referred to as "the EIS," Draft C of the 1996 EIS is meant. There have been earlier Environmental Impact Statements - these are referred to by their date.

[2] Hanford waste is unique in the DOE complex because it contains substantial amounts of glass-forming oxides. Thus, to make a specific silicate glass, fewer chemicals are needed as additives. This results in higher waste loadings than for other DOE waste glasses, which often is misunderstood.

waste operations at the Hanford Site. The total mass of waste constituting the LANL inventory is smaller than the EIS inventory, and attempts to accurately represent actual sludge and salt cake. Table 1 lists the LANL inventory, and the EIS inventory. The relationship between the two is shown in the last column. The total inventory developed by LANL is smaller, primarily due to smaller amounts of sodium, nitrate, and phosphate. However, species subject to glass processing limits (e.g., Cr, Al, Fe) are significantly enriched in the LANL inventory. Thus, even though the LANL inventory is smaller, it is likely to provide an upper bound for the amount of glass to be produced. Efforts are underway to reconcile the two inventories, and, more importantly, to bring the LANL inventory into agreement with analyses of actual wastes. The IRT concluded that the actual inventory will most likely be somewhere in between the two shown in Table 1.

• Amount retrieved. For the calculations, it was assumed that 99% of the waste in the tanks would be retrieved. Given the refractory nature of some of the material in the tank, it is not clear that this will be achieved. If it is not, then the calculated number of canisters will be overestimated (It is very improbable that more than 99% of the waste will be removed from the tanks.).

• Blending factor. The values in the EIS are based on the assumption that all of the insoluble material is perfectly blended. In practice, this is unlikely to be achieved.

• Pretreatment efficiencies. The flowsheet is based on a water wash to remove soluble species, followed by caustic leaching of the insolubles. The values in the EIS reflect the best judgement based on incomplete experimental work. Thus, these constitute a potentially significant source of uncertainty (The uncertainties in these factors are discussed in more detail in Attachment 5.).

• Glass processing limits. The number of canisters in the EIS is based on adding the minimum amount of glass-forming materials necessary to meet glass solubility limits, as known in 1994. No attempt was made to optimize the glass composition, nor was an effort made to determine whether the glass could actually be produced.

As implied above, an increase in either the total inventory or in the amount of a single component does not necessarily mean an increase in the number of canisters. Since the number of canisters is calculated based on meeting glass processing limits, only a few critical elements affect the calculation. The most important elements appear to be Cr, P, Na and Al. Of these, Cr and P appear to be the most critical. These elements are nearly at the upper limit suggested by glass composition studies carried out by Hanford Site personnel, and thus determine the amount of glass produced.

EVALUATION OF EIS VALUES

The IRT examined each of the canister production values in the EIS. The IRT has concluded that the lower bound is, in fact, an appropriate lower bound. However, neither the planning value nor the upper bound reflect the progress made in the last two years in understanding waste inventory and waste pretreatment. While both of these values are conservative, better values are available.

Lower Bound

The lower bound value of 13800 was evaluated by comparing it to more realistic calculations, and by examining the effects of the uncertainties identified above on the calculated value. The IRT has concluded that the EIS value is a credible lower bound to the number of canisters which will be produced.

A new estimate of the total number of canisters has recently been made using a modified EIS inventory (Minor increases were made in the amounts of Al and Cr to address accounting errors; a minor decrease was made in the PO_4^{3-} content to take into account transfers of phosphate waste to the waste cribs). The waste was partitioned into insoluble and soluble fractions based on the LANL effort. Thus, although the total inventory was not very different from that used for the EIS, the partition of elements between sludge and salt cake was more realistic. Water washing and caustic leaching efficiencies were modified to reflect the more current values of Colton. This led to a projected canister count of 14600, indicating that the EIS value of 13800 is probably a lower bound.

The IRT also considered the effects of the other uncertainties listed above. Since perfect blending is assumed, the EIS value is certainly a lower bound compared to a more realistic case. In order to examine the effects of glass processing limits, the glass compositions for both the EIS and the modified EIS basis were examined. These are shown in Table 2. The total waste loading for the EIS glass is 46.5 wt%, including the Na and Si in the waste (As noted later, this waste loading factor is an important source of misunderstanding over these calculations.). Use of the LANL inventory would require more canisters, because of the higher Cr content, again indicating that the EIS value is a lower bound. Because of the lower amounts of Na and Si in the LANL inventory, the waste loading for this glass decreases to 43.3 wt%. Projected DWPF and West Valley glass compositions are shown in Attachments 6 and 7. Comparing Table 2 and the attachments, the Hanford glass compositions are within the range of compositions defined by the other two sites, even though the nominal waste loadings are considerably different. Thus, while clearly an underestimate of the number of canisters, the calculation leads to a glass composition which could be processed in current production facilities.

Johnson also looked at the effects of all of the uncertainties, except for blending, on the number of canisters. He allowed each of the various sources of uncertainty to vary between a high, medium and low value, and assigned a probability value 0.25, 0.50, and 0.25, respectively (This approximates a normal distribution about the median value). Using the EIS inventory, he constructed a cumulative distribution function for the amount of glass which would be produced (The number of canisters is this value divided by 0.62). This is shown as Case 1 in Figure 1.

The y-axis shows the probability of producing no more than the amount of glass indicated on the x-axis. As the Figure shows, there is less than a 10 % probability that the number of canisters produced will be less than the 13800 value in the EIS (This corresponds to 8500 m^3 of glass). The IRT thus has concluded that this is an appropriate lower bound for use in the EIS.

Upper Bound and Median Value

The median and upper bound values in the EIS were based on subjective judgements of what the likely effects of the uncertainties identified earlier might be. The value of 70000 canisters is based on the assumption that the total uncertainties in processing, particularly in blending, will lead to a five-fold increase in the number of canisters compared to the lower bound. The factor of was taken from an earlier system study; but its bases have been superseded by the more recent data. Calculations recently performed by Certa show that any realistic feed pretreatment scenarios consistent with the current flowsheet give rise to no more than 20% more glass than a perfectly blended inventory.

Similarly, there is no basis for arbitrarily reducing the waste loading, as is done in the planning case. It is unlikely that a plant operator would do so without reason. The IRT has concluded that selection of a specific waste loading thus overly constrains the calculation of the number of canisters, in an artificial manner. As a result, overly conservative values are calculated.

For this reason, the IRT developed a median and an upper bound value to evaluate the corresponding values in the EIS. As a starting point for the upper bound, the LANL inventory was chosen because it would produce more glass than the EIS inventory, as can be seen in Figure 1 (comparing Case 2 - LANL inventory to Case 1 - EIS inventory). This case used glass processing limits which are somewhat more restrictive than necessary, and thus would produce more glass. To produce an upper bound, the IRT selected the glass production value which corresponds to a 95% probability that it will not be exceeded - 26000 m^3. This value was multiplied by the factor of 1.2 obtained from Certa, and converted to canisters by dividing by 0.62. This results in a value of 50000 canisters. Based on this value, the IRT concludes that the 70000 value in the EIS is not only conservative, but overly so. Because the 50000 canister value developed by the IRT reflects the progress made in the last two years, it provides a more appropriate upper bound than the 70000 canister value.

As a starting point for the median value, the LANL value was again used. However, the IRT used values for the glass processing limits which reflected expert judgement applied to glass processing. This corresponds to the assumption that between now and the time glass production begins, means will be found to either increase solubility limits in the glass or decrease the amount of limiting components such as Cr going into the glass (e.g., through enhanced pretreatment). The IRT used Case 4 in Figure 1. Since a median value is most appropriate for the planning value, the amount of glass corresponding to a probability of 0.5 was used - 12000 m^3. Using the same blending factor and converting from glass volume to canisters in the same manner as for the upper bound, a value of 23000 is obtained. The IRT thus concludes that the 33400 value in the EIS is conservative. Again, the IRT's value is more consistent with the current understanding of Hanford waste behavior.

CONCLUSIONS AND TECHNICAL RECOMMENDATIONS

The IRT has completed a review of the number of canisters of waste glass which will be produced from Hanford tank wastes. Based on this review, the following conclusions were drawn:

• The current range, and median value, of the number of canisters which will be produced from Hanford HLW contained in the EIS (13800 to 70000, and 33400, respectively) are conservative.

• A range of 13800 to 50000 canisters, and a median value of 23000 canisters, better reflects the current state of understanding of Hanford waste than the EIS estimates. The value of 23000 canisters provides a more representative case for detailed planning of environmental impacts.

• In spite of the apparent high waste loading factors, the projected glass compositions are in the same range as nominal DWPF and West Valley glasses. As noted earlier, the high waste loading is deceptive due to the large amount of Na and Si contained in Hanford HLW.

Based on this review, the IRT makes the following technical recommendations:

• Completion of ongoing studies. As noted above, reconciliation of inventory data with the results of tank samples is not yet complete. Validation of assumptions about the efficiency of water washing and caustic leaching are also not yet completed. The IRT does not expect that new results will significantly change the total number of canisters which will be produced. However, it is imperative that these studies be brought to a conclusion, so that contingencies for the uncertainties in the inventory and in the washing and caustic leaching efficiencies can be minimized. In particular, further work is needed with Redox sludge, since this is the major source of Cr in the waste.

• Improvement of current models for decision-making. It appears that sufficient conservatism has been incorporated into the calculations performed by Johnson (Figure 1), so that the statistical uncertainties in the data have been appropriately addressed. However, an estimate of the standard deviation in the experimentally determined washing factors needs to be correlated to the range of washing factors used in Johnson's calculations. In particular, the IRT recommends examining a broader range of Na washing factors. In addition, a blending factor should be included to provide more complete calculations.

• Use of the Johnson study to prioritize further work. The IRT was impressed by the wealth of information contained in the Johnson study. In particular, his results clearly show the importance of gaining as much information as possible about the amount of Cr in the waste, and the efficiency of removal of Cr during pretreatment. This study provides valuable insight into the relative importance of different factors and needs to be used to prioritize further work in these areas.

NOTE ON COMMUNICATION OF TECHNICAL BASES

The IRT recognizes that selection of the values in the EIS has been controversial and contentious. Based on the IRT's experience, this is due in large part to miscommunication of the technical bases of the calculated values in the EIS. This miscommunication resulted in misconceptions on the part of those not involved in performing those calculations. Improved clarity in the presentation of the bases, coupled with better communications, would help to avoid this sort of problem in the future. In particular, calculations which result in numbers of canisters also result in associated glass compositions. Hanford Site personnel should present these in the context of the DWPF and West Valley glass compositions. This would help to avoid misconceptions about the very deceptive waste oxide loadings quoted in several of the studies.

ACKNOWLEDGEMENT

The IRT is grateful for the patience shown by Hanford Site personnel in presenting material, and fielding a large number of questions.

Table 1. Total inventories of Hanford waste: EIS basis, and LANL inventory.

Component	EIS (MT)	LANL (MT)	LANL / EIS
Al^{3+}	2.96E03	5.26E03	1.78
Bi^{3+}	2.61E02	6.64E02	2.54
Ca^{2+}	1.28E02	5.36E02	4.18
Cancrinite[a]	2.70E03	1.94E03	0.719
Cl^-	4.15E02	3.50E02	0.843
CO_3^{2-}	1.66E03	2.73E03	1.64
Cr^{3+}	2.68E02	7.47E02	2.79
F^-	8.12E02	5.39E02	0.663
Fe^{3+}	6.31E02	2.59E03	4.10
K^+	5.53E01	1.31E02	2.37
La^{3+}	1.88E00	4.01E01	21.3
Mn^{4+}	1.0E02	1.75E01	0.146
Na^+	5.73E04	2.97E04	0.513
Ni^{2+}	2.03E02	2.10E02	1.03
NO_2^-	6.52E03	5.57E03	0.852
NO_3^-	1.00E05	4.28E04	0.426
OH^-	1.06E04	1.70E04	1.60
Pb^{4+}	2.83E01	1.32E01	0.466
PO_4^{3-}	4.73E03	3.91E03	0.827
Si^{4+}	1.45E01	9.41E01	6.49
SO_4^{2-}	1.65E03	4.32E03	2.62
Sr^{2+}	3.60E01	1.57E02	4.36
UO_2^{2+}	1.61E03	1.92E03	1.19
Zr^{4+}	3.82E02	9.36E01	0.245
Total Organic Carbon	4.73E02	2.99E02	0.633
TOTAL	1.94E05	1.22E05	0.629

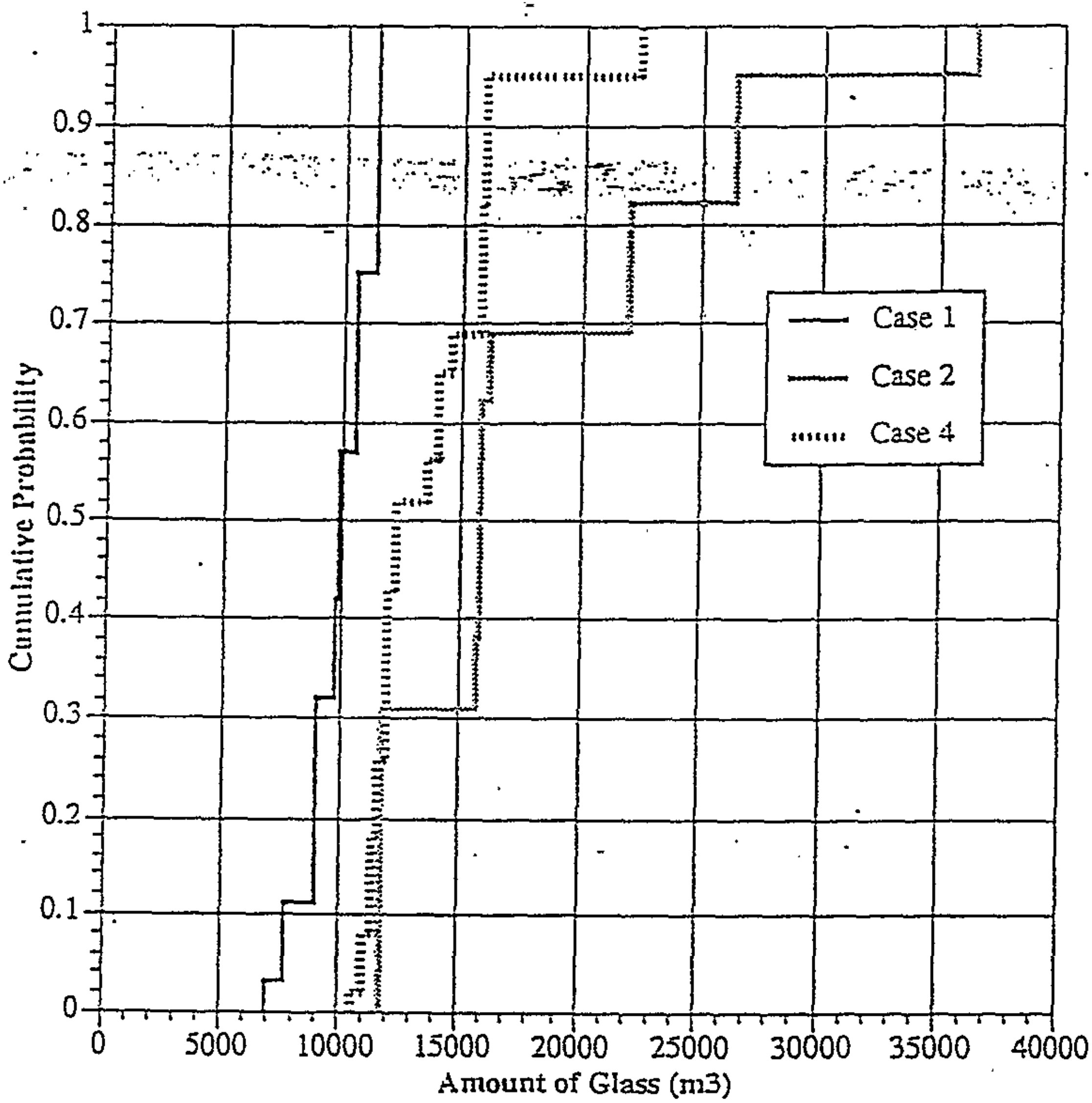
[a] Chemical composition: $2NaAlSiO_4{:}0.52NaNO_3{:}0.68H_2O$.

Table 2. Glass compositions based on EIS and modified EIS inventories.

	EIS glass composition (wt%)			Modified EIS glass composition (wt%)		
Component	Waste	Additives	Glass	Waste	Additives	Glass
Fraction[a]	46.6	53.4		50.9	49.1	
Al2O3	6.0	0	6.0	9.3	0	9.3
B2O3	0	9.7	9.7	0	7.0	7.0
CaO	1.0	0	1.0	0.8	0	0.8
Fe2O3	5.1	0	5.1	4.5	0	4.5
Li2O	0	2.7	2.7	0	2.0	2.0
Na2O	11.8	0	11.8	12.3	0	12.3
P2O5	2.3			1.6	0	1.6
SiO2	4.9	41.1	46.1	5.9	40.1	46.0
UO3	6.8	0	6.8	6.7	0	6.7
ZrO2	3.3	0	3.3	3.8	0	3.8
Other	5.4	0	5.4	6.0	0	6.0

[a] Fraction of glass produced by waste or additives, in wt%.

Figure 1. Projected glass production for various scenarios.



Attachment 1

Independent Review Team Membership

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STATEMENT OF WORK
HANFORD HLW CANISTER PROJECTION ASSESSMENT

Background

The Department of Energy (DOE) and the Washington Department of Ecology are preparing an Environmental Impact Statement (EIS) to assess the environmental impacts of the Hanford Tank Waste Remediation System. The document is being prepared to meet the requirements of the National Environmental Policy Act. Included in this EIS are assumptions for low activity waste (LAW) and high-level waste (HLW) loading estimates, tank waste blending factors, and estimates of the total number of canisters of both immobilized LAW and HLW glass likely to be produced during the vitrification process.

In order to assure the analysis in the EIS is technically defensible and the analysis methodology is understandable to the general public both HQ/EM and RL have agreed to establish an Independent Review Team (IRT).

Scope of Work

The IRT will convene and be presented the TWRS HLW volume analysis. The IRT will establish any additional data requirements necessary to provide a technically supportable estimate of the Hanford waste tank contents which would be delivered for high level waste immobilization. The team will provide their requirements to both HQ/EM and RL. HQ/EM and RL will collect the necessary information and provide the information to the team in a timely fashion.

The IRT will evaluate the TWRS process, technical basis, and available data in order to develop an independent assessment of the results from the analysis conducted on the tank waste. The focus of the evaluation will be on the high level waste fraction to be vitrified. The presentations to the IRT will include the sources of data used to establish the mass, the uncertainties in the data, the uncertainties in the mass amount, and a conservative determination of the mass which should be used to provide an upper bound of waste delivered for immobilization. This conservative upper bound, if determined to be appropriate by the IRT, will be used in the EIS for the case of enhanced sludge washing. If the IRT does not accept the conservative upper bound currently used in the draft EIS then the IRT will present to HQ/EM and RL a recommended upper bound and the basis for the recommendation. The methodology for the analysis, a clear audit trail showing the data quality, and level of uncertainty will also be provided.

Only the operations used in the EIS description of Enhanced Sludge Washing will be used in the determination of separations. Available data on the process should be used to assess efficiencies of separations including the assessment of uncertainty.

Schedule/Deliverables

To insure the results of the independent review team are usable, the review team will present a schedule following their initial meeting, recognizing that time is of the essence. Attempts should not be made to compromise quality of the resulting assessment as the impacts of getting an incomplete assessment would be significant.

William J. Taylor
Director, Waste Disposal Division
Richland Operations Office

Ken Lang
TWRS Team Leader, EM-38
Office of Waste Management

PROPOSED WORKSHOP AGENDA - HANFORD HLW CANISTER PROJECTION ASSESSMENT

March 4-8, 1996
3170 George Washington Way
Sigma IV Building, Moon Room
Richland, Washington

March 4, 1996

7:30	Independent Review Team (IRT) Meet for breakfast at Tower Inn	H. Sutter D. Stracken J. Plodinec L. Holton
9:00	Introductory Remarks/Expectations	W. Taylor
9:15	TWRS Reference Processing Strategy	R. Gilbert
9:30	Tank Waste Inventory	M. Kupfer
11:00	Enhanced Sludge Washing	D. Washenfelder
12:30	Lunch	
1:30	Blending Strategies	P. Certa
2:30	Glass Processing/Waste Oxide Limitations	N. Brown
3:30	TWRS Flowsheet	R. Orme
4:30	Decision Analysis Model	M. Johnson
5:15	Hanford Canister Projection	R. Gilbert
5:45	Adjourn	

ADDITIONAL ATTENDEES: BILL ROOT, CAROLYN HAASS

March 5-8

The schedule details for March 5-8 will be developed by the morning of March 5, 1996 by the IRT in conjunction with the Hanford team.

WORKSHOP AGENDA - HANFORD HLW CANISTER PROJECTION ASSESSMENT
March 4-8, 1996
3170 George Washington Way
Sigma IV Building, Moon Room
Richland, Washington

March 4, 1996

1. TWRS Reference Processing Strategy

2. Tank Waste Inventory

- History of TWRS Waste Inventory Development
- Adjustments to FY 1994 Inventory for FY 1995 Rev. 1 Flowsheet
- Comparison of Rev. 1 Inventory and LANL Model
- Reconciliation activities for TWRS Inventory and LANL Model

3. Enhanced Sludge Washing

- TWRS Rev. 1 Inventory distribution among SSTs using LANL Tank Layering Model LA-UR-94-4269, Rev. 1 (1995); among DSTs using tank samples from WHC 74A20-96-30 Appendix B (1996)
- Division of SST inventory between saltcake and sludge using Tank Layering Model
- Saltcake 99% water solubility basis from RHO-SA-51 (1980); assignment of insoluble fraction to sludge inventory (zero sums)
- Sludge water solubility basis from 27 samples in PNL-10512 (1995)
- Sludge caustic solubility basis from PNL-10512 and TWRSPP-95-024 (1995)
- Match of empirical caustic solubility sample data with expected solubility for Al and PO4
- Example derivation of insoluble Al using TWRS Process Flowsheet WHC-SD-WM-TI-613 Rev. 1 (1995)
- Solubility variation treatment by the Decision Analysis Model in WHC-EP-0874 (1995)

4. Glass Processing/Waste Oxide Limitations

- Comparison of TWRS Rev. 0 and Rev. 1 HLW glass volumes
- Limiting component loadings for various canister counts compared to HWVP-CVS component limits

5. TWRS flowsheet

- Key assumptions used in the Rev. 1 process flowsheet affecting HLW glass volume and bases: tank inventories; retrieval rate and performance; sludge settling, wash steps, and duration; HLW melter volatility

WORKSHOP AGENDA - HANFORD HLW CANISTER PROJECTION ASSESSMENT (cont.)

March 5, 1996

6. Blending Strategies

- Description of physical plant modelling and incidental waste mixing
- Model operation and inputs
- Effect of reduced HLW glass loadings on blend factor

7. Decision Analysis Model

- Development, operation, and validation of model
- Model parameters relevant to HLW glass volume: selection of TWRS Rev. 1 inventory or LANL inventory; treatment of sludge solubility uncertainty; selection of waste oxide loading limits
- Identification of major sensitivities from tornado diagrams
- Calculation of probable outcomes

8. Hanford Canister Projection

- Derivation of [draft] EIS canister projection

(References cited during discussions listed on the following page.)

HANFORD HLW CANISTER PROJECTION ASSESSMENT

Pacific Northwest National Laboratory

PNL-9814, Revision 2, "The Sort on Radioactive Waste Type Model: A Method to Sort Single-Shell Tank into Characteristic Groups," 1995.

PNL-10512, Revision 0, "Sludge Pretreatment Chemistry Evaluation: Enhanced Sludge Washing Separation Factors," 1995.

PNL-8558, "Pretreatment of Neutralized Cladding Removal Waste Sludge: Status Report," 1993.

PNL-7758, "Characterization of the First Core Sample of Neutralized Current Acid Waste From Double-Shell Tank 101-AZ," 1989.

PNL-8601, "Pretreatment of Plutonium Fishing Plant (PFP) Sludge: Report for the Period October 1990 - March 1992," 1993.

PNL-9747, "Pretreatment of Neutralized Cladding Removal Waste Sludge: Results of the Second Design Basis Experiment," May 1994.

PNL-10712, "Washing and Caustic Leaching of Hanford Tank Sludges: Results of FY 1995 Studies," 1995.

PNL-8536, "Pretreatment of Neutralized Cladding Removal Waste (NCRW) Sludge - Results of FY 1991 Studies," 1993.

Westinghouse Hanford Company

WHC-SD-WM-DTP-033, Revision 1, "TWRS Process Flowsheet," 1995.

WHC-SD-WM-RPT-167, "Preliminary Retrieval and Blending Strategy" 1995.

WHC-SD-WM-ES-366, "Determine Waste Separations Process Strategy Decision," 1996.

WHC-EP-0874, "Decision Analysis Model for Assessment of Tank Waste Remediation System Waste Treatment Strategies," 1995.

Internal Memo, 74A20-96-30, "Chemical and Radionuclide Inventory for Single and Double-Shell Tanks," 1996.

RHO-SA-51, "Removal of Radionuclides from Hanford Defense Waste Solutions," 1980.

WHC-SD-WM-TI-613, Revision 1, "TWRS Process Flowsheet," 1995.

Letter, 9554823, "Hanford Federal Facility Agreement and Consent Order Target Milestone M-50-03-T2A, Submit Report Summarizing the Testing of Enhanced Sludge Washing and Related Tank Waste Sludge Pretreatment Methods for Samples of Tank Waste," J. O. Honeyman, WHC, to W. J. Tyler, DOE-RL, September 14, 1995.

Los Alamos National Laboratory

LAUR 95-2070, "Sludge Washing and Alkaline Leaching Tests on Actual Hanford Tank Sludge: A Status Report," 1995.

Pacific Northwest National Laboratory

PNL-9814, Revision 2, "The Sort on Radioactive Waste Type Model: A Method to Sort Single-Shell Tank into Characteristic Groups," 1995.

PNL-10512, Revision 0, "Sludge Pretreatment Chemistry Evaluation: Enhanced Sludge Washing Separation Factors," 1995.

PNL-8558, "Pretreatment of Neutralized Cladding Removal Waste Sludge: Status Report," 1993.

PNL-7758, "Characterization of the First Core Sample of Neutralized Current Acid Waste From Double-Shell Tank 101-AZ," 1989.

PNL-8601, "Pretreatment of Plutonium Fishing Plant (PFP) Sludge: Report for the Period October 1990 - March 1992," 1993.

PNL-9747, "Pretreatment of Neutralized Cladding Removal Waste Sludge: Results of the Second Design Basis Experiment," May 1994.

PNL-10712, "Washing and Caustic Leaching of Hanford Tank Sludges: Results of FY 1995 Studies," 1995.

PNL-8536, "Pretreatment of Neutralized Cladding Removal Waste (NCRW) Sludge - Results of FY 1991 Studies," 1993.

Westinghouse Hanford Company

WHC-SD-WM-DTP-033, Revision 1, "TWRS Process Flowsheet," 1995.

WHC-SD-WM-RPT-167, "Preliminary Retrieval and Blending Strategy" 1995.

WHC-SD-WM-ES-366, "Determine Waste Separations Process Strategy Decision," 1996.

WHC-EP-0874, "Decision Analysis Model for Assessment of Tank Waste Remediation System Waste Treatment Strategies," 1995.

Internal Memo, 74A20-96-30, "Chemical and Radionuclide Inventory for Single and Double-Shell Tanks," 1996.

RHO-SA-51, "Removal of Radionuclides from Hanford Defense Waste Solutions," 1980.

WHC-SD-WM-TI-613, Revision 1, "TWRS Process Flowsheet," 1995.

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Uncertainties in Pretreatment Parameters

The object of pretreatment is to reduce the HLW volume before vitrification. The flow sheet incorporates two major pretreatment steps, a "water wash" (actually dilute $NaOH/NaNO_2$) and a caustic leach (3M NaOH), followed by additional washing. The calculation of the amount and composition of waste that remains after pretreatment is an important part of the calculations of the final canister count.

Flow sheet calculations begin by dividing the total waste inventory into water soluble and water insoluble fractions. The former is called "salt cake" and the latter "sludge". The fraction of each of these that remains after each pretreatment step is then calculated.

"Salt cake" is assumed to be 99% water soluble. This is a reasonable assumption since the partitioning into "salt cake" includes only soluble compounds. Real salt cake taken from the tanks is a worst case approximation of the "salt cake" used in the calculations because it may include a number of insoluble compounds that have coprecipitated or become entrained through mixing. Such materials are correctly accounted for in the calculations by apportioning them to the water insoluble sludge fraction. Where they actually reside in the tank is immaterial. The solubility of real salt cake was examined by Schulz. Schulz examined 200-500 g amounts of salt cake taken from eight different SST's. The tanks sampled (116-TX, 105-B, 105-S, 108-S, 109-S, 110-S, 102-SX and 103-SX) represent the two predominant types of salt cake produced by evaporation of Hanford wastes. Schulz' data allows calculation of the insoluble portion of the salt cake on a vol/vol basis. The average value is 0.5% with a maximum value for any tank of 1.2%.

The flow sheet (Revision 0) used in the EIS used limited data and best engineering judgement to apportion the waste into water soluble and insoluble fractions and to calculate the effects of caustic leaching. Calculations have been substantially refined since then. The LANL model (Agnew et. al.) has been used as the basis for apportioning the waste into water soluble and insoluble fractions and to break down the total inventory into individual waste types. Colton has analyzed water leach results for 127 SST sludges obtained during waste characterization studies. Although these results were obtained from a single water wash at a relatively high water to waste ratio (100:1), they provide a reasonable estimate of the results that would be obtained from several washes at a lower ratio. The results were used to calculate a mass weighted average soluble fraction for each component of the sludge.

Calculations of caustic leach factors are based on much more limited data. Rapko et. al., examined sludges from seven tanks. Temer and Villarreal examined sludges from six tanks. Two tanks were examined by both studies, so the combined data covers eleven tanks. The largest uncertainty in the results of these studies is the representativeness of the samples studied. Most of the samples were composites, but often of two or three segments out of a total core of eight or more. The representativeness of the cores themselves has also been questioned by critics of the Characterization Program. However, the data are the best available and reasonably consistent for the two tanks analyzed by both studies. One major weakness in the studies is that they include samples from only one tank containing redox waste. Redox waste will be a major source of aluminum and chrome which in turn may be major drivers of glass volume.

The calculation of caustic leach factors in the EIS does not depend on experimental studies. It assumes that only aluminum, chromium, and phosphorus leach with caustic. Leach factors for these three elements were determined by a number of assumptions about the compounds formed and the solubility of these compounds in caustic. Colton compared these assumptions with the PNNL experimental work. The calculated and experimental results compare quite well for aluminum and phosphorus with the calculated results being more conservative. The chromium results also compare well, but the calculated results are less conservative.

There is no doubt that present calculations of wash and leach factors are on much more solid ground than they were when the present EIS was written. The data used are the best available at this time and the calculations have been carried out in a straightforward and reasonable manner. Although not without uncertainty, the present wash and leach factors are technically defensible. Uncertainty in the factors has been incorporated into the probabilistic assessment of the canister count.

ATTACHMENT 6

Composition Range for DWPF Waste Glass

	Range (wt. %)	
Component	Minimum	Maximum
SiO_2	44.6	54.4
Al_2O_3	2.9	7.1
B_2O_3	6.9	10.2
CaO	0.8	1.2
MgO	1.3	1.5
Na_2O	8.2	12.1
K_2O	2.1	4.6
Li_2O	3.1	4.6
Fe_2O_3	7.4	12.7
MnO	1.6	3.1
TiO_2	0.6	1.0
U_3O_8	0.5	3.2
ThO_2	0.01	0.8
Group A[a]	0.08	0.2
Group B[b]	0.08	0.9

[a]Isotopes of Tc, Se, Te, Rb and Mo
[b]Isotopes of Ag, Cd, Cr, Pd, Ti, La, Ce, Pr, Pm, Nd, Sm, Tb, Sn, Sb, Co, Zr, Nb, Eu, Np, Am, and Cm.

ATTACHMENT 7

Composition Range for WVDP Glass

	Range (wt. %)	
Component	Minimum	Maximum
SiO_2	38.8	43.2
B_2O_3	11.0	14.8
$K_2O + Li_2O + Na_2O$	14.7	18.8
Fe_2O_3	10.2	13.8
Al_2O_3	5.4	6.6
$BaO + CaO + MgO$	1.2	1.6
MnO	0.7	0.9
P_2O_5	0.0	4.0
ThO_2	3.0	4.1
UO_3	0.5	0.7
ZrO_2	1.1	1.5
Other[a]	1.0	8.0

[a]Includes CeO_2, Cr_2O_3, Cs_2O, CuO, La_2O_3, MoO_3, Nd_2O_3, NiO, PdO, Pr_6O_{11}, Rh_2O_3, RuO_2, SnO_2, TeO_2, Y_2O_3, and ZnO.

Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

APR 23 1996

96-WDD-029

Dr. A. L. Trego, President
Westinghouse Hanford Company
Richland, Washington

Dear Dr. Trego:

OFFICE OF TANK WASTE REMEDIATION SYSTEM (TWRS) HIGH-LEVEL WASTE (HLW) CANISTER PROJECTION ASSESSMENT AND PROJECT BASELINE GUIDANCE

An independent review team (IRT) convened in Richland, Washington on March 4-6, 1996, to review the Ex-Situ Intermediate Separations Tank Waste Alternative in the Draft Environmental Impact Statement (EIS) for the TWRS (DOE/EIS-0189). The review was to ensure that the analysis supporting the Intermediate Separations alternative was technically defensible and that the analysis methodology was understandable to the general public. The team's charter and report of its findings and recommendations are enclosed.

Report Conclusions

The team reported its findings as follows:

1. "The current range, and median value, of the number of canisters which will be produced from Hanford HLW contained in the EIS (13,800 to 70,000, and 33,400, respectively) are conservative."

2. "A range of 13,800 to 50,000 canisters, and a median value of 23,000 canisters, better reflects the current state of understanding of Hanford waste than the EIS estimates. The value of 23,000 canisters provides a more representative case for detailed planning of environmental impacts."

3. "In spite of the apparent high waste loading factors, the projected glass compositions are in the same range as nominal Defense Waste Processing Facility and West Valley glasses. As noted earlier, the high waste loading is deceptive due to the large amount of Na and Si contained in Hanford HLW."

Project Baseline Guidance

Westinghouse Hanford Company (WHC) is directed to adopt the median 23,000 canister estimate as the technical baseline for future work. WHC will use this canister estimate as its program planning baseline for purposes of estimating the size of processing facilities and the duration of facility operations and associated capital and expense cost estimates. Future work shall extend from this baseline and be traceable to it.

WHC should use the information and conclusions provided by the IRT to support closure of appropriate Systems Requirements Review Action Plan findings and recommendations.

Multi-Year Program Plan Guidance

The IRT was encouraged by the progress made in defining the tank waste inventory, and in representing uncertainty using the decision model described in WHC-EP-0874, "Decision Analysis Model for Assessment of TWRS Waste Treatment Strategy" (1995). As noted in the technical recommendations of the team's report, however, the studies presented during the review need to be completed for the disposal mission technical basis, as well as to fully utilize the emerging strengths of the decision model. WHC will work to complete the activities identified in the IRT technical recommendations with the limited funds available in Fiscal Year 1997. WHC should work closely with the Tank Focus Area to support this effort as well as complete the required workscope to meet Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Milestone M-50-03, "Complete Evaluation of Enhanced Sludge Washing."

WHC shall continue to plan to retrieve the double shell tank and single shell tank waste and separate the waste into High-Level and Low-Activity fractions. Enhanced sludge washing (caustic leaching and water washing) shall continue to be the reference process for project planning purposes until the decision is made through the TWRS EIS and M-50-03 decision analysis.

The M-50-03 sludge process decision will provide information allowing the Richland Operations Office to establish minimum performance requirements to be used in writing the TWRS Privatization Phase II Request for Proposal.

In-tank enhanced sludge washing is the reference process to support delivery of feed to the private contractors in Phase I of TWRS Privatization. The need to perform the caustic leaching process step for HLW feed in Phase I will be established after the contractor's process, Management and Integration Contractor capabilities, and life cycle costs are better understood.

We appreciate the steadfast support provided by your staff during the review of the HLW canister projection, particularly:

A. L. Boldt
P. J. Certa
M. E. Johnson
M. J. Kupfer
R. M. Orme.
D. J. Washenfelder
N. G. Colton (PNNL)

If you have questions regarding this letter, please contact me on 376-7591, or William J. Taylor on 372-3864.

Sincerely,

for Jackson Kinzer, Assistant Manager
Office of Tank Waste Remediation System

WDD:RG

Enclosure

cc: K. Gasper, WHC
J. Honeyman, WHC
R. Powell, WHC
D. Washenfelder, WHC
G. Mellinger, PNNL

APR 23 1996

If you have questions regarding this letter, please contact me on 376-7591, or William J. Taylor on 372-3864.

Sincerely,

ORIGINAL SIGNED BY
C P Baker for

Jackson Kinzer, Assistant Manager
Office of Tank Waste Remediation System

WDD:RG

Enclosure

cc: K. Gasper, WHC
J. Honeyman, WHC
R. Powell, WHC
D. Washenfelder, WHC
G. Mellinger, PNNL

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R. Gilbert, WDD
N. Brown, WDD
C. Haass, MSD
R. Carreon, WDD
D. Button, WDD
WDD RDG FILE
WDD OFF FILE
CC RDg FILE

RECEIVED

OFFICE >	WDD	WDD	AMF	TWR	APR 25 1996
SURNAME>	GILBERT	TAYLOR	WIRKKALA	KINZER	~~DOE RL/CCC~~
DATE >	Previously	Concurred	~~4/19/96~~	~~4/25/96~~	

(Please Return To Peggy Nazarali, 3-0068 SIGMA IV) DOCUMENT No. 67352