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Neutralized Current Acid Waste Consolidation Management Plan

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Westinghouse Hanford Company, Richland, WA 99352
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Abstract: The scope of this evaluation is to recommend a management plan for the high-heat tank waste, including neutralized current acid waste (NCAW) in AY and AZ Tank Farms, and tank C-106 waste. The movement of solids, liquids, and salt cake in the designated tank farms is included. Decision analysis techniques were used to determine a recommended alternative.

The recommended course of action was replacement of a 75-hp mixer pump in tank AY-102 and in-tank concentration of tank AZ-102 supernate. The alternative includes transfer of tank C-106 sludge to tank AY-102, then transfer of tank AY-102 and tank C-106 sludge to tank AZ-101 using the new 75-hp mixer pump installed in tank AY-102. Tank AZ-101 becomes a storage tank for high-level waste (HLW) sludge, with the capacity to mix and transfer sludge as desired.

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NEUTRALIZED CURRENT ACID WASTE CONSOLIDATION MANAGEMENT PLAN

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CONVERSION TABLE

From	To	Multiply by
Kgal	kL	3.78
gal	L	3.78
lb	g	454
inches	cm	2.54

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NEUTRALIZED CURRENT ACID WASTE CONSOLIDATION MANAGEMENT PLAN

1.0 SUMMARY

As a result of the indefinite postponement of the Multi-Waste Tank Farm (MWTF), specific waste management actions were identified. Included in these actions was a need to consolidate the wastes in the aging waste Tank Farms (AY and AZ) to maximize storage capacity. In addition, safety considerations have necessitated the retrieval of the wastes in tank C-106 to one of the aging waste tanks (AY-102). Disposal planning includes a mixer pump process test and sludge washing process test in AZ-101, and high-level waste (HLW) privatization desires washed-sludge feeds for its Phase I demonstration.

The scope of this evaluation is to recommend a management plan for the high-heat tank sludges, including neutralized current acid waste (NCAW) in AY and AZ Tank Farms, and tank C-106 waste. The movement of solids and liquids in the designated tank farms are included. To perform this evaluation, systems engineering decision analysis techniques were used. The management plan and analysis format followed the modified WHC-IP-1101, *TWRS Systems Engineering Desk Instruction*, TWRS-SE-04, "Trade Study/Decision Analysis" (Eiholzer 1994). The purpose and scope of the investigation have been set and reviewed by cognizant engineers and management.

The results of this study will be used as input to a systems engineering decision process which will establish final Westinghouse Hanford Company (WHC) recommendations for future transmittal to Department of Energy (DOE). Final decisions for WHC will be made by a management decision analysis board.

The initial Planning Case for the NCAW and C-106 consolidation is given in a memo from R. F. Bacon to C. A. Augustine (Bacon 1995), which provides instruction to plan to consolidate high-heat sludge from tanks C-106 and AZ-101 into tank AZ-102. It further directs that Tank Waste Remediation System (TWRS) Engineering and the ongoing systems engineering study (documented in this report) have the responsibility to determine the best alternative and schedule to consolidate high-heat waste from AZ, AY, and C-106 tanks.

Requirements and decision criteria for this study were developed in a top-down perspective from DOE/RL-92-60, *Tank Waste Remediation Systems Functions and Requirements* (DOE-RL 1993). Weighing of the decision criteria was performed by the six-member team. Two team members did not agree with the consensus team weighting, and their weightings were analyzed as outliers in the sensitivity analysis. Alternatives were brainstormed, revised, and evaluated to the decision criteria, then again modified to obtain the optimum alternative.

Sensitivity studies were developed to determine what would happen if the weighing of individual criteria was changed. The top six alternatives were found to be reasonably insensitive to individual weighting changes of 50% or more. Other sensitivity studies were performed on the weighting data using

the two outliers from the team weighting. The outliers did not significantly affect the top alternatives.

Technical safety risks were handled in context with identification of the unresolved safety questions (USQ) required for evaluation of different alternatives. All alternatives except the "Do Nothing" case included fairly high risk due to required USQ evaluations. Key USQ evaluations included: criticality limits, 5*M* sodium rule, tank heat-up and tank bump reevaluations. These USQs should be manageable with prompt recognition of their importance and analysis/action.

The leading alternatives were evaluated for risks. Two of the alternatives (0b, Minimal Effort, and 2, Evaporator Concentrate) contained significant risks related to insufficient HLW feed. In these two alternatives, only the 35 Kgal* of sludge currently in AZ-101 would be available for HLW feed.

The recommended course of action was Alternative 7b, Installation of a 75-hp Mixer Pump in AY-102, including in-tank concentration of AZ-102 supernate. This alternative includes transfer of C-106 sludge to AY-102, then transfer of AY-102 and C-106 sludge to AZ-101 using a new 75-hp mixer pump installed in AY-102. Tank AZ-101 becomes a storage tank for HLW sludge, with the capacity to mix and transfer sludge as desired.

In Alternative 7b, the HLW feed will undergo one water washing as it is recovered. If a second water washing is necessary, it could be performed as the feed is being transferred to HLW disposal facilities by replacement of the contaminated supernate solution on top of the sludge with dilute supernate.

In these alternatives, it is possible that if tank space becomes constricted enough a 7*M* sodium solution will have to be placed on top of the HLW feed. This action will again contaminate the solids with sodium, but the solids can be washed prior to transfer to HLW vitrification, or tank AZ-101 can be designated the non-complexed receiver tank for cross-site transfers. This would provide dilute non-complexed waste for several washings, and conserve required tank space.

The schedule for Alternative 7b shows that the initial supernate and sludge consolidation is complete in fiscal year (FY) 2002, including consolidation of 192 Kgal of sludge in AZ-101 by FY 1998. This timing should be adequate to meet projected HLW disposal needs (FY 2001 startup). Final sludge consolidation (final cleanout of C-106) is not complete until FY 2003. Final sludge consolidation in FY 2003 has the capability to add about 36 Kgal of sludge to AZ-101, bringing the total HLW sludge in AZ-101 to 228 Kgal.

The evaluation team determined that the next best alternative (fallback) is modified Alternative N3, Bottom Sludge Transfer to AY-102 with in-tank concentration of AZ-102 supernate. In this alternative, as much C-106 sludge as possible is transferred from AY-102 to AZ-101 by using the bottom transfer system as the C-106 sludge settles. Alternative N3 is a natural fallback if the 75-hp mixer in AY-102 should become inoperable for any reason. This

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*See the Conversion Table in front matter of document.

alternative is modified to perform in-tank evaporation instead of evaporation at the 242-A evaporator. For both Alternative 7b and modified Alternative N3, the option of concentration at the 242-A evaporator becomes a fall-back position if in-tank evaporation becomes impossible or untimely.

Except where noted, Table 1-1 outlines the raw decision criteria data developed for Alternative 5a, Planning Case (Bacon 1995); the recommended Alternative 7b, 75-hp Mixer Pump in AY-102; and back-up Alternative N3, Bottom Sludge Transfer of settling solids in AY-102 (modified for in-tank concentration of NCAW high-heat supernate). Where noted, individual decision criteria values also are given for the "no leaching" improved Planning Case, Alternative N5a. Comparison of these cases should allow the reader to determine where the differences in the scenarios exist. The main equipment differences between the Planning Case (Alternative 5a) and the 75-hp Mixer Pump in AY-12 (Alternative 7b) is that in Alternative 7b, mixing systems do not need to be installed in AZ-102; instead, Alternative 7b replaces an existing, inoperable 75-hp mixer in AY-102 with a new one. This new mixer provides more C-106 waste to AZ-101 than does the Planning Case (Alternative 5a). In the Planning Case, the sludge consolidation tank is AZ-102; in the 75-hp Mixer Case, it is AZ-101, which has mixers already installed.

The recommended course of action and the fall back alternative are different from the Planning Case. The recommended alternative has less risk and has a potential for significant cost deferral and avoidance. Total cost is included in Table 1-1, but is an independent variable in the analysis. Cost was not included in the calculation of the total "value" of the alternative.

Table 1-1. Comparison of Recommended and Backup Alternatives with Planning Case. (sheet 1 of 2)

Description	Alternative		
	Planning Case (Bacon Letter)* (evaporation at 242-A)	75-hp Mixer in AY-102 (in-tank evaporation)	Bottom Decant of AY-102 (modified-with in-tank evaporation)
Alternative number	5a (modified to reduce leaching)	7b (recommended alternative)	N3 (modified)--alternate to recommended alternative
Description of solids transfers	C-106 >>AY-102, settling solids transfer to >>AZ-101 >>AZ-102	C-106 >>AY-102 (75-hp mixer) >>AZ-101	C-106 >>AY-102 (without mixer) >>AZ-101
Overall "value" from decision analysis	0.47 (5a) 0.58 (N5a)	0.73	0.67 (estimated)
Total cost (million $)	62 (5a) 52 (N5a)	29	28
Decision criteria and scale units			
Number of washes and leaches	2	0	0
Number of sludge mixing	4	1	2
Number of slurry transfers	4	2	2
Number of decant and supernate transfers	15	27	16
Number of tank drain line modifications	0	1	0
Number of process pit modifications	14	11	10
Number of DST sludges to mobilize	4	2	1
Number of bottom transfers with settling operations	1	0	1
Number of DST sludges washed	1	1.2	1.2
Number of DSTs retrieved	3	1.5	1

Table 1-1. Comparison of Recommended and Backup Alternatives with Planning Case. (sheet 2 of 2)

Description	Alternative		
	Planning Case (Bacon Letter)* (evaporation at 242-A)	75-hp Mixer in AY-102 (in-tank evaporation)	Bottom Decant of AY-102 (modified-with in-tank evaporation)
Number of DSTs leached	1	0	0
Flexibility in out-years (number of mixer systems installed)	2	1.3	1
Personnel risk (rem)	24	16	15
Offsite personnel risk (waste transfer pits entered)	22	15	16
Tank bump (100% = best avoidance, based on sludge height and heat)	78%	65%	95%
Number of major USQs required	3	2	2
Number of minor USQs required	9	12	11
Number of runs at 242-A evaporator	1	0	0
Fluffy settled solids height (final ft)	10.6	15.6	9.1
HLW feed available (Kgal)	223	228	133
C-106 start (date)	10/96	10/96	10/96
End date (year)	2002	2002	2002
Tank volume savings (Kgal)	790 (5a) 990 (N5a)	990	990

*Bacon, R. F., 1995, *Double-Shell Tank Waste Consolidation and Retrieval Planning Base Case* (internal memo 73510-95-017 to C. A. Augustine et al., August 29), Westinghouse Hanford Company, Richland, Washington.

DST = Double-shell tank
HLW = High-level waste
USQ = Unresolved safety question

The following near-term actions are recommended for timely completion of the preferred alternative:

1. A 75-hp mixer pump must be obtained for installation in AY-102 to replace the existing, inoperable 75-hp mixer pump. The purchase of a spare 75-hp mixer pump should be considered to provide a backup to the proposed 75-hp mixer pump. Any other burial equipment required to remove and dispose of the old pump should be designed and obtained.

2. Initiate unresolved safety question (USQ) evaluations for tank bump avoidance scenarios in AZ-101. At least two alternatives are available: one uses the mixer pumps in AZ-101 as mitigation devices, and the other alternative uses increased annulus flow in AZ-101 as a tank bump mitigation device. Initially, about 75% of the heat load and sludge volume from C-106 could be used as a design basis.

3. Modify the design of Project W-320 slurry distributor for AY-102. The slurry distributor needs to be able to preferentially place solids in the immediate vicinity of the AY-102 transfer pump. The (now inappropriate) Project W-320 slurry distributor is ready for installation.

4. Sample AZ-101 and AZ-102 supernate and perform a boildown in the laboratory to ensure that precipitation will not occur prior to achievement of a 6.5*M* to 7*M* sodium concentration. Also, evaluate the potential need for a USQ for modifying the 5*M* sodium operating specification documentation (OSD) for aging waste supernate. Start in-tank evaporation of AZ-102 aging waste supernate as soon as possible after confirming that precipitation will be limited.

5. Revise criticality prevention specifications to allow consolidation of waste to AZ-101 and AY-102.

6. Revise/modify tank heat-up rates of <1.7 °C/day (<3 °F/day) as given in the *Operating Specifications for Aging Waste Operations in 241-AY and 241-AZ* (Bergmann 1994). Mixer pumps need to be able to be run long enough to mix and transport waste, and to release/move hot spots in the sludge, especially in tank AZ-101.

These activities should be completed by October 1996 to meet the U.S. Department of Energy (DOE) Secretarial Initiative for startup of the tank C-106 waste retrieval system. It may be possible to install the new mixer pump following startup of the C-106 waste recovery, if the initial waste recovery is limited.

The following decisions/actions may be delayed:

- Design of the mixer pump system for AZ-102 as noted in Bacon (1995)

- The USQ evaluation allowing processing of 99% of C-106 sludge into AZ-101

- Demonstration of the in-tank leaching process for C-106 waste is not recommended at this time due to impacts to tank space, additional transfers (operational risk) and increased evaporator cost. This evaluation may need to be reanalyzed if tank space becomes available, and appropriate need is shown for HLW vitrification product volume reduction.

2.0 INTRODUCTION

2.1 PURPOSE

The purpose of this management plan is to perform a technical evaluation to determine how best to manage tank C-106 and high-heat waste (waste in AY and AZ Tank Farms) using systems engineering decision logic. This study recommends the best technical alternative and at least one back-up alternative. The decision to implement this recommendation, or some other alternative, will be made by programmatic decision-makers.

The objectives of the study are to determine how to consolidate existing and new waste (from tank C-106) in the minimum amount of double-shell tank (DST) space possible, and to position waste for ultimate retrieval activities while avoiding construction of expensive, new facilities. Associated objectives of the study are to provide costs and schedules for the recommended actions.

Basis/Assumptions

The following are the major basis and assumptions used for the evaluation.

- NCAW consolidation will allow the *Hanford Federal Facility Agreement and Consent Order*, also known as the Tri-Party Agreement (Ecology et al. 1994) milestones to be met.
- Project performance will be as described in the Design Requirements Document.
- Safety and operating limits can be modified with appropriate documentation and analysis.
- The basis of this analysis will be strictly technical.
- The cutoff point for new information that could influence the study was August 1, 1995, for Revision 0. Significant program or technical perturbations after that time will be developed in subsequent studies, if necessary.

2.2 SCOPE AND APPLICABILITY

The scope of this analysis is the management of the high-heat tank wastes, including NCAW in AY and AZ Tank Farms, and C-106 waste. The movement of solids, liquids, and salt cake in the designated tank farms is included.

Determination of the most appropriate waste management processing scenario is part of the scope, as is development of the cost and schedule of the selected alternative. This study includes investigations that are in-depth enough to determine significant issues, but does not attempt to analyze those issues in enough detail to resolve them. Rather, the study identifies the issues that will have to be addressed in each alternative, and estimates funding and timing requirements for implementation of the recommended alternative.

The management plan and analysis followed modified WHC-IP-1101, *TWRS Systems Engineering Desk Instruction*, TWRS-SE-04, "Trade Study/Decision Analysis (Eiholzer 1994). In addition:

- Qualitative risk analyses for selected alternatives were evaluated in this study.

- After the August 1, 1995, cutoff date for new material, interim procedures WHC-IP-__ TSEP-07, *Decision Management (Interim)* (WHC 1995a) and WHC-IP-__ TSEP-03, *Alternative Generation and Selection (Interim)* (WHC 1995b) were issued. These procedures were briefly reviewed and compared to the desk instructions. The decision was made to follow the desk instructions.

The results of this management plan will provide information to ongoing projects concerning selection of the tanks in which to install mixing and transfer equipment, and how to expect to use the equipment from a process management standpoint. This analysis also will provide a basis for scheduling and funding that should allow implementation of the recommendations.

2.3 BACKGROUND

On January 13, 1995, Westinghouse Hanford Company recommended to the U.S. Department of Energy, Richland Operations Office that Project W-236A, Multi-Function Waste Tank Facility, be phased out (Alumkal 1995). The *Multi-Function Waste Tank Facility Phase Out Basis*, WHC-SD-W236A-ER-021 (Awadalla 1995) notes that the most recent information shows that wastes in the TWRS current baseline can be managed within the existing waste tank capacity through FY 2003. Additional DST storage capacity is not needed until FY 2004 or later.

Nine major assumptions that need to become reality to avoid building new tanks are identified (Awadalla 1995). The first assumption is that NCAW needs to be consolidated with C-106 to provide about 980 Kgal of tank space. This report was initiated by the need to determine how NCAW and C-106 wastes could best be consolidated to meet the needs of the Hanford Site. Awadalla (1995) further notes that "managing the present and projected wastes within the existing DST system requires accepting increased risk, and implementing several new waste management actions." An example of this is the decision to continue to use the existing mixing pump to mitigate the flammable gas safety issue in tank SY-101.

The initial Planning Case for the NCAW and C-106 consolidation is given in a memo from R. F. Bacon to C. A. Augustine (Bacon 1995), which provides instruction for planning to consolidate high-heat sludge from tanks C-106 and AZ-101 into tank AZ-102. It further directs that TWRS Engineering and the ongoing systems engineering study (documented in this report) have the responsibility to determine the best alternative and schedule to consolidate high-heat waste from AZ, AY, and C-106 tanks.

2.3.1 Hanford Site

In 1943, the U.S. Army Corps of Engineers selected an area of about 600 mi^2 in semiarid southeastern Washington State for producing plutonium and other nuclear materials supporting weapons' production for World War II. This area, called the Hanford Site, is divided into three major operation areas supporting plutonium production: the 100 Areas for reactor operations; the 200 Areas for fuel reprocessing, plutonium recovery, and waste management; and the 300 Area for fuel fabrication.

Liquid waste from the separations processes in the 200 Areas was neutralized and piped to large tanks, several of which comprise a tank farm.

The initial radionuclide separations process was the bismuth phosphate process used in B and T Plants. It generated large amounts of dilute waste in comparison to the later reduction and oxidation (REDOX) and plutonium uranium reduction and extraction (PUREX) separations processes. Waste tanks were equipped to contain boiling waste and used air-lift circulators (ALC) to keep the tank contents mixed. The 241-AZ and -AY tanks comprise two DST farms that have two aging waste tanks (AWT) in each farm; each tank was designed to contain boiling waste. Each tank in AY and AZ Tank Farms has 22 ALCs which are used to control temperatures in the tanks. These ALCs were shut off in tank AZ-101 in 1993 to determine if a settle/decant process could safely be used (Winkler 1995). This test was a success and all the ALCs in AWTs have been turned off since 1993.

There are 149 single-shell tanks (SST) and 28 DSTs in the 200 Area of the Hanford Site. Tank C-106 is one of these SSTs located in the 200 East Area near the AY and AZ Tank Farms. Project W-320 is planning to sluice the solids from C-106 to AY-102 starting about October 1996. Sluicing will demonstrate initial cleanout of an SST.

2.3.2 Tri-Party Agreement

In 1993 and early 1994, the Tri-Party Agreement was renegotiated (Ecology et al. 1994). The Tri-Party Agreement revision shifts the emphasis from early HLW vitrification to early low-level waste (LLW) vitrification. Certain chemical separations must also be deployed earlier to support LLW vitrification. Separations for the new basis are focused on cesium removal from LLW. An enhanced sludge-washing process emerged as the reference strategy.

Major milestones driving the LLW program became: M-60-04, Initiate hot operations of the LLW vitrification facility (June 2005); and M-60-00, Complete vitrification of Hanford low-level tank waste (December 2028).

Other programs affected include HLW, which deleted the M-03 series of milestones for the Hanford Waste Vitrification Plant and established a new series (M-51) for HLW vitrification. A significant milestone in this effort is M-51-03, Initiate hot operations of the HLW vitrification facility (December 2009).

New Tri-Party Agreement milestones for the SSTs include M-45-03A, Initiate sluicing retrieval of C-106 (October 1997), and M-45-03-T02, Initiate final retrieval demonstration of C-106 (June 2002).

In 1994, the startup of C-106 retrieval became a DOE Secretarial Initiative with a startup date of October 1996. This accelerated startup is not part of the Tri-Party Agreement.

2.3.3 Aging Waste Composition

The following values in Table 2-1 were used in the analysis to calculate consolidated sludge volume and heat content.

2.3.4 Criticality

The criticality concerns of the proposed waste transfers among tanks AY-101, AY-102, AZ-101, and AZ-102, and the waste transfer from C-106 and AY-102, were reviewed. Discussion and analysis are given in Appendix C. Because this consolidation involves a major revision or exception to the criticality specifications, it could be a major issue in the consolidation of waste in C-106 and AWTs.

It was concluded by this review that no actual criticality concerns exist for tank-to-tank transfers of waste because the minimum concentration of plutonium required to cause a criticality is 2.6 g/L in a very large volume (Sederburg 1994). The minimum plutonium concentration that can cause a criticality in a liquid system is about 7 g/L. No known mechanism capable of approaching possible criticality through concentration of plutonium in a receiver tank exists.

The specification documents must be revised or an exception made to reflect the acceptance of the planned transfers into and within the AWTs.

Table 2-1. Background Information--High Heat Tanks.

Tank	Existing sludge volume (Hanlon 1995)[a] (kgal)	Heat generation (KBtu/h)		Specific gravity		Total organic carbon	
		Liquid	Sludge	Liquid	Sludge	Liquid (gC/L)	Sludge (gC/Kg)
AZ-101	35	90-110[b]	143-180[b]	1.2	1.7	0.87 gC/kg	9.2
AZ-102	95	54-80[b]	120-150	1.1	1.4	1.4 gC/kg	2.65
AY-102	32	Small	40[f]	1.0	1.4	0.08	16.5
AY-101	83	Small	80	1.1	N/A	3.4[c]	25[d]
C-106	197	Small	110-130[e]	1.2	1.4	20-2.5	7.5-4.6

[a]Hanlon, B. M., 1995, Waste Tank Summary Report for Month Ending March 31, 1995, WHC-EP-0182-84, Westinghouse Hanford Company, Richland, Washington.

[b]Larger values calculated from RADNUC total about 20% greater than those found in the TCR (Hodgson, K. M., 1995, Tank Characterization Report for Double-Shell Tank 241-AZ-101, WHC-SD-WM-ER-410, Rev. 0, Westinghouse Hanford Company, Richland, Washington; and Ryan, G. W., 1995b, Tank Characterization Report for Double-Shell Tank 241-AZ-102, WHC-SD-WM-ER-411, Rev. 0, Westinghouse Hanford Company, Richland, Washington).

[c]TOC value has been steadily decreasing from a high of 6.78 in 2/85 (Castaing, B. A., 1994, 101-AY, 102-AY, & 106-C Data Compendium, WHC-SD-WM-TI-578, Rev. 1, Westinghouse Hanford Company, Richland, Washington) to a low of 3.38 in 1994 (Vogel, R. E., 1994, Results for Tank 241-AY-101 (internal memo 8E480-94-108 to J. M. Jones, October 19), Westinghouse Hanford Company, Richland, Washington.)

[d]The 246 g/Kg value given as an upper limit in the TCR (Castaing 1994 [see footnote c for reference citation]) was normalized to 100% with few anions included and is not appropriate for this application.

[e]Project W-320 information and others--best estimate.

[f]Best estimate from process knowledge. Casting (1994) gives 88 KBtu/h for a "grab" sample of the sludge.

The above values are from the respective TCR unless noted otherwise (Ryan, G. W., 1995a, Tank Characterization Report for Double-Shell Tank 241-AY-102, WHC-SD-WM-ER-454, Rev. 0, Westinghouse Hanford Company, Richland, Washington; and Ryan, G. W., 1995b, Tank Characterization Report for Double-Shell Tank 241-AZ-102, WHC-SD-WM-ER-411, Rev. 0, Westinghouse Hanford Company, Richland, Washington; Hodgson 1995 [see footnote b for reference citation]; Castaing 1994 [see footnote c for reference citation]).

N/A = Not applicable
TCR = Tank Characterization Report
TOC = Total organic carbon

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3.0 TRADE STUDY/MANAGEMENT PLAN

3.1 SCREENING/ANALYSIS APPROACH

This section presents a comprehensive analysis of the performance of NCAW HLW technical alternatives on values and objectives. The methodology used for the analysis, the values that were identified, how performance was measured, the performance of alternatives, the results of the analysis, and a discussion of the results are described.

Decision analysis was used to guide the collection and analysis of data and the logic of the evaluation. Decision analysis is a structured process for the analysis and evaluation of alternatives. It is theoretically grounded in a set of axioms that capture the basic principles of decision making (Von Neumann and Morgenstern 1947). Decision analysis objectively specifies what factors are to be considered, how they are to be measured and evaluated, and their relative importance. The result is an analysis in which the underlying rationale or logic upon which the decision is based is made explicit. This makes possible open discussion of the decision basis in which facts and values are clearly distinguished, resulting in a well-documented decision that can be clearly explained and justified.

The strategy of decision analysis is to separately analyze the various components relevant to the decision and then to integrate the individual judgments to arrive at an overall decision. This ensures that all the relevant factors are identified and their relative importance is considered. The procedure for obtaining the individual judgments, and the decision rules for combining them and evaluating alternatives, has both theoretical and empirical foundation in mathematics, economics, and psychology.

Decision analysis makes use of numbers rather than qualitative expressions to construct scales, represent preferences, and express uncertainties. The relationship between qualitative preference structures and quantitative scales is given a precise and rigorous description in the discipline of measurement theory (Krantz et al. 1971), which is part of the theoretical foundation of decision analysis. An understanding of the logic of these relationships is especially important when there are multiple, possibly conflicting, objectives to be considered in the analysis. The standard reference for multi-attribute decision analysis is *Decisions with Multiple Objectives: Preferences and Value Tradeoffs* (Keeney and Raiffa 1976). Decision analysis also has formal procedures for considering uncertainty in the analysis. This makes it possible to evaluate the risks associated with each of the alternatives.

The steps in the decision analysis process are as follows.

- DEFINE SCOPE, PURPOSE AND BASIS
- OBTAIN CONSTRAINTS AND REQUIREMENTS
- BRAINSTORM ALTERNATIVES
- PERFORM INITIAL SCREENING OF ALTERNATIVES AGAINST CONSTRAINTS

- DETERMINE HOW WELL EACH ALTERNATIVE SATISFIES EACH SELECTION CRITERION
- PROVIDE UNBIASED WEIGHTING OF THE SELECTION CRITERIA
- SELECT THE BEST ALTERNATIVE
- PERFORM SENSITIVITY AND CONTINGENCY ANALYSES
- EVALUATION OF ISSUES AND RISKS FOR PREFERRED ALTERNATIVE.

This is an iterative process in which some of the steps are interactive. The general framework holds whether a few simple calculations or an extremely complex and detailed analysis are performed. The extent of the analysis is guided by the stakes involved and the difficulty of the decision. Time is also an important consideration. The objective of any analysis is to specify the decision basis and arrive at a clear course of action. A sound strategy is to error, initially, on the side of simplicity, and to extend the complexity of the analysis as necessary.

3.2 PRELIMINARY CONSTRAINT LISTING

This section describes the various components that formed the basis of the analysis.

3.2.1 Systems Engineering Functions and Requirements (F&R)

The TWRS F&R document, DOE/RL-92-60 (DOE-RL 1993), was used to determine topics of relevance from a top-down system architecture. Because limited detailed requirements were available from this document, only major topics of interest are listed herein. These major topics were considered when proposing the evaluation requirements and criteria.

As defined in DOE/RL-92-60, the mission of the TWRS program is: "to store, treat, and immobilize highly radioactive Hanford waste in an environmentally sound, safe and cost effective manner."

The following major topics that are considerations in this study are listed in DOE/RL-92-60:

- Remediate Tank Waste, Section 4.2, repeats the TWRS mission statement listed above
- Manage Tank Waste, Section 4.2.1, includes safe compliant storage, waste characterization, waste retrieval, waste concentration, and waste transfer
- Process Waste, Section 4.2.2, includes pretreating tank waste to separate the LLW, HLW, and transuranic (TRU) waste. Immobilize the HLW and TRU. Section 4.2.2 also includes interim storage.

- Pretreat Waste, Section 4.2.2.1, indicates that the tank waste will be separated into an HLW/TRU fraction and an LLW fraction suitable for immobilization. Pretreatment includes preparing all retrieved tank waste for separations processes.

- Section 4.2.2.1, C10, includes Tri-Party Agreement Milestone M-50-03, Complete evaluation of enhanced sludge washing to determine whether advanced sludge separation processes are required. A plan for meeting this milestone is provided in WHC-EP-0805, *Enhanced Sludge Washing Evaluation Plan* (Jensen 1994). The focus of the plan is a decision model and laboratory testing with tank waste, and a sludge washing-process test in tank AZ-101. The milestone is met with this development. The plan indicates that further in-tank testing is anticipated by slurrying AZ-101 solids to AZ-102 and then performing a process test for sludge washing in AZ-102. This last solids movement is not part of the Tri-Party Agreement milestones.

- Immobilize HLW/TRU Waste, Section 4.2.2.2, immobilizes pretreated HLW and TRU waste. Section 4.2.2.2.I7 provides required tank characterization information.

- Manage System Generated Waste and Excess Facilities, Section 4.2.3

- TWRS, Section 4.2, includes managing existing tanks, operations buildings, vaults, and new facilities needed to accomplish the TWRS mission.

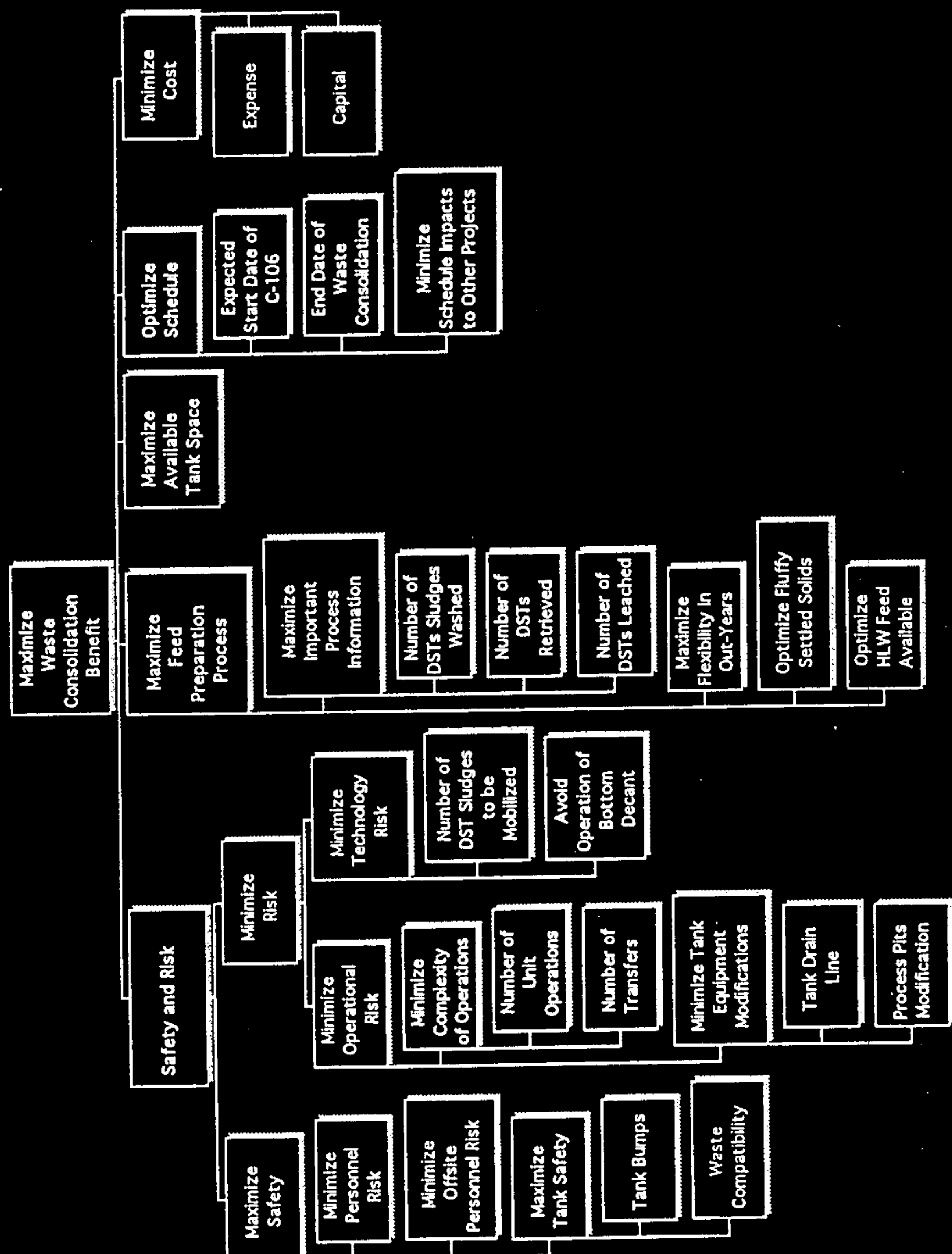
These topics were used as reminders to ensure that global issues were not forgotten and are represented in the detailed criteria.

3.2.2 Decision Criteria

Decision criteria are statements of what performance factors are important in the evaluation of alternatives. Figure 3-1 shows the criteria that formed the basis for this analysis. These values resulted from a series of workshops with technical personnel. Associated with the values are measurable scales that clearly define the degree to which the objectives are achieved. The objectives have been derived from technical considerations specific to this decision, but they can easily be related to a more general set of public values that have been identified in numerous previous studies. The values are intended to be an inclusive set that captures all the technical concerns relevant to deciding between NCAW consolidation alternatives.

The identified values, as shown in Figure 3-1, consist of maximizing safety and minimizing risk, maximizing the feed preparation process (for separations and treatment), maximizing the available tank space, optimizing schedule, and minimizing costs. Each of these values has been further specified to capture all aspects of interest in the value. Thus, minimizing risk has been further specified as operational risk and technical risk.

Figure 3-1. Value Hierarchy for Evaluating Neutralized Current Acid Waste Consolidation Alternatives.



At each level of specification the value immediately above in the hierarchy is partitioned in a way that breaks out all aspects of the value while minimizingany overlap. The specification of values was carried out until a level was reached that consisted of specific criteria for which a scale could be identified for precisely measuring the performance of each alternative. For example, tank safety is further specified as tank bumps and waste compatibility. Waste compatibility was further specified as the number of major and minor non-tank bump safety USQ evaluations required.

3.2.2.1 Criteria/Scales. The criteria scales were identified to determine end points in the value hierarchy and make possible well-defined measurement of the degree to which the objectives were achieved. The scales have been selected with the alternatives in mind to make the collection of performance data reasonable, considering the time and effort available. The scales used in the analysis are shown in hierarchical fashion (see the outline in Subsection 3.2.2.3).

Several types of scales are used in the analysis. The scales may be natural or constructed, and either type may be a proxy scale that provides an indirect measure of the value of concern (Keeney and Raiffa 1976). Natural scales are those that have a common, well-understood interpretation with a unit of measurement that people naturally associate with measurement. For example, "dollars" is a natural scale for the objective to minimize cost. Constructed scales consist of a series of short scenarios or descriptions that represent different levels of performance on the objective. "Tank bumps" is a constructed scale for one aspect of "maximize tank safety", Figure 3-3. This scale considers the depth of the waste in inches and heat in british thermal units per hour (Btu/h). Combinations of these units were identified as scenarios that represent different levels of performance. These were assigned values ranging from 0 to 100. The numbers ranging from 0 to 100 that are associated with the constructed scales are value functions that capture the relative importance of different levels of performance.

3.2.2.2 Value Functions. Value functions were assessed to measure the relative importance of different levels of performance on each of the criteria. Value functions translate the various levels of performance as measured by the scales and map it onto either the unit interval or a 0-to-100 range. Value functions capture the fact that, for a given objective, more may be better or worse, and they reflect the fact that changes in importance of different levels of an objective may not be linear with its scale. They also capture the fact that for some objectives, value is non-monotonically related to scale (e.g., there may be some optimum score above and below whose value is less; the optimum number of feet of fluffy settled solids is ten, for example). Value functions were developed based on discussions among the engineers and the analyst in the workshops. Value functions for eight of the criteria were judged to be non-linear. Six of these value functions are shown in Figure 3-2. For example, consider the value function for the number of DSTs leached. This is valuable to the extent that it provides important process information. Leaching one tank gets a score of 60, and leaching two tanks receives a score of 90. This reflects the judgment that the information provided by the second leaching would only have an additional value of one-half the information gained by leaching one tank instead of none.

Figure 3-2. Non-Linear Value Functions Used in the Neutralized Current Acid Waste Consolidation Analysis.

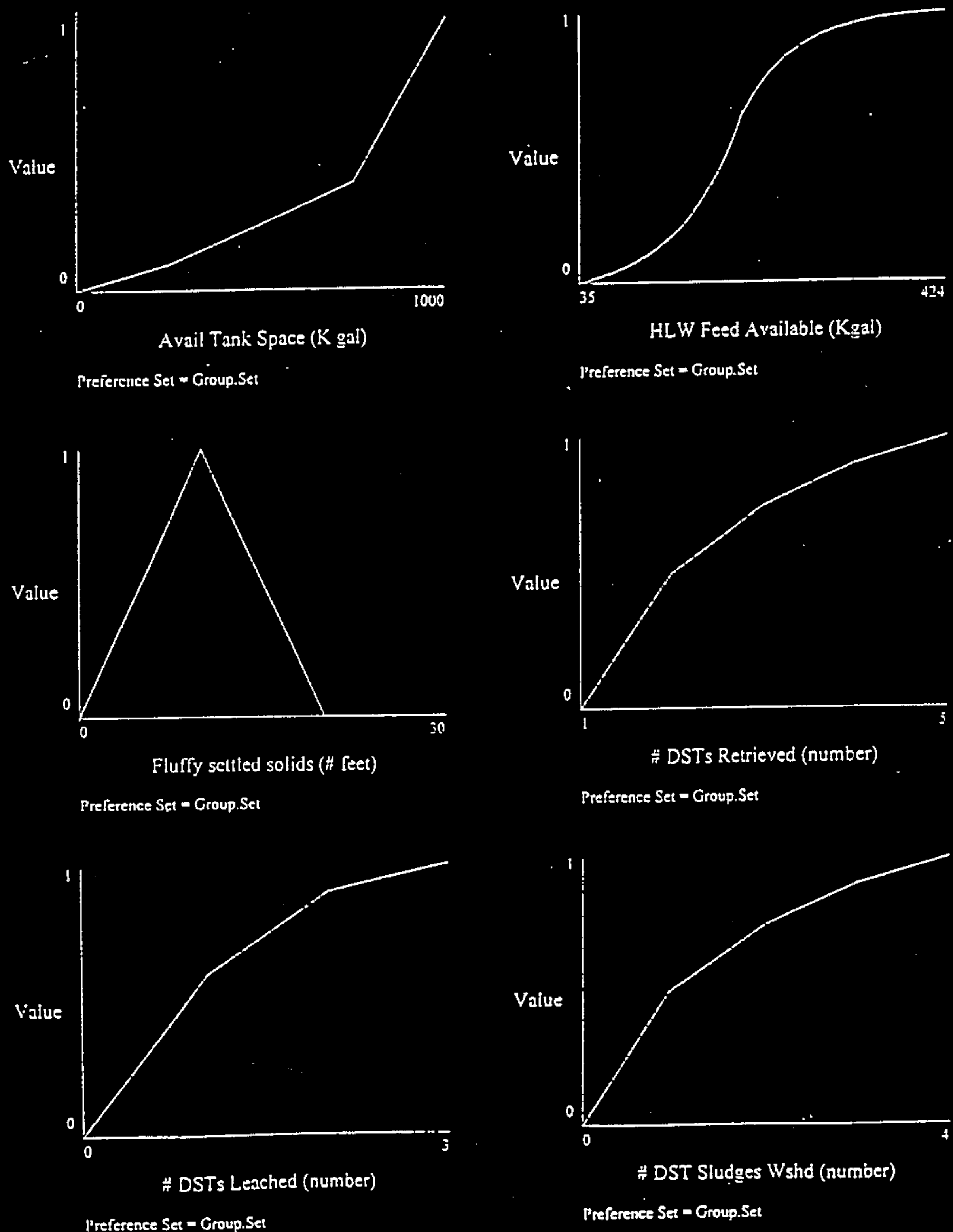
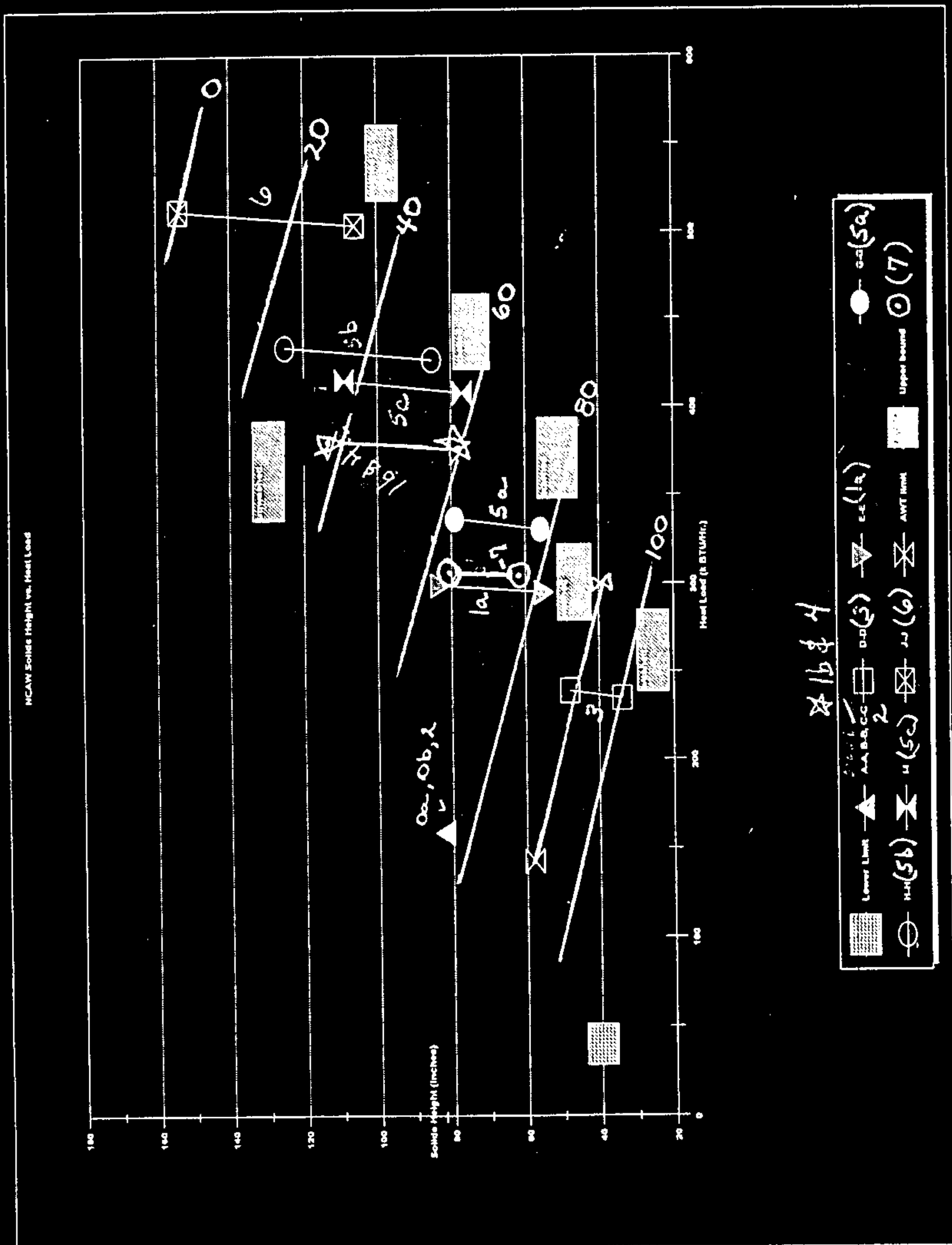


Figure 3-3. Aging Waste Tank Bump Evaluation.



3.2.2.3 Decision Criteria. The preliminary decision criteria were evaluated, modified, and reorganized in a hierarchy system as shown in Figure 3-1. The hierarchy system was organized in outline form, as shown below, with the scales that were used to evaluate the alternatives.

I. Maximize Safety
  A. Minimize personnel risk
    1. Radiation dose to personnel (mrem exposure)
      a. mrems of exposure from tank samples
      b. mrems of exposure from removal of failed pumps or other equipment (pulling equipment)
      c. mrems of exposure from installation of equipment
      d. mrems of exposure from jumper changes
  B. Minimize offsite personnel risk
    1. Number of jumper changes
  C. Maximize tank safety
    1. Tank bumps (see Figure 3-3)
      a. For solids >27 cm (10.7 in.) heat load versus sludge height requirement
    2. Waste compatibility (major and minor USQs)
      a. Total number of major safety USQs (potential sources)
        (1) Evaporator accident, waste <6 Ci/gal
        (2) Criticality, <50 plutonium Kg/tank (OSD)
        (3) Tank heat-up rate, <1.7 °C/day (<3 °F/day)
      b. Total number of minor safety modifications (potential sources)
        (1) Criticality
          • ≤200 g (0.4 lb) plutonium/transfer
          • ≤0.05 g (0.01 lb) plutonium/gal
        (2) 5*M* Na rule (OSD)
        (3) 90-day rule (OSD)
        (4) Hydroxide concentration (OSD)
        (5) Air-lift circulator operation (operating safety requirements [OSR]/OSD)
        (6) Shielding <6 Ci/gal, tank farms/evaporator; and special evaporator areas <3 Ci/gal
        (7) Mixing NCAW with other wastes (data quality objective)

II. Minimize Operational Risk
  A. Minimize complexity of operations
    1. Number of unit operations
      a. Number of runs of concentrated high-heat waste from evaporator
      b. Number of sets of wash and leaches
      c. Number of sludges mixed
    2. Number of Transfers
      a. Number of solids transfers
      b. Number of decant and supernate transfers
  B. Minimize tank equipment modifications
    1. Tank drain line
      a. Number of tanks that exceeds a solids level of 152 cm (60 in.)
    2. Process pits modification
      a. Number of rigid jumpers requiring cover block modification

III. Minimize Technology Risk
   A. Number of DST sludges to be mobilized, (Mono decreasing linear value function)
   B. Avoid operation of bottom decant (number of bottom decants)

IV. Maximize Feed Preparation Process
   A. Maximize important process information
      1. Number of DST sludges washed
         a. 0% = 0
         b. 50% = 1
         c. 75% = 2
         d. 90% = 3
         e. 100% = 4
      2. Number of DSTs retrieved
         a. 0% = 0
         b. 50% = 1
         c. 75% = 2
         d. 90% = 3
         e. 100% = 4
      3. Number of DSTs leached
         a. 0% = 0
         b. 60% = 1
         c. 90% = 2
         d. 100% = 3
   B. Maximize flexibility in out-years processing
      1. Number of tanks with mixer pumps (linear-scale mono increasing)
   C. Optimize fluffy, settled solids
      1. 0 to 6 m (0 to 20 ft) have value for potential washing scenarios
      2. 3 m (10 ft) is optimum (triangular scale 0 ft and 6 m [20 ft] are zero, 3 m [10 ft] is 100), See Figure 3-2
   D. Optimize HLW feed available
      1. Range 35 Kgal to 424 Kgal
         a. Scale is "lazy S" curve with 50% point at about 155 Kgal, Figure 3-2

V. Maximize Available Tank Space
   A. Number of gallons of space potentially made available in FY 2004
      1. 0 gal to 1 million gal (0 L to 3,800,000 L), Figure 3-2

VI. Optimize Schedule
   A. Expected start date of C-106 transfer (linear scale with 2 slopes)
      1. 10/96) = 100%
      2. 4/97 = 10% (inflection point)
      3. 10/97 = 0%
   B. End date of waste consolidation (linear scale with 2 slopes)
      1. 100% = 1998
      2. 85% = 2001 (inflection point)
      3. 0% = 2004
   C. Minimize schedule impacts to other projects
      1. Project W-030 high-heat waste vent system, move/replace AZ-101 large condenser to service another AWT
         a. Months of project delay, 0 to 12, linear scale

VII. Minimize Cost, independent variable, not part of value system, Appendix A
   A. Project cost
   B. Operating cost
   C. Expense cost profile by year

3.3 REQUIREMENTS LISTING

The following requirements or "needs" were listed in order to make a preliminary sorting of the viable alternatives. Requirements are defined as the minimum specifications the alternatives must meet. The alternatives were discarded in the initial screening if they did not meet the requirements. The exception to this was Alternative 0a, "Do Nothing" approach, which was further evaluated in order to develop a baseline for tank waste volume comparisons. The requirements were taken from the F&R document (DOE-RL 1993) general headings and brainstormed in team meetings.

Requirements:

1. Maintain spare AWT space, i.e., 3,800 to 3,800,000 L (1,000 to 1 million gal) in savings more than the nonconsolidation ("Do Nothing") case.

2. No unacceptable safety analysis report (SAR) events

3. No tank bumps

4. Meet Tri-Party Agreement milestones. The major milestone of interest is tank C-106 retrieval by October 1997.

The rationale in determining Requirement 1 was to avoid building new tanks. The waste volume projections call for 3,800,000 L (1 million gal) of tank space to be provided from consolidation, so the requirement was set that the alternative had to provide more tank space than the "Do Nothing" approach (Alternative 0a).

Requirement 3 may be part of Requirement 2. The major unacceptable SAR event that concerned team members was the tank bump event. Consolidation of high-heat waste tends to set up the conditions for a tank bump. The tank bump event may be an acceptable accident in the SAR now but may not remain so with increased sludge volume. Therefore, the tank bump issue was specifically called out. To mitigate the tank bump, it was decided that mixer pumps would always be available in the tank in which the sludge was consolidated (when heat or sludge height was greater than existing limits, proposed Project W-320 or IOSR limits). Mixing the sludge with the redundant mixer pumps would avoid the tank bump as well as ignitable gas issues.

Requirement 4 is to meet the Tri-Party Agreement milestones which are legally binding, and those that are listed but may not be legally binding. It was assumed that a good faith effort to meet all milestones would be made, and that the Hanford Site would come very close to meeting them. If an alternative caused a non-legally binding milestone date to be missed by a relatively small amount of time, then the alternative proceeded to the final selection evaluation.

3.4 ALTERNATIVES

The preliminary alternatives are listed below and described in terms of solid waste transfers. The shorthand version of the transfers is listed after the alternative number. Normally, when solids are transferred it is assumed that mixer pumps are installed in the initiating tank. The exception is the "bottom solids transfer" using C-106 solids settling into AY-102 and transferring the settling solids to the next tank. This is usually done using only the existing transfer pump in AY-102.

Unless noted otherwise, the preliminary transfer scenarios refer to solids, not to supernate. The supernate transfers were not thought to be critical in this first evaluation. The following preliminary process scenarios were brainstormed; the first two are expanded from the shorthand version to assist the reader:

A. Do Nothing - Transfer C-106 Slurry to (>>>) AY-102

   The supernate in AZ-102 would be concentrated from 2.3*M* sodium to 5*M* sodium. The AY tanks also would store waste at 5*M* sodium because they contain high-heat solids. This alternative was kept as a comparison case although it would normally be rejected due to Requirement 1.

B. Minimal Effort - Transfer C-106 Solids (and Supernate) to (>>>) AY-102

   Concentrate high-heat supernate from AZ-101 and AZ-102 in AY-101 to 7*M* sodium from their respective 5*M* and 2.3*M* sodium values. This will allow concentration of about 6,800,000 L (1.8 million gal) of supernate into the 3.59 million L (0.95 million gal) available in tank AY-101.

C. C-106 >>> AY-102 >>> AZ-101

   Bottom slurry transfer from AY-102 to AZ-101.

D. Planning Case (Bacon 1995)
   C-106 >>> AY-102 >>> AZ-102 (bottom slurry transfer AY-102 to AZ-102)
   AZ-101 >>> AZ-102

E. C-106 >>> AY-102 >>> AZ-102 (bottom slurry transfer AY-102 to AZ-102)
   AZ-101 >>> AZ-102
   AY-101 >>> AZ-102
   and/or AY-102 >>> AZ-102 (mixer pump installed in AY-102)

F. C-106 >>> non-AWTs (split solids)

   This scenario modifies Project W-320 by splitting the solids from C-106 to go to two separate non-AWTs (AN-106 and AN-104). The pipeline would be changed by turning a valve or changing a jumper at a new or existing diversion box near one of the DSTs. Modification of the design and installation of the transfer line and diversion box would delay the project causing the transfer to be initiated after the Tri-Party Agreement start date of October 1997. Rejected due to Requirement 4.

G. C-106 >>> AZ-102
AZ-101 >>> AZ-102

Reroute Project W-320 pipelines to AZ-102.

H. C-106 >>> AY-101

Rejected due to delay of the C-106 Tri-Party Agreement Milestone date, Requirement 4. By the time required missing waste composition information on AY-101 were gathered and the project completed, the C-106 milestone deadline would be exceeded. All consolidation of high-heat sludge to AY-101 requires sampling of the sludge in AY-102.

I. C-106 >>> AZ-101

Reroute Project W-320 new waste pipeline from C-106 to AZ-101.

J. C-106 >>> AZ-102

Reroute Project W-320 pipeline from C-106 to AZ-102.

K. C-106 >>> AZ-102
AZ-101 >>> AZ-102

Concentrate supernate in AY-102; do not include potentially complexed supernate from AY-101.

L. C-106 >>> AY-102 >>> non-AWTs

Rejected due to high-heat solids causing: (1) tank bump, Requirement 4, and/or (2) loss of tank storage space, Requirement 1.

M. C-106 >>> AZ-101
AY-102 >>> AZ-101
AY-101 >>> AZ-101
AZ-102 >>> AZ-101

Concentrate supernate in non-AZ-101 tank (or supernate >>> non-AWT).

Not optimum scenarios. See Alternative E for a better consolidation alternative requiring less rerouting of lines and better timing.

N. Do not retrieve C-106. Continue with process and mixer pump testing. Consolidate NCAW solids into one AWT. Rejected due to Requirement 4--does not meet Tri-Party Agreement, and Requrirement 2, unacceptable safety concern.

O. Consolidate NCAW solids then transfer C-106 solids to AWT. Rejected due to Requirement 4. The timing required to install mixer pumps would miss the Tri-Party Agreement milestone by years, and would also continue the safety concern of high-heat waste in C-106.

P. Consolidate all high-heat and C-106 solids into one AWT (Alternative M and/or different consolidation tank). Consolidate AZ-101 and AZ-102 supernate into the consolidated sludge tank. Rejected due to large tank bump potential (800 KBtu/h and 1,122 cm [442 in.] of solids) even though mixer pump(s) are installed, Requirement 3.

3.5 INITIAL SCREENING OF ALTERNATIVES

Eleven alternatives designated 0a, 0b, 1a, 1b, 2, 3, 4, 5a, 5b, 5c, and 6 were initially chosen for continued analysis from the above preliminary alternatives. The reasons that the preliminary alternatives were screened out are given below their description in Section 3.3. This selection of alternatives was designed to analyze the strengths and weaknesses of the general processing scenarios and thus exemplify the major trade-offs. The initial analysis used caustic leaching and water washing on all the retrieved sludges except AZ-101. The solids in AZ-101 would not benefit from caustic leaching.

After the initial analysis, it was found that only C-106 sludge might need to be caustic leached (Vienna and Hrma 1995). Therefore, the scenarios that retained caustic leaching were optimized to caustic leach only solids from C-106. This reduced the total amount of caustic leaching and improved the scores (value) of those alternatives that contained caustic leach.

3.5.1 Screening of Alternatives

.After the initial evaluation was performed, eight more alternatives were included which did not include any special leaching and washing in their operations. The letter "N" was added before the modified alternative and stood for "no special leaching or washing," and the leaching and washing steps were removed from those alternatives. Otherwise, the "N" alternatives were the same as the non-"N" alternatives. These non-leach alternatives were designated N1a, N1b, N3, N4, N5a, N5b, N5c, and N6. One alternative (7a) was added during group analysis and brainstorming to attempt to optimize all the scenarios, and another alternative (7b) was later added to confirm that in-tank concentration of AZ-102 aging waste supernate would be preferable to concentration at the 242-A evaporator.

3.5.2 Summary of Transfers and Analyses

3.5.2.1 Alternative Assumptions. This section contains the major assumptions for transfer of sludge and supernate in the alternatives.

- All the alternatives (except 0a) include an option to fill the consolidated solids tank with concentrated 7*M* Na liquid, which will tend to recontaminate clean (washed) solids for final vitrification. This step is envisioned to be the last resort to make tank space or if leaching and washing of the sludge did not need to be performed.

- All the scenarios (except 0a) consolidate high-heat supernate from AZ-101 and AZ-102 in one AWT. The tank chosen for supernate consolidation was normally the tank that had the lowest amount of heat content in the sludge. This reduces the likelihood of a tank bump in the tank with the high-heat supernate. The supernate tank usually carried an insignificant risk of heating up the sludge to form enough steam to cause a tank bump.

- Reducing the heat load in C-106 is one goal of Project W-320 (Bailey 1995). Whenever C-106 solids are transferred to AY-102, <40,000 Btu/h (36% of the heat load) should remain in C-106. This is about 130 Kgal of solids transferred to AY-102, assuming heat and mass ratios are equal. For final configuration of mass balances, the following Tri-Party Agreement milestones relating to C-106 were considered:

  - Milestone M-45-T01, "Complete SST waste retrieval demonstration" in September 2003. Initiate and complete a full-scale demonstration of SST retrieval technology. This demonstration will be considered complete when <99% of the waste inventory is removed from an SST. (This would be about (9,080 L [2,400 gal] remaining in C-106 [Harris 1995]).

  - Milestone M-45-03-T02, "Initiate final retrieval demonstration of C-106" in June 2002. "Initiate final retrieval of tank 241-C-106 to complete initial demonstration of SST retrieval technologies."

- For final configuration (FY 2004) of tank C-106, it has been assumed that 99% of its solids have been transferred to AY-102 or other appropriate receiver tank, depending on the alternative. It was further assumed that the 99% cleanout of C-106 would occur in time to qualify for any leaching and washing called out in the alternatives. See Table 3-1 for general retrieval assumptions.

Table 3-1. Percent Sludge Retrieved From Tanks.

	Tanks				
	AZ-101	AZ-102	AY-101*	AY-102*	C-106
Percent sludge retrieved with large mixers (C-106 uses Project W-320 sluicing system)	95	95	99	99	75
Percent sludge retrieved from C-106 final cleanout demonstration, FY 2003	--	--	--	--	99

*Tanks AZ-101 and AZ-102 are assumed to have two 250-hp mixer pumps and two 300-hp mixer pumps, respectively. AY tanks are assumed to have four 250-hp mixer pumps.

FY = Fiscal year

- When C-106 solids are transferred by bottom sludge transfer (defined as a transfer of a settling slurry using only the AY-102 transfer pump) from AY-102 to other tanks, 50% of the C-106 solids are transferred. None of the solids in AY-102 are transferred. When a 75-hp rotating mixer pump is installed in AY-102, replacing the existing inoperable pump, it is assumed that 90% of the C-106 solids are transferred to the next tank and 25% of the solids in AY-102 are transferred as shown in Table 3-2.

Table 3-2. Percent Sludge Retrieved from AY-102, With and Without 75-hp Mixer Pump.

	Tanks	
	AY-102	C-106
Percent sludge retrieved from AY-102 not using 75-hp mixer	0	50
Percent sludge retrieved from AY-102 using 75-hp mixer*	25	90

*A rotating 75-hp mixer pump is assumed to be a replacement for the existing unit in AY-102.

- The year 2004 was used as the end point for this study because all solids consolidation activities from all scenarios could be completed by then. This is also well in advance of the tank space shortage that is expected in FY 2006 (Koreski and Strode 1995).

- The 5*M* or 7*M* Na waste supernate used to fill tanks or supplement in-tank concentration efforts is assumed to be a low-heat, clear, convective liquid that comes from the 242-A evaporator. This will be non-complexed waste. Waste at 7*M* Na was chosen to be put on top of aging waste solids because it is generally considered to be free of precipitates and can produce a clean, convective liquid (Powell 1995).

- Sludge transfer ratios average 3-to-1 water-to-sludge by volume, as assumed by Koreski and Strode (1995).

- Washing of consolidated sludge takes about five times as much water as the volume of sludge it cleans (MacLean and Powell 1995). When available, washing of sludge is performed twice. Slurry transport can perform sludge washing if dilute liquid waste is used.

- Caustic washing of sludge requires a volume of 50% sodium hydroxide equal to 82% of the volume of consolidated sludge (MacLean 1995) for C-106. Of all the sludge in AWTs, it is anticipated that only C-106 sludge may need to be caustic leached to lower waste vitrification product volumes. In Alternatives 1a, 1b, 3, 4, 5 (all), and 6, one caustic leach is performed on C-106 solids when mixer pumps are available; this may entail leaches on portions of C-106 waste. No caustic leaching is performed in the other alternatives.

- Sodium hydroxide has a specific gravity of 1.35 at 32% and 0 °C (32 °F). The sodium hydroxide was assumed to be diluted before reaching the tank, from 50% to 32%, or about 60% dilution to ensure that the data quality objective specific gravity limit of 1.35 was adhered to.

In the transfer summary section below, the volume of slurry is estimated to the nearest 50,000 gal.

3.5.2.2 Alternatives. The main alternatives that passed the initial screening are listed below. They contain all the transfers anticipated to be encountered in the operation of the alternatives. Also listed are approximate volumes of the transfers as well as source and destination of the transfers.

These transfer scenarios have been optimized as far as possible in the time available. There may be minor improvements possible to reduce or delete some transfers. Minor changes are not anticipated to alter the score of the alternative. All alternatives include the following transfers to start the process:

Transfers/activities	Comments
1. AY-101 supernate to AP Tank Farm	Routine, 850 Kgal
2. AZ-101 supernate to AY-101	Routine (6 Ci/gal cesium-137, typical), 900 Kgal

0a. "Do Nothing"
C-106 (solids) >> AY-102

The solutions in the AWTs are concentrated to 5*M* Na after the solids from C-106 are transferred to AY-102. Waste in AZ-102 is concentrated in-tank to obtain supernate at 5*M* Na. Waste concentrated to 5*M* Na is added to AY-102 from the evaporator. Evaporated waste is sent to AZ-102 as tank space becomes available in AZ-102. This in-tank concentration is performed with AZ-102 supernate, taking 3.5 to 4 years to complete. When space is available and after AY-101 is no longer needed as a receiver, dilute waste is concentrated to 5*M* Na at the evaporator and transferred to AY-101.

Transfers/activities	Comments
3. AY-102 supernate to AZ-101 for process test using W-151 mixers	Routine 750 Kgal
4. Transfer C-106 to AY-102	800 Kgal slurry transfer
5. Supernate in AZ-101 to AW Tank Farm for concentration	Routine, 750 Kgal
6. High-heat supernate in AY-101 to AZ-101	Routine, 900 Kgal
7. Concentrated 5*M* Na from AW Tank Farm to AY-102 (as required)	Routine, 900 Kgal

8. Concentrated 5*M* Na from AW Tank Farm to AZ-102 (as required as in-tank concentration continues*)	Two routine, 200 Kgal each
9. Concentrated 5*M* Na from AW Tank Farm to AY-101	Routine, 850 Kgal

*The tank containing AZ-102 supernate will slowly (during 3.5 to 4 years) condense 400 Kgal of condensate to AZ-151. This condensate will be transferred to the aging waste dilute receiver tank, probably AY-101.

0b. "Minimal Effort"
C-106 >> AY-102

Supernate in the AWTs is concentrated to 7*M* Na after the solids from C-106 are transferred to AY-102. Waste in AZ-101 and AZ-102 is concentrated in-tank to obtain supernate at 7*M* Na. Waste concentrated to 7*M* Na is added to AZ-101, AZ-102, AY-101, and lastly to AY-102 as tank space becomes available and volume constraints dictate. This in-tank concentration takes about 1.5 years for AZ-101 supernate (in tank AZ-101) and 5 to 6 years for AZ-102 supernate (in tank AZ-102). The AY-101 tank supernate is transferred out after the tank is no longer needed as a dilute receiver. Then dilute waste is concentrated to 7*M* Na at the evaporator and transferred to AY-101. The 7*M* Na solution is equal to clean, convective solids and probably would require the equivalent of a minor USQ to delete the 5*M* Na OSD limit for supernate stored above aging waste solids.

Transfers/activities	Comments
3. AY-102 supernate to AZ-101 for process test	Routine, 750 Kgal
4. Transfer C-106 to AY-102	800 Kgal slurry transfer
5. AZ-101 supernate to AW Tank Farm for concentration	Routine, 750 Kgal each
6. High-heat AY-101 supernate back to AZ-101, in-tank concentration continues to 7*M* Na*	Process test on 5*M* Na limit, sample boil down, 900 Kgal
7. AW Tank Farm concentrated 7*M* Na waste to AZ-101, as required*	Routine, 250 Kgal
8. Concentrated 7*M* Na from AW Tank Farm to AY-102	900 Kgal
9. Concentrated 7*M* Na from AW Tank Farm to AZ-102 (as required, and in-tank concentration continues*)	Two transfers probable, 250 Kgal each
10. Concentrated 7*M* Na from AW Tank Farm to AY-101	850 Kgal

*The tank containing the original AZ-101 supernate will transfer (in 1 to 2 years) 250 Kgal of condensate to AZ-151 and to the aging waste dilute receiver tank. The tank containing AZ-102 supernate will slowly (5 to 6 years) transfer 500 Kgal of condensate to AZ-151 and to a dilute receiver AWT, probably AY-101.

1a. "Pipeline Reroute to AZ-101"
C-106 (solids) >>>> AZ-101 (Project W-320 pipelines rerouted to AZ-101)
(store high-heat supernate in AY-102)

Transfers/activities	Comments
3. AY-102 supernate to AZ-101 for AZ-101 process test	Routine, 750 Kgal
4. AZ-101 supernate back to AY-102	Routine, 750 Kgal
5. C-106 solids to AZ-101	800 Kgal slurry transfer
6. AZ-102 supernate to AW Tank Farm for evaporation	Two transfers at 4 Ci/gal cesium-137, 420 Kgal/each
7. High-heat AZ-101 supernate in AY-101 to AY-102 (in-tank concentration to 8 Ci/gal cesium-137, typical*)	Routine, 850 Kgal
8. High-heat AZ-102 evaporated supernate from AW Tank Farm to AY-102 at 12 Ci/gal cesium-137 (typical)	Two transfers, 140 Kgal/each
9. *7M* Na to AZ-102	500 Kgal
10. Double-shell slurry feed (DSSF) to AY-101	950 Kgal at specific gravity limit
11. Leach and wash AZ-101 supernate to AP or AW Tank Farm, retain last wash	Five liquid transfers, one caustic in at 250 Kgal (32% sodium hydroxide) and one out at 250 Kgal, two dilute liquid in at 800 Kgal, one dilute liquid out at 800 Kgal

*The tank containing the original AZ-101 supernate will slowly (in 1 to 2 years) transfer at least 250 Kgal of condensate to AZ-151 and from there to the aging waste dilute receiver tank.

1b. "AZ-101 Reroute & Consolidate"
C-106 (solids) >>>> AZ-101
AZ-102 (solids) >>>> AZ-101 (high-heat supernate in AZ-102)

Changes to 1a are shown below:

Transfers/activities	Comments
7. Wash AZ-102, to AP Tank Farm	Three routine transfers, two dilute washes in of 300 Kgal each, one dilute wash out

8. Caustic leach and wash AZ-101 and C-106 solids, supernate to AP Tank Farm	Four routine transfers, one caustic transfer of 400 Kgal 7*M* NaOH in from 204-AR, one high sodium transfer out of 400 Kgal, one dilute wash in of 500 Kgal, one dilute wash out of 100 Kgal
9. AZ-102 solids to AZ-101	One slurry transfer of 400 Kgal
10. High-heat AY-101 concentrated supernate to AZ-102, in-tank concentration*	One supernate transfer of <800 Kgal
11. High-heat concentrated supernate from AW Tank Farm to AZ-102 at 12 Ci/gal cesium-137 (typical)	Two supernate transfers of 150 Kgal each
12. 7*M* Na to AY-101	850 Kgal
13. 7*M* Na to AY-102	800 Kgal

*About 250 Kgal of (AZ-101) high-heat supernate condensate will be transfered (in a 1 to 2 year period) to AZ-151 and from there to the aging waste dilute receiver tank.

**2. "Minimal Case - Evaporator Concentrate"
C-106 (solids) >>> AY-102
(high-heat supernate to AY-101)**

This alternative uses the 242-A evaporator to concentrate AZ-102 supernate to 7*M* Na instead of in-tank evaporation as done in Alternative 0b. Alternative 2 does not include mixer pumps in AY-102 so no further washing and leaching can be performed until mixer pumps are available.

Transfers/activities	Comments
3. AY-102 supernate to AZ-101 for process test	Routine 750 Kgal
4. Transfer C-106 to AY-102	800 Kgal slurry transfer
5. AZ-102 supernate to AW Tank Farm for concentration	Two transfers at 4 Ci/gal cesium-137, 450 Kgal each
6. AW Tank Farm AZ-102 concentrated high-heat supernate to AY-101 at 12 Ci/gal cesium-137 (typical)*	Two transfers, 150 Kgal each
7. 7*M* Na to AZ-102	900 Kgal
8. 7*M* Na to AZ-101	900 Kgal

*About 250 Kgal of (AZ-101) high-heat supernate condensate will be transfered (in a 1 to 2 year period) to AZ-151 and from there to the aging waste dilute receiver tank.

3. **"Bottom Slurry Transfer (Decant) to AZ-101"**
C-106 (solids) >> AY-102 (solids) >> AZ-101
(high-heat supernate to AZ-102)

Transfers/activities	Comments
3. AY-102 supernate to AZ-101 for process test	Routine 750 Kgal
4. AZ-101 supernate to AW Tank Farm	Routine 750 Kgal
5. C-106 transfer to AZ-101 via AY-102	800 Kgal slurry transfer to AY-102 (may be recycled to C-106), 600 Kgal bottom decant slurry transfer from AY-102 to AZ-101
6. Caustic leach and wash AZ-101, keep last supernate	Five transfers, one caustic in at 100 Kgal, one caustic out at 100 Kgal, two dilute liquid in at 300 Kgal, one dilute liquid out at 300 Kgal
7. High-heat AZ-102 supernate to AW Tank Farm for evaporation	Two transfers at 4 Ci/gal cesium-137, 450 Kgal each
8. High-heat AZ-101 supernate in AY-101 to AZ-102, continue in-tank concentration*	Routine 800 Kgal
9. AW Tank Farm AZ-102 concentrated supernate to AZ-102 at 12 Ci/gal cesium-137 (typical)	Two transfers at 150 Kgal each
10. 7*M* Na concentrate from AW Tank Farm to AY-101	850 Kgal
11. 7*M* Na concentrate from AW Tank Farm to AY-102	850 Kgal

*About 250 Kgal of (AZ-101) high-heat supernate condensate will be transfered (in a 1 to 2 year period) to AZ-151 and from there to the aging waste dilute receiver tank.

4. **"Reroute and Consolidate to AZ-102"**
C-106 (solids) >>>>> AZ-102
AZ-101 (solids) >>>> AZ-102 (high-heat supernate to AZ-101)

Transfers/activities	Comments
3. AY-102 to AZ-101 for process test	Routine 750 Kgal
4. AZ-102 supernate transfer to AW Tank Farm for concentration	Two transfers at 4 Ci/gal cesium-137, 450 Kgal each
5. C-106 directly to AZ-102	800 Kgal slurry transfer

6. Caustic leach and wash AZ-102 supernate to AP Tank Farm	Six routine transfers, one out at 500 Kgal, one caustic in at 250 Kgal, one high sodium out at 250 Kgal, two washes in at 800 Kgal, one wash out at 800 Kgal
7. Wash AZ-101 supernate to AP Tank Farm, retain last wash	Three transfers, two dilute washes in at 200 Kgal, one wash out at 200 Kgal
8. Transfer AZ-101 solids to AZ-102	250 Kgal
9. High-heat supernate in AY-101 to AZ-101*	Routine, 800 Kgal
10. Concentrated AZ-102 supernate from AW Tank Farm to AZ-101 at 12 Ci/gal cesium-137 (typical)	Two transfers at 150 Kgal each
11. AY-102 supernate to AP Tank Farm	Routine, 700 Kgal
12. DSSF from AW Tank Farm to AY-102	900 Kgal
13. 7*M* Na from AW Tank Farm to AY-101	850 Kgal

*About 250 Kgal of (AZ-101) high-heat supernate condensate will be transfered (in a 1 to 2 year period) to AZ-151 and from there to the aging waste dilute receiver tank.

5a. "Planning Case" (Bacon 1995)
AZ-101 (solids) >>> AZ-102
C-106 (solids) >>> AY-102 (C-106 [solids]) >>> AZ-101 (solids) >>> AZ-102
(high-heat supernate in AZ-101)

Transfers/activities	Comments
3. AY-102 supernate to AZ-101	Routine 750 Kgal
4. AZ-102 supernate to AW Tank Farm for evaporation	Two transfers at 4 Ci/gal cesium-137, 450 Kgal each
5. AZ-101 solids to AZ-102	Two transfers, 800 Kgal liquid and solids to AZ-102
6. C-106 solids to AZ-101 via AY-102	800 Kgal slurry transfer to AY-102 (may be recycled to C-106), 600 Kgal bottom decant slurry transfer from AY-102 to AZ-101
7. Caustic leach and wash AZ-101, supernate to AP Tank Farm, retain last wash liquid	Five routine, one caustic in at 100 Kgal from 204-AR, one caustic out at 100 Kgal, two dilute liquid in at 500 Kgal, one dilute liquid out at 500 Kgal
8. Wash AZ-102 supernate to AP Tank	

Farm	Four routine, two dilute liquid in at 500 Kgal each, two dilute liquid out at 500 Kgal each
9. AZ-101 solids to AZ-102	600 Kgal slurry transfer
10. AY-101 high-heat supernate to AZ-101, continue in-tank concentration*	Routine, 700 Kgal
11. AW Tank Farm (concentrated AZ-102 supernate) to AZ-101 at 12 Ci/gal cesium-137 (typical)	Two transfers, 150 Kgal each
12. DSSF to AY-102	850 Kgal
13. DSSF to AY-101	950 Kgal

*About 250 Kgal of (AZ-101) high-heat supernate condensate will be transfered (in a 1 to 2 year period) to AZ-151 and from there to the aging waste dilute receiver tank.

5b. **"AY-102 Consolidation"**
AZ-101 (solids) >>> AZ-102
C-106 (solids) >>> AY-102 (C-106 solids) >>> AZ-101 (solids) >>> AZ-102
AY-102 (solids) >>> AZ-102

Change Alternative 5a starting with the following steps:

Transfers/activities	Comments
12. Decant AZ-102 supernate to AW Tank Farm for concentration	Routine, 500 Kgal
13. Leach and wash AY-102 supernate to and from AP Tank Farm and 204-AR, retain last wash	Five routine, one caustic in at 100 Kgal from 204-AR, one caustic out at 100 Kgal, two dilute liquid in at 500 Kgal, one dilute liquid out at 500 Kgal
14. AY-102 solids to AZ-102	600 Kgal
15. 7*M* Na to AY-102	Routine, 950 Kgal
16. DSSF to AY-101	900 Kgal

5c. **"AY-101 Consolidation"**
AZ-101 (solids) >>> AZ-102
C-106 (solids) >>> AY-102 (C-106 solids) >>> AZ-101 (solids) >>> AZ-102
AY-101 >>>> AZ-102

Change Alternative 5a starting with the following steps:

Transfers/activities	Comments
12. Decant AZ-102 supernate to AW Tank Farm for concentration	Routine, 500 Kgal
13. Wash AY-101 supernate to	

AP Tank farm, retain last wash	Three routine, two in at 400 Kgal, one out at 400 Kgal
14. AY-101 solids to AZ-102	500 Kgal
15. DSSF to AY-102	850 Kgal
16. DSSF to AY-101	Routine, 950 Kgal

Note: Sludge sampling required in AY-101.

6. **"Ultimate Consolidation"**
AZ-101 (solids) >>> AZ-102
C-106 (solids) >>> AY-102 (C-106 solids) >>> AZ-101 (solids) >>> AZ-102
AY-101 (s) >>> AY-102 (s) >>> AZ-102

Alternative 6 transfers all aging waste solids into AZ-102. It is the same as Alternative 5a with the following changes:

Transfers/activities	Comments
12. Dilute waste from AP to AY-101	Routine, 400 Kgal, first wash
13. AY-101 solids to AY-102	Minor USQ evaluation, 500 Kgal
14. Leach and wash AY-102 supernate to AP Tank Farm, retain last wash	Six routine, one caustic in at 100 Kgal, one caustic out at 100 Kgal, two wash in at 750 Kgal, two wash out at 750 Kgal, and 150 Kgal
15. AY-102 solids to AZ-102	Possible safety assessment 800 Kgal
16. DSSF to AY-102	Routine, 950 Kgal
17. DSSF to AY-101	Routine, 950 Kgal

Note: One possible safety assessment required; sludge sampling required in AY-101.

7. **"75-Hp Mixer Pump"**
C-106 (solids) >> AY-102 (solids) >> AZ-101
(high-heat supernate to AZ-102)

This alternative is the same as Alternative 3 except that the existing 75-hp mixer pump in AY-102 is removed and replaced. Then 90% of the C-106 sludge is assumed to be transferred to AZ-101 from AY-102, and 25% of the AY-102 sludge to AZ-101. These transfer distributions are based on process knowledge. Caustic leaching is not performed.

Transfers/activities	Comments
3. AY-102 supernate to AZ-101 for process test	Routine 750 Kgal
4. AZ-101 supernate to AW Tank Farm	Routine 750 Kgal
5. C-106 transfer to AZ-101 via AY-102, first wash C-106 sludge	800 Kgal slurry transfer to AY-102 (may be recycled to

		C-106), 600 Kgal 75-hp mixer pump slurry transfer from AY-102 to AZ-101
6.	High-heat AZ-102 supernate to AW Tank Farm for evaporation	Two transfers at 4 Ci/gal cesium-137, 450 Kgal each
7.	High-heat AZ-101 supernate in AY-101 to AZ-102, continue in-tank concentration*	Routine 800 Kgal
8.	AW Tank Farm AZ-102 concentrated supernate to AZ-102 at 12 Ci/gal cesium-137 (typical)	Two transfers at 150 Kgal each
9.	7*M* Na concentrate from AW Tank Farm to AY-101	850 Kgal
10.	7*M* Na concentrate from AW Tank Farm to AY-102	950 Kgal

*About 250 Kgal of (AZ-101) high-heat supernate condensate will be transfered (in a 1 to 2 year period) to AZ-151 and from there to the aging waste dilute receiver tank.

The remaining alternatives (N1a, N1b, N4, N5 [all], and N6) are duplicates of the above namesake alternatives but without caustic leaching and additional water washing. In the "N" alternatives, the volume of liquid transferred to the evaporator for processing is reduced because leaching and special washing are not included. In alternative 7b alternative 7a was modified and optimized to concentrate AZ-102 waste by in-tank evaporation instead of in the 242-A evaporator.

For all alternatives except Alternative 0a, experimental verification that AZ-101 and AZ-102 high-heat aging waste supernate can be concentrated without significant precipitation is required. The best alternative may be to take samples of the supernate and concentrate them in the laboratory.

3.6 EVALUATION OF REMAINING ALTERNATIVES VERSUS SELECTION CRITERIA

3.6.1 Alternative's Satisfaction of Raw Decision Criteria

In all cases, the data used to evaluate the performance of NCAW consolidation alternatives are based on best engineering judgment. Detailed analysis was carried out to generate the data. The performance of alternatives to the decision criteria is shown in Table 3-3. This section provides an understanding of the basis for the data.

The assumptions and reasoning behind gathering the data are given in Appendix C. The discussion topics are arranged in the same order as in the waste decision criteria outline, Section 3.2.2.3.

Table 3-3. Results of Raw Decision Criteria Evaluation. (sheet 1 of 2)

Alternatives		Performance measures													
Number	Description	Offsite persn'l risk	Onsite person'l risk	Tank bumps	# Mjr sfty USQ eval	# mnr sfty USQ Ev	# runs to cnc to evapr	# wash & leach	# mixing of sludges	# solid transfers	# decant & supernat	Tank drain line	Process pits mods	# DST sldgs to mblz	Bottom decant oper
0a	Do Nothing	15	14000	75	2	6	0	0	1	1	17	0	9	1	0
0b	Minimal Case	15	14000	75	2	7	0	0	1	1	25	0	9	1	0
1a	Pipe Rerout AZ101	20	22000	80	3	12	1	1	1	1	16	0	12	1	0
1b	R&C to AZ101	18	17000	55	3	9	1	2	2	2	16	1	12	2	0
2	242-A Evaporator	20	15000	75	3	10	1	0	1	1	15	1	14	1	0
3	Bttm Dcnt to AZ101	16	15000	100	3	11	1	1	1	2	16	0	10	1	1
4	R&C to AZ102	18	17000	55	3	9	1	1	2	2	16	1	12	2	0
5a	Planning Case	22	24000	78	3	9	1	2	4	4	15	0	14	4	1
5b	P.C. + AY102	27	25000	50	3	9	1	2	5	5	16	1	19	5	1
5c	P.C. + AY101	27	25000	55	3	9	1	3	5	5	17	1	19	5	1
6	Ultimate Retrieval	30	25000	30	3	9	1	3	6	6	17	1	22	6	1
7a	75-HP Mixer	17	16000	65	3	12	1	0	2	2	16	1	11	2	0
7b	75-HP Mixer	15	16000	65	2	12	0	0	2	2	27	1	11	2	0
N1a		20	21000	63	3	12	1	0	1	1	16	1	11	1	0
N1b		18	15000	37	3	9	1	0	2	2	16	1	12	2	0
N3		16	15000	95	3	11	1	0	1	2	16	0	10	1	1
N4		18	15000	37	3	9	1	0	2	2	16	1	12	2	0
N5a		22	22000	65	3	9	1	0	4	4	15	1	14	4	1
N5b		27	23000	25	3	9	1	0	5	5	16	1	19	5	1
N5c		27	23000	38	3	9	1	0	5	5	17	1	19	5	1
N6		30	23000	0	3	9	1	0	6	6	17	1	22	6	1

Table 3-3. Results of Raw Decision Criteria Evaluation. (sheet 2 of 2)

Alternatives		Performance measures									
Number	Description	# DST sludges wshd	# DSTs retrieved	# DSTs leached	Flex in out yrs	Fluffy settled solids	HLW feed available	Avail tank space	C-106 start	End date	Schd impcts othr pr mnths
0a	Do Nothing, in-tank evaporation	0	1	0	1	2.39	35	0	10/96	2000	0
0b	Minimal Case, in-tank evaporation	0	1	0	1	2.39	35	994	10/96	2002	0
1a	Pipe Rerout to AZ-101	0	1	1	1	10.43	222	565	4/97	1999	0
1b	R&C to AZ-101	1	2	1	2	14.66	320	565	4/97	2002	0
2	Minimal Case, 242-A Evaporator	0	1	0	1	2.39	35	994	10/96	1998	0
3	Bttm Transfer to AZ-101	0	1	1	1	6.41	133	780	10/96	1999	0
4	R&C to AZ-102	1	2	1	2	14.93	320	565	10/97	2002	0
5a	Planning Case	1	3	1	2	10.57	223	791	10/96	2002	0
5b	P.C. + AY-102	2	4	2	3	15.95	348	578	10/96	2004	0
5c	P.C. + AY-101	2	4	1	3	14.45	303	791	10/96	2004	0
6	Ultimate Retrieval	3	5	2	4	19.77	429	585	10/96	2004	12
7a	75 HP Mixer	1.2	1.5	0	1.3	15.56	228	994	10/96	1999	0
7b	75 HP Mixer	1.2	1.5	0	1.3	15.6	228	994	10/96	2002	0
N1a	non-leached...	0	1	0	1	15.14	222	994	4/97	1999	0
N1b		1	2	0	2	21.82	320	994	4/97	2001	0
N3		0	1	0	1	9.07	133	994	10/96	1999	0
N4		1	2	0	2	21.82	320	994	10/97	2001	0
N5a		1	3	0	2	15.2	223	994	10/96	2001	0
N5b		2	4	0	3	23.73	348	994	10/96	2003	0
N5c		2	4	0	3	20.66	303	994	10/96	2003	0
N6		3	5	0	4	29.25	429	994	10/96	2003	12

3.6.2 Weighing of Selection Criteria

Value functions capture the importance of different levels of performance on a single objective, weights capture the relative importance of the different objectives or values. For example, weights answer the question of whether the technical risks are more important than the operational risks. Weights logically depend on the potential ranges over which the alternatives can vary. A common error is to specify weights in a "top down" process without considering the potential ranges of the impacts. The method used to develop the weights in this study tied the importance of objectives to their ranges in a "bottom up" assessment process.

The methodology used for determining the relative weights is a standard decision analysis procedure known as "swing weighting." This procedure requires that the set of criteria within each category or subcategory first be ordered according to rank, and then the ratios of relative importance are determined. Evaluators are asked to consider a situation in which a hypothetical alternative would score at the worst level for all criteria within a particular category. They are then asked to imagine that if the alternative could be improved to the best level on one criterion, which criterion would be their first choice for the improvement, second choice, etc. This provides a basis for the rankings. Ratio judgments of relative importance are then obtained. The process is repeated for each of the categories and extended to obtain judgements across categories. The importance ratios are normalized so the sum of weights across all categories is one.

Weights were elicited from the evaluation team. Weights represent value judgments; consequently, there is no "correct" answer as to the relative importance that should be given to various criteria. This is in contrast to estimates of performance which, while they may not be known, are thought to have correct answers. The process used for eliciting weights consisted of individuals making independent judgments followed by a group discussion. In most instances for this team, a consensus was reached. In two instances, team participants believed strongly enough about their differences that two "outlier" sets of weights also were considered.

No attempt was made in the weight elicitation to trade off the performance criteria against dollar costs. The analysis uses the elicited weights to arrive at an overall "benefit" score for each technical alternative and then directly compare performance on overall value with cost. This method of analysis makes it possible to identify dominating alternatives, i.e., technical alternatives that provide more value for less cost. It also keeps visible the cost-performance trade-offs among the dominating alternatives. Thus, the reader can decide whether the higher performing alternatives are worth the additional cost.

The weights resulting from the elicitation are shown in Table 3-4. The first column in the table shows the major categories of values, in bold, along with the subcriteria. The next column is an abbreviated description of the scale associated with the subcriteria. The next three columns show group weights, used in the main analysis, and the two outlier weights. Each column shows the weights for the major public values (shaded) as well as weights for the specific subcriteria. The sum of the shaded numbers and the non-shaded numbers is one. Thus, the shaded numbers capture the relative importance of

Table 3-4. Weights Used in the Analysis of the Neutralized Current Acid Waste Consolidation Alternatives.

Criteria	Performance measures	Weights		
		Evaluator		
		Group	Outlier G	Outlier 1
MAXIMIZE SAFETY		0.233	0.188	0.190
PERSONNEL RISK	mrem	0.078	0.063	0.063
OFFSITE PERSONNEL RISK	# Jumper changes	0.058	0.047	0.048
TANK SAFETY				
Tank Bumps	Constructed scale 155, 510 KBtu 40, 300 KBtu	0.049	0.040	0.040
Waste Compatibility	# Major safety evaluations	0.040	0.032	0.032
	# Minor safety evaluations	0.008	0.006	0.006
OPERATIONAL RISK		0.163	0.219	0.167
COMPLEXITY OF OPERATION				
# Unit Operation	# of evap runs to conc high-heat waste	0.027	0.036	0.027
	# washes and leaches	0.021	0.029	0.022
	# mixing of sludges	0.013	0.018	0.014
# of Transfers	# solid transfers	0.046	0.061	0.047
	# decant & supernate transfers	0.023	0.031	0.023
TANK EQUIPMENT MODS				
Tank Pit Drain Line	# tanks with solid level >60"	0.005	0.007	0.006
Process Pits Modification	# rigid jumpers req cover blk mod	0.027	0.036	0.028
TECHNOLOGY RISK		0.116	0.031	0.119
# DST SLUDGES TO MOBILIZE	# DST sludges mobilized	0.078	0.021	0.079
BOTTOM DECANT OPER	# of bottom decants	0.039	0.010	0.040
FEED PREP PROCESS		0.209	0.313	0.214
PROCESS INFORMATION				
	# DST sludges washed	0.012	0.018	0.012
	# DSTs retrieved	0.047	0.071	0.049
	# DSTs leached	0.014	0.021	0.015
FLEX IN OUT-YRS PROCES	# tanks with mixer pumps	0.051	0.077	0.053
FLUFFY SETTLED SOLIDS	# feet	0.011	0.016	0.011
HLW FEED AVAILABLE	kgal	0.073	0.110	0.075
AVAILABLE TANK SPACE	kgal	0.209	0.156	0.238
SCHEDULE		0.070	0.094	0.071
START DATE OF C-106	start date	0.011	0.014	0.011
END DATE OF WASTE CNSLD	end date	0.054	0.072	0.055
SCHED IMPACTS OF PROJECTS	W 030: months delay	0.005	0.007	0.005

DST = Double-shell tank
HLW = High-level waste

the major criteria, and the non-shaded numbers provide the relative importance of specific criteria across all categories. Note that Available Tank Space is a major category and also a specific criteria. Thus, its weight needs to be added to the non-shaded weights so the sum is one.

As can be seen in Table 3-4, both outlier G and outlier 1 judged the safety risks to be of less concern than the group as a whole. Outlier G placed more weight on operational risk and on the feed preparation process and more weight on schedule. Outlier 1 placed more weight on making tank space available. The alternatives were initially analyzed with all three sets of weights. Alternative rankings with the three sets of weights were not very different; consequently, the majority of the analysis was carried out using the "group" weights. These analyses are discussed further in the following sections.

3.6.3 Ranking of Alternatives/Analysis

The data shown in Table 3-3 represent the facts used in the analysis of the NCAW consolidation alternatives. No alternative scored best on all criteria; consequently, additional analysis that considers costs and benefits and the judgments of trade-offs among values is needed. The following subsections analyze the strengths and weaknesses of the NCAW consolidation alternatives.

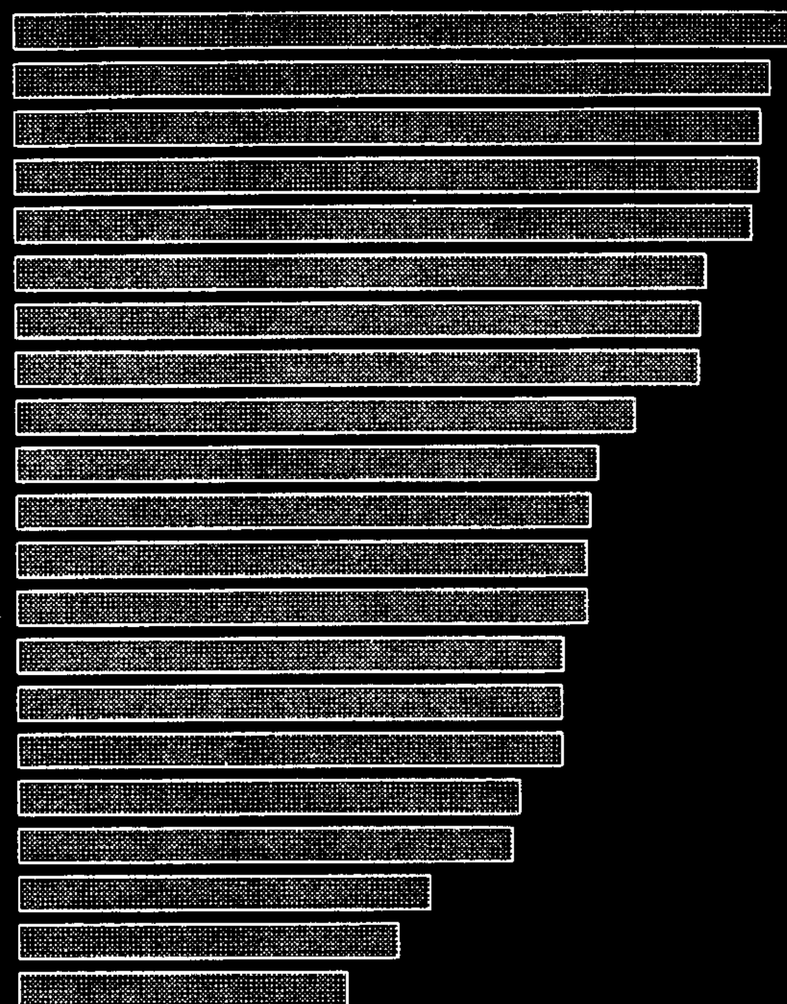
Figure 3-4 shows the results of the analysis of NCAW consolidation alternatives' overall performance on the criteria. Performance on values is considered from each of three value perspectives. An analysis of the cost-benefit trade-offs, which reveal about six alternatives that are the leading contenders, is presented. Most of the other alternatives provide less value at more cost. A detailed analysis showing which specific criteria are driving the overall performance of the alternatives, and identifying the trade-offs, is presented.

3.6.3.1 Overall Performance on Decision Criteria. Figure 3-4 shows the alternative's overall numerical value and a bar graph illustrating the score. Alternative 7b scored higher than all others by about 2.7% of the highest score. Alternatives 0b, N1b, N4, and 7a scored closely in a group, and Alternatives N1a, N3, and 2 and were the third group.

The overall consolidation benefit scores were determined by taking the raw scores on each of the criteria and transforming them into a value from 0 to 1 using the value functions for the criteria, and then taking a weighted sum of these values where the weights used were the group weights as described in this report. The resulting scores have a potential range from 0 to 1, where 1 would indicate the highest possible score on all criteria and 0 would result from the lowest score on all criteria. As can be seen in Figure 3-4, the scores ranged from 0.31 to 0.73.

Figure 3-4. Overall Performance on Decision Criteria.

Alternative	Value
7b	0.733
0b	0.713
N1b	0.704
N4	0.703
7a	0.695
N1a	0.651
N3	0.645
2	0.644
N5a	0.584
4	0.548
1b	0.542
3	0.538
0a	0.538
1a	0.516
N5c	0.514
N5b	0.513
N6	0.474
5a	0.466
5c	0.389
5b	0.359
6	0.312



Preference Set = Group.Set

In every case, it was found that the sister alternatives that did not contain special caustic leaching and washing unit operations recoded a better value than those that did (value of N1a>1a, N1b>1b, N3>3...).

These overall values do not consider cost. They are a weighted sum of all criteria with the exception of cost. Cost-benefit trade-offs will be considered in the following subsections.

3.6.3.2 Overall Performance from Different Value Perspectives. The overall values shown in Figure 3-4 depend, in part, on the weights used to trade off the values. Three sets of weights were developed as described in this report: one majority consensus and two outliers. A comparison of the results using these three different value perspectives is shown in Figure 3-5. As can be seen in the figure, an analysis from all three value perspectives results in Alternative 7b or (0b followed by 7b in outlier 1) having the highest score and Alternative 6 having the lowest score. Also, Alternatives 7b, 0b, N1b, 7a, and N4 are the top five scores from all three perspectives. In general, the overall pattern of rankings, as seen in Figure 3-5, is similar. Consequently, subsequent analysis is carried out using the group weights.

3.6.3.3 Cost-Benefit Analysis. The costs of the NCAW consolidation alternatives are given numerically and shown graphically in Figure 3-6. Costs were estimated for capital and expense. Costs range from $23 million to $132 million. As can be seen in Figure 3-6, Alternative 6 has the greatest total cost and Alternative 0a the least. For many of the alternatives, capital cost is small. Year-to-year expense cost profiles are given for each alternative in Appendix A. A detailed analysis of the expense and cost elements for each alternative is given in Appendix A.

To more clearly depict the relationship between costs and benefits, the alternatives are plotted in a two-dimensional cost-versus-benefit space shown in Figure 3-7: the horizonal axis is the total cost and the vertical axis is the overall value. The best alternatives are in the upper left corner of the figure; these alternatives provide the most value for the least cost. The alternatives in the upper left corner dominate those that are below and to the right, which provide less value at more cost.

Figure 3-7 shows a somewhat negative correlation between cost and value. The higher-valued alternatives tend to cost less. This is a somewhat unusual situation in that there is usually positive correlation between cost and value. The reason for the negative correlation may be that the more costly alternatives are more involved in terms of the number of transfers, etc., and thus incur more risks than the simpler, less costly alternatives. Safety and risk were heavily weighted in the analysis.

Alternative 7b clearly has the most value and is close to having the least cost. A consideration of overall value and cost suggests the following alternatives as the leading contenders: 7b, 0b, 7a, 2, and N3. Alternative 7b provides more value than Alternative N3 for a slight increase in cost. This is because Alternative N3 uses the 242-A evaporator to concentrate the aging waste supernate in AZ-102.

Figure 3-5. Comparison of Team Values with Outlier Values.

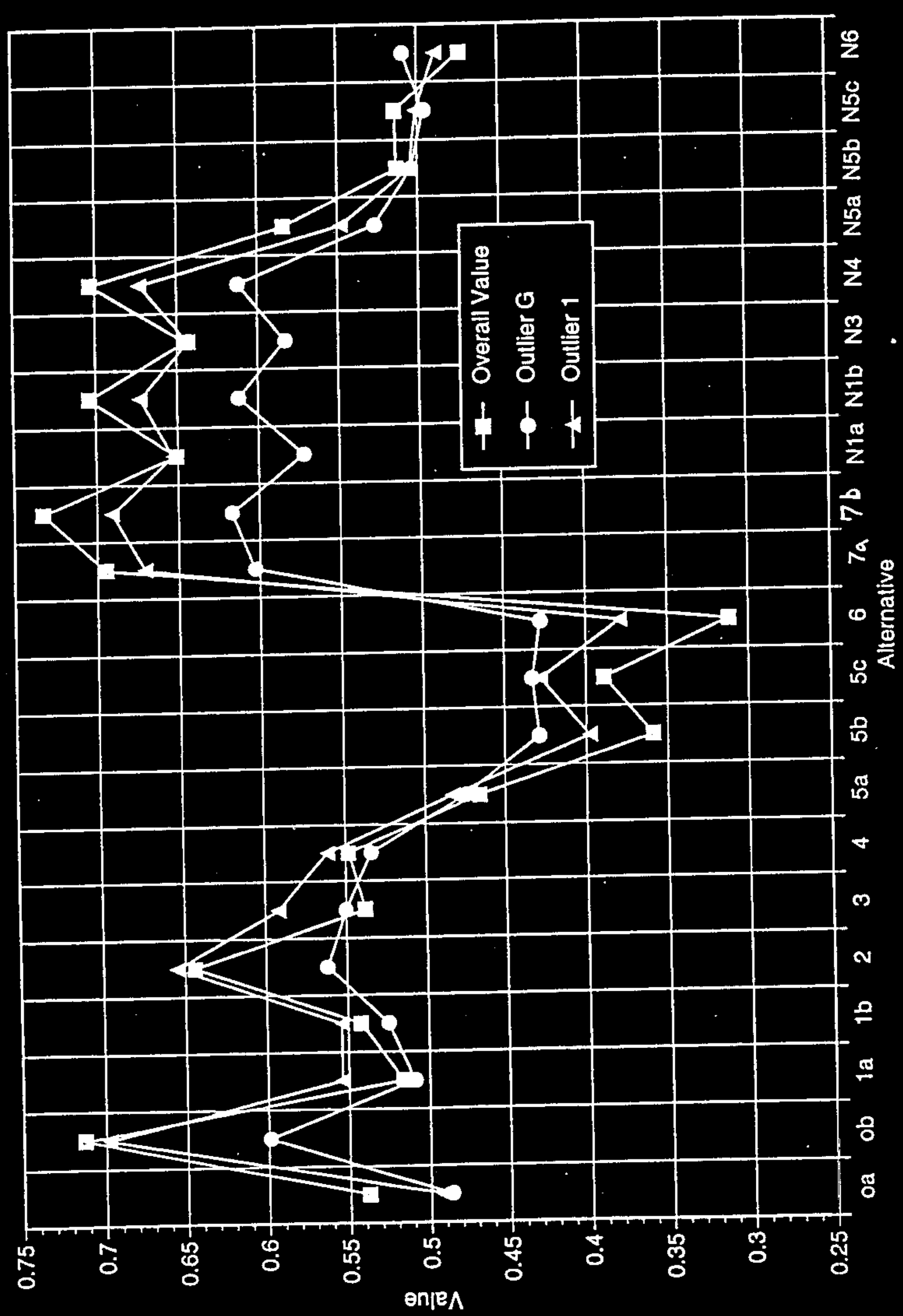
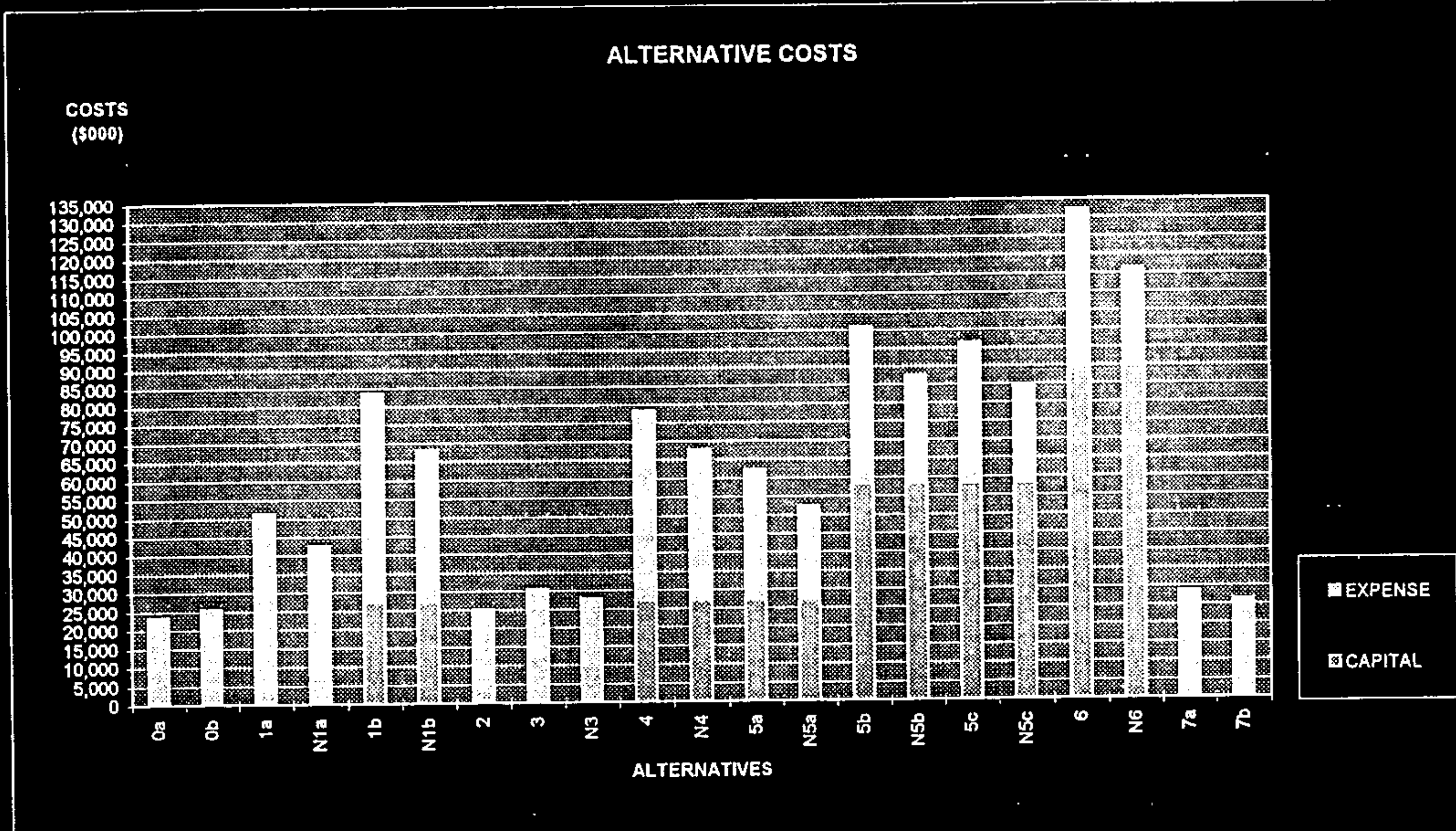
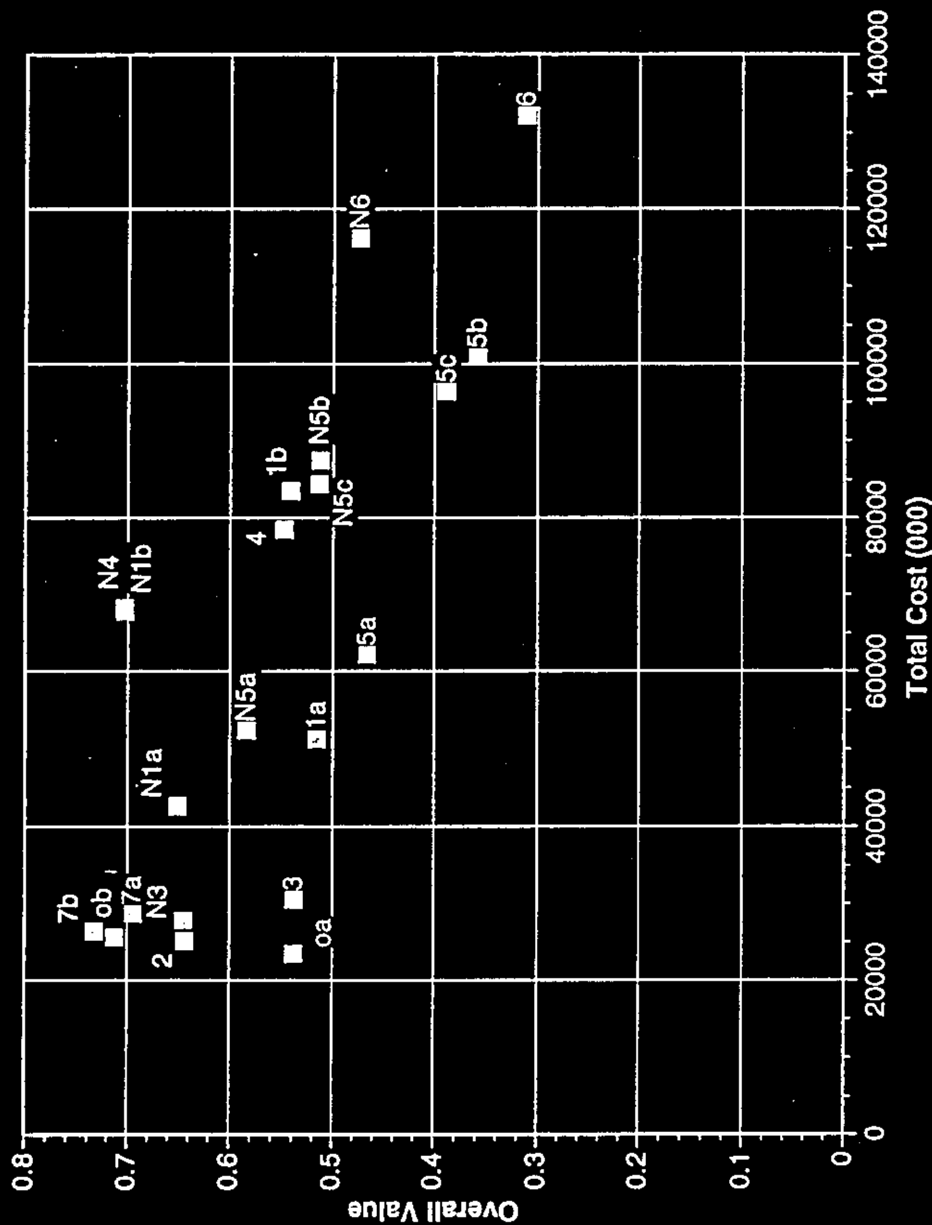


Figure 3-6. Costs for Neutralized Current Acid Waste Consolidation Alternatives.



ALTERNATIVES	0a	0b	1a	N1a	1b	N1b	2	3	N3	4	N4	5a	N5a	5b	N5b	5c	N5c	6	N6	7a	7b
CAPITAL	400	400	800	800	26,920	26,920	800	800	800	26,920	26,920	26,920	26,920	58,210	58,210	58,210	58,210	89,500	89,500	800	800
EXPENSE	23,010	25,204	50,488	41,788	56,595	41,197	24,319	29,718	26,957	51,473	40,797	35,236	25,455	42,709	29,209	38,182	26,182	42,640	26,800	27,957	25,557
TOTAL ($000)	23,410	25,604	51,288	42,588	83,515	68,117	25,119	30,518	27,757	78,393	67,717	62,156	52,375	100,919	87,419	96,392	84,392	132,140	116,300	28,757	26,357

Figure 3-7. Overall Value Versus Total Costs.



If Alternative N3 were to be rerun using in-tank evaporation, it would score about 0.68 and cost less than Alternative 7b due to the reduced cost of running the 242-A evaporator. More detailed comparisons and analyses are presented in following subsections.

3.6.3.4 Performance and Safety/Risk Comparisons. Some of the primary purposes of the NCAW consolidation effort are to make available both tank space and HLW feed. To accomplish this, there are two categories of costs: (1) the dollar cost that must be paid, and (2) the cost in terms of personnel safety and technical and operating risks. The calculation of overall value is based on >50% of the weight being placed on safety and risk. It is instructive to look more closely at the trade-offs between performance and safety/risk.

3.6.3.4.1 Safety and Risk Versus Available Tank Space. For a better understanding of the relationship between safety/risk and tank space availability, alternatives are plotted in a two-dimensional space of safety/risk versus tank space as shown in Figure 3-8. The best alternatives are in the upper right corner of the figure; these alternatives maximize safety and minimize risk while making the most tank space available. Alternative 0b is the dominant alternative from this perspective. Other alternatives to be considered, in order, are 7b, 2, N3, 7a, N1a, N1b, and N4. The other alternatives score poorly on either the amount of tank space made available or on safety and risk.

3.6.3.4.2 Safety and Risk Versus Available HLW Feed. Safety and risk versus HLW feed made available were considered next. A comparison of alternatives on these two dimensions are shown in Figure 3-9. The best alternatives from this perspective are in the upper right corner of the figure. Alternatives N1b, N4, 4, and 1b provide more HLW feed than the Planning Case (Alternative 5a) and score moderately well on safety/risk. Alternatives 7b, 7a, N1a, and 1a scored equal to the Planning Case (Alternative 5a) on HLW feed, and Alternative 7b scored significantly better in safety and risk than did others near the upper right corner of the chart. Alternatives 0a and 0b scored high on safety and risk; however, they make only a minimum amount of HLW feed available. Alternative 0b is especially conspicuous as it was the first or second leading contender from the perspective of overall value, cost, and tank space. However, it makes only the minimum amount of tank feed available.

3.6.4 Summary of Initial Analysis

A discussion of the initial analysis is summarized in Table 3-5, which shows the leading alternatives from the perspective of overall value without consideration of cost, cost versus overall value, safety/risk versus tank space, and safety/risk versus HLW feed available. Alternatives with the most value are shown first, the ones with the least value (among the top six to eight alternatives) are shown last. Natural break points were taken to determine the number of alternatives chosen from each chart/table.

Figure 3-8. Tank Space Available Versus Safety/Risk.

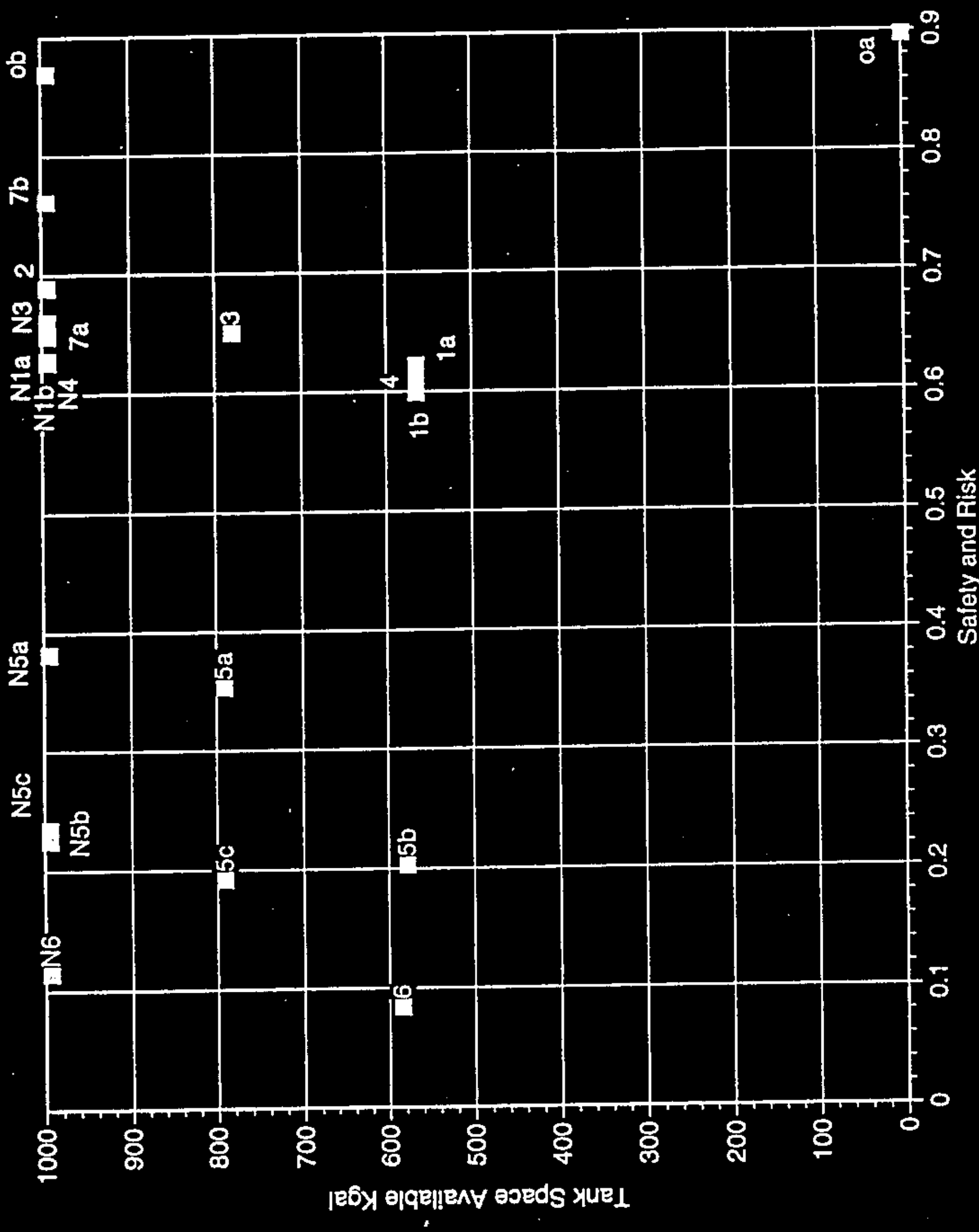
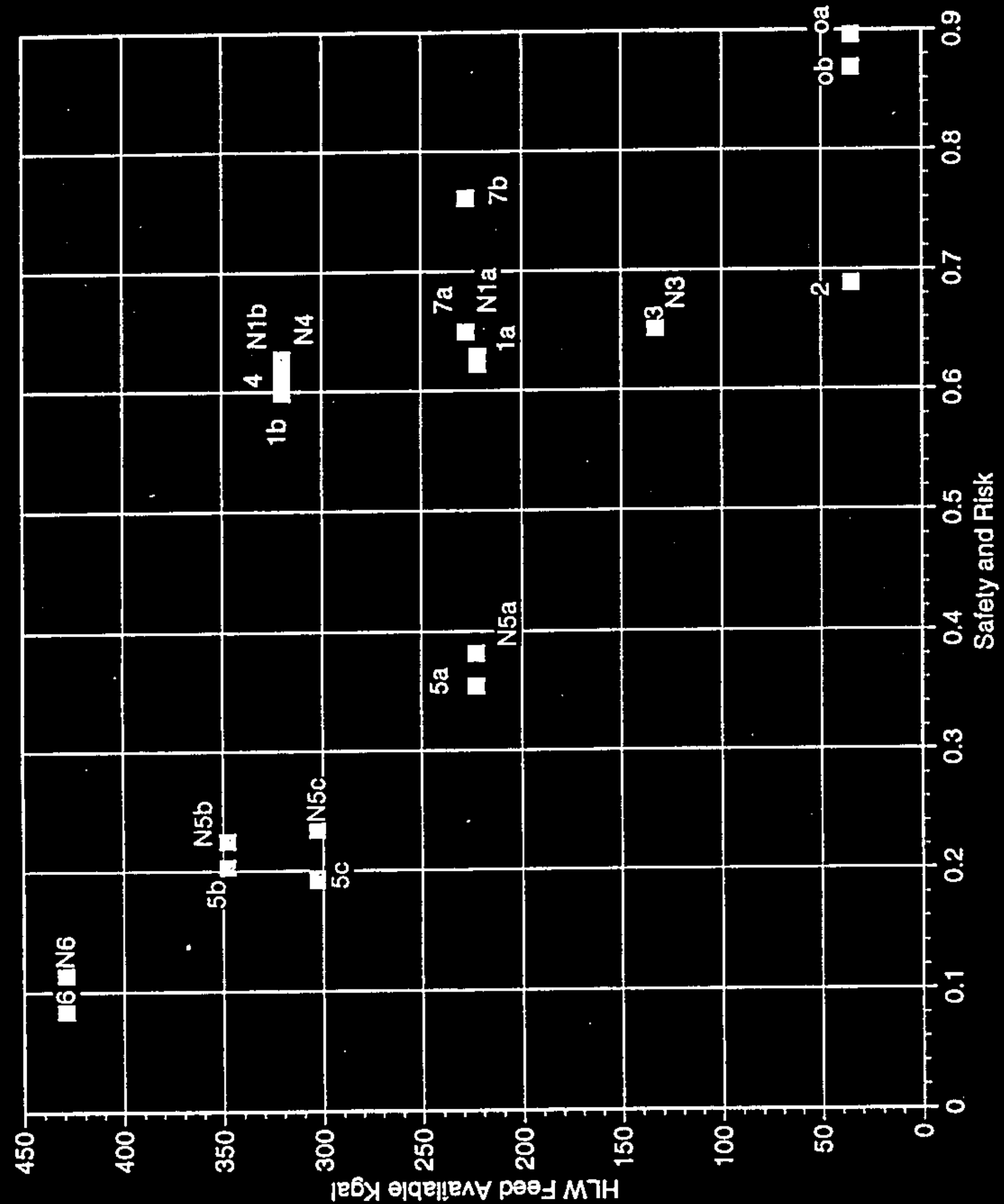


Figure 3-9. High-Level Waste Feed Available Versus Safety/Risk.



The boxes in Table 3-5 that show multiple entries are ones that have virtually no difference between alternatives. Alternatives that are common winners from all five of these considerations are 7b and 7a.

3.6.5 Sensitivity Analysis

A sensitivity analysis was conducted to explore the strength of alternative rankings to changes in the weight assigned to major value categories. This is separate from the sensitivity analysis to different value perspectives as shown in Figure 3-4. The sensitivity analysis to weights placed on the major categories of public values is shown in Figures 3-10, 3-11, and 3-12. Each figure shows the effect of varying the weight placed on one value from 0% to 100% while keeping the weights on the other values at their relative proportions.

Table 3-5. Consolidation Results.

Ranking	Overall value only	Cost vs. value	Safety and risk vs. HLW feed	Tank space vs. safety and risk
1	7b	7b	0b	7b
2	0b	0b	7b	N1b, N4, 4, 1b
3	N1b, N4,	7a	2	7a
4	7a	N2, N3	N3, 7a	N1a, 1a
5	N1a, N3, 2	N1a	N1a, N1b, N4	--

HLW = High-level waste

Figure 3-10 is composed of graphs in the general heading of Safety and Risk. The graphs are arranged from most general at the top to more specific at the bottom. They illustrate what happens when the weight on the individual or general headings is changed.

Figure 3-11 is graphs of weight on the Feed Preparation Process. Again, the graphs are arranged from general at the top of the page to more specific at the bottom of the page.

Figure 3-12 shows graphs of weights on Available Tank Space, Optimize Schedule, and HLW Feed Available. The graph of HLW Feed Available is used to illustrate what happens when the weight of the Decision Criteria is changed. The horizontal axis is the weight placed on HLW feed on a 0-to-100% scale. The vertical axis is the value on a 0-to-1 scale. The plotted lines show how the value for each of the technical alternatives changes as a function of the weight placed on HLW feed availability.

Figure 3-10. Sensitivity Study Safety and Risk.

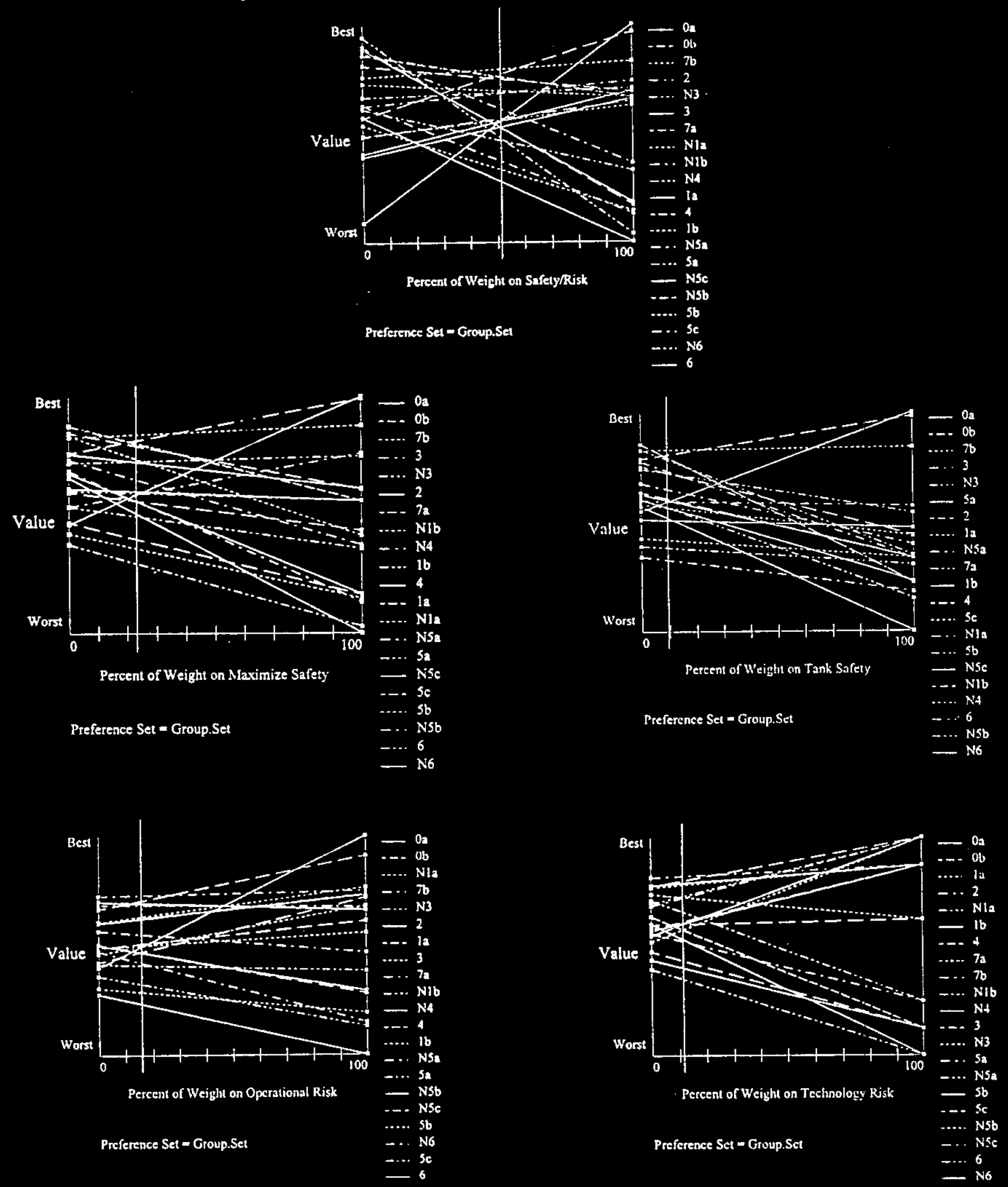


Figure 3-11. Sensitivity Study Feed Preparation Process.

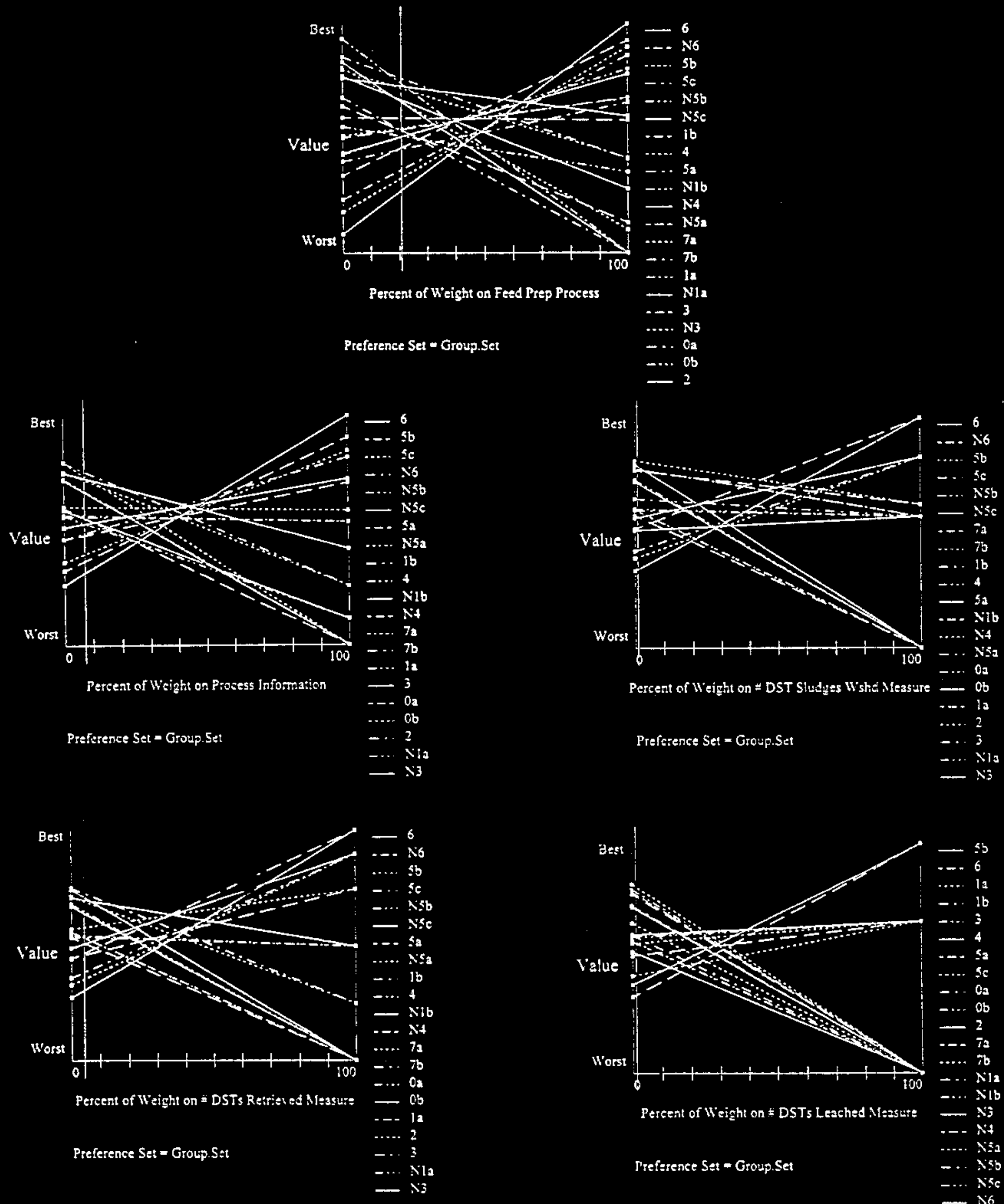
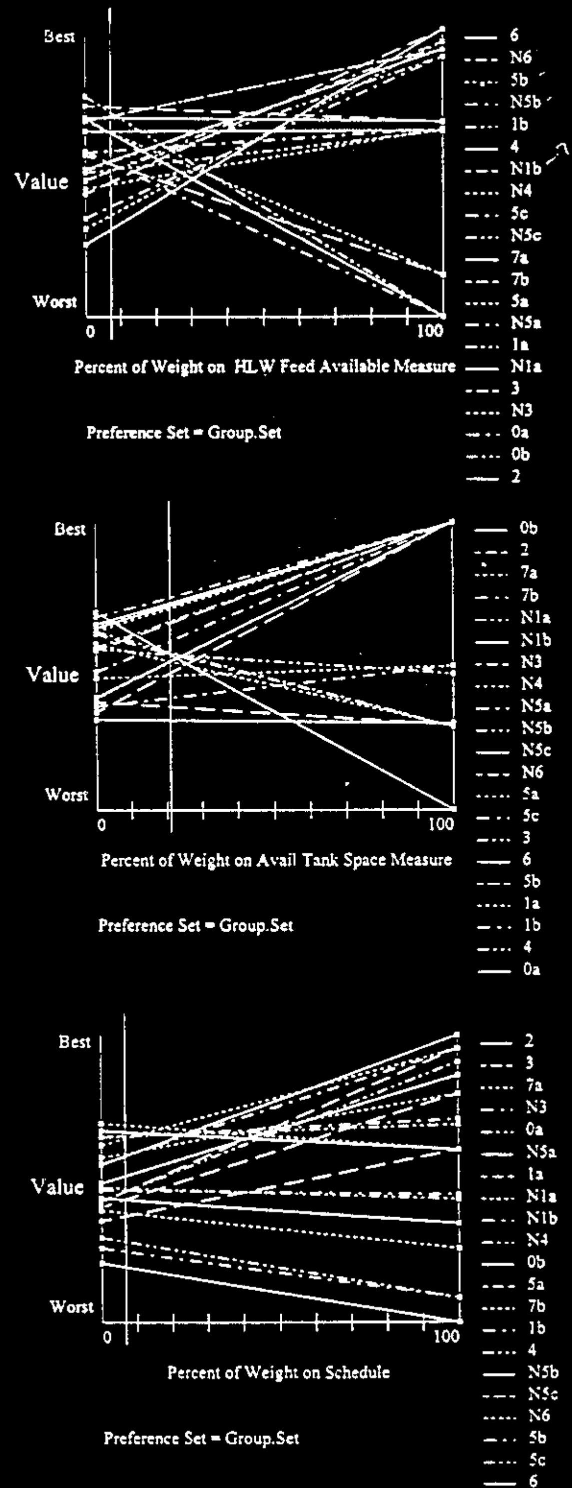


Figure 3-12. Sensitivity Study High-Level Waste Feed, Tank Space, Schedule.



Note that the order in which the lines appear in the legend is the same order in which they fall at 100% weight on the right.

The other vertical solid line through 8% in Figure 3-12, HLW Feed Available, represents the group's weighting of the HLW feed criteria. The 8% weighting line currently indicates that Alternative 7b, the 75-hp Mixer Pump in AY-102, without leaching, is the largest value. Mentally changing the weighing by moving the vertical line through 8% to the left or right will change the outcome of the analysis. It is evident that placing less weight on HLW feed available would change the order of the first alternative when the weighting is reduced to about 6%; then Alternative 0b, the Minimal Case alternative, would have the higher value. If additional weight is placed on HLW feed by moving the line to the right, then at about 18% the leading alternative would change to Alternative N1b, AZ-101 Pipeline Reroute and Consolidate, without leaching. If the line is continued to move to the right, at about 80% the largest value becomes N6, the Ultimate Consolidation alternative without leaching.

The other graphs in Figures 3-10 and 3-11 are included to allow the reader to determine the effects of modifying the team weighing of the criteria. The other major headings of Safety and Risk, Maximize Feed Preparation Process, Maximize Available Tank Space, and Optimize Schedule are all illustrated. In addition, the subtopics Maximize Safety and Minimize Operational and Technical Risk are shown. In general, modification of the weighing of any of the headings by 50% or less produces little if any change in the leading six or seven alternatives, which include: 7b, 0b, 7a, N3, N4, N1b, N1a, and sometimes 2. Usually, it does not change the top alternative, 7b, the 75-hp Mixer Pump in AY-102.

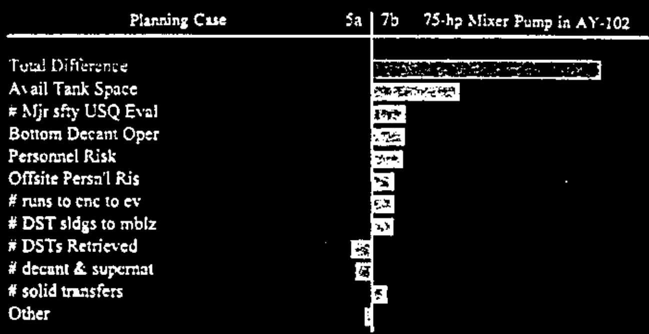
3.6.6 Comparison of Alternative Pairs

Performance profiles show the relative strengths and weaknesses of each technical alternative. Figure 3-13 indicates some leading alternatives compared to each other and to the Planning Case. These performance profiles show the overall values for the alternatives above the figure. A bar graph is used to quantify the relative amount of value associated with the decision criteria. The decision criteria are found on the left-hand side of the figure. The graph shows the only differences between the two alternatives, not where they rank equally.

The first profile in Figure 3-13 compares the leading alternative (7b), 75-hp Mixer Pump in AY-102, with the Planning Case, Alternative 5a. The 75-hp Mixer Pump in AY-102 alternative leads in every category except in number of DSTs retrieved, and in number of decants and supernate transfers. This indicates that the Planning Case alternative performed worse or equal to the 75-hp Mixer Pump in AY-102 alternative in every decision category except those mentioned. Several other figures are shown for other top alternatives. They indicate that the 75-hp Mixer Pump in AY-102 (Alternative 7b) has no major deficiencies compared with other leading alternatives and to the Planning Case alternative.

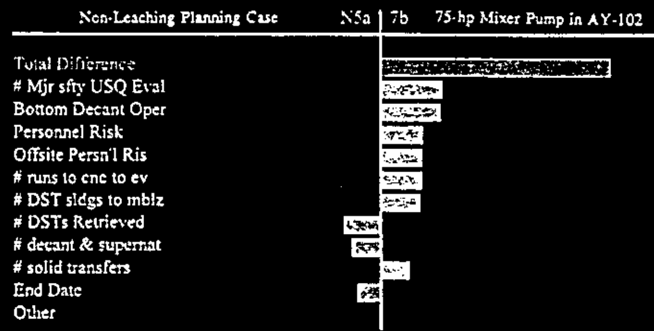
Figure 3-13. Performance Profiles.

Overall Value for		
	7b (Alt1)	0.733
	5a (Alt2)	0.466
	Difference	0.267



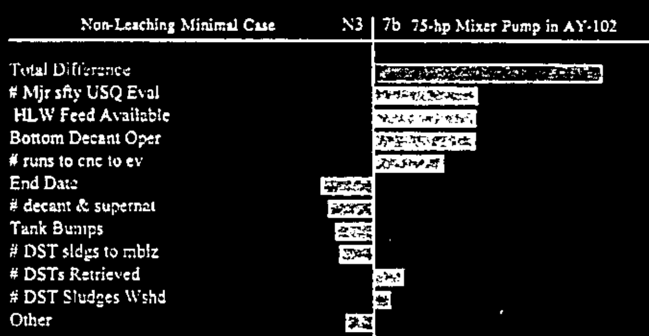
Preference Set = Group.Set

Overall Value for		
	7b (Alt1)	0.733
	N5a (Alt2)	0.584
	Difference	0.149



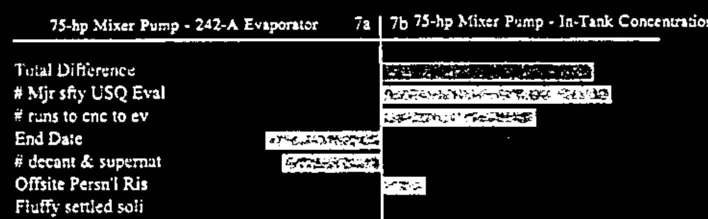
Preference Set = Group.Set

Overall Value for		
	7b (Alt1)	0.733
	N3 (Alt2)	0.645
	Difference	0.088



Preference Set = Group.Set

Overall Value for		
	7b (Alt1)	0.733
	7a (Alt2)	0.695
	Difference	0.037



Preference Set = Group.Set

3.7 EVALUATION OF ISSUES AND RISK FOR PREFERRED ALTERNATIVE

The leading alternatives are grouped together and need to be analyzed for potential risk. They include Alternatives 7b, 0b, 7a, 2, and N3, with Alternatives N4 and N1b trailing behind due to cost.

3.7.1 Risk Analyses: Alternative 0b, Minimal Effort, and Alternative 2, Evaporator Concentrate

Evaluation of the second leading alternative, 0b, shows that it provides only a small amount of feed to HLW vitrification, about 16% of that called for in the Planning Case, Alternative 5a (Bacon 1995). This lack of HLW feed would require serious restructuring of the HLW feed pilot plant phase 1 efforts, and would remove only a small volume of HLW feed (132,000 L [35,000 gal] in AZ-101) from the DST system. This alternative might be made workable from the privatization viewpoint, but it would significantly change existing plans.

The value of Alternative 2, Evaporator Concentrate, is 0.07 less than that of Alternative 0b. Alternative 2 is the same as Alternative 0b except that the AZ-102 supernate is sent to the 242-A evaporator for concentration instead of performing in-tank concentration. It also does not move the recovered C-106 sludge from AY-102. This alternative suffers from the same problem as Alternative 0b in that it only delivers the sludge already in AZ-101 to HLW disposal.

3.7.2 Risk Analyses: Alternatives N1b, Reroute and Consolidate to AZ-101, and N4, Reroute and Consolidate to AZ-102

These alternatives assume that Project W-320, Tank 241-C-106 Waste Retrieval, is complete but that final pumps and equipment have not been installed in AY-102. In Alternatives N1b and N4, another expense project would reroute the new pipelines (currently going from C-106 to AY-102) to AZ-101 or AZ-102, respectively. The new project also moves pumps and other equipment. For either alternative, a poor expense profile is projected in FY 1996. Figures A-2 and A-3 (see Appendix A) indicate that an additional $7 million expense expenditure in FY 1996 is necessary to reroute the pipelines. These two alternatives are significantly more expensive in total cost than the others with the same value (about $70 million compared to $30 million).

3.7.3 Risk Analysis: Alternative 7b, 75-hp Mixer Pump in AY-102, with In-Tank Evaporation

Alternative 7b, the 75-hp Mixer Pump in AY-102, with in-tank evaporation, appears to be the preferred alternative. The risks associated with this alternative are listed below.

The 75-hp mixer pump in AY-102 is a time-intensive alternative. It is important to move quickly to specify, obtain, and install another mixer pump for AY-102 as soon as possible. The DOE Secretarial Initiative date of October 1996 for startup of C-106 retrieval was estimated to be met in this analysis, based on equipment being available to remove and store the inoperable 75-hp mixer pump in AY-102.

The tank bump (and criticality) USQs will need to be resolved before slurry is moved into AZ-101. This slurry transfer to AZ-101 should begin by about October 1996. The major risks are outlined in the bulleted items as follows:

- Revising existing SARs to allow mixer pumps to become tank bump mitigating devices
- Obtaining SAR revisions to allow other mitigating features, such as increased annulus airflow in AZ-101.

A possible drawback to Alternative 7b, and most other alternatives that consolidate sludge in AZ-101, is that it may be necessary to revise a portion of the mixer system in AZ-101 to obtain a safety-class system. This would ensure continued operation in case of single point failure. An example of such a system is the safety-class control system installed for the SY-101 mixer pump. The cost of annulus or control modifications was not included in any of the cost estimates. The major USQ analysis for the SAR revision was included. It is probable that the technical safety analysis will show that equipment upgrades are not required if ultra-conservative assumptions can be reduced.

One of the safety advantages of having a mixer pump in AY-102 is that the controlled addition of C-106 sludge from AY-102 to AZ-101 is likely to detect (by temperature measurement), and allow mitigation (mixing) of, any tank bump issues/situations before they become serious.

- Allow in-tank concentration to be used to concentrate to 12 Ci cesium-137/gal.

This is the preferred concentration method for all alternatives. The alternative to in-tank evaporation of AZ-102 supernate is to use the 242-A evaporator to concentrate the AZ-102 supernate (Alternative 7a). Alternative 7a is actually a subset of Alternative 7b and differs only in how evaporation is conducted.

- Possible interference with the Project W-320 retrieval of C-106.

A flowsheet analysis may assist in reducing and quantifying this relatively low risk.

Cost and schedule estimates are contained in Appendixes A and B respectively. The schedule for Alternative 7b shows that initial supernate and sludge consolidation is complete in FY 2002, and the initial 192 Kgal of sludge consolidation in AZ-101 is complete by FY 1998. This timing should be adequate to meet projected HLW disposal needs. Final sludge consolidation (final cleanout of C-106) is not complete until FY 2003. Final sludge consolidation in FY 2003 has the capability to add about 36 Kgal of sludge to AZ-101 and bring the total of HLW sludge in AZ-101 to 228 Kgal. The total of 228 Kgal HLW feed is essentially the same as the Planning Case (Alternative 5a) and should be sufficient for Phase I of HLW vitrification.

In-tank evaporation is mainly a timing issue. It will take about 5 to 6 years to in-tank evaporate AZ-102 supernate. Alternative 7b is less sensitive to this timing issue than the more complicated alternatives because it does not require new large mixer pumps and their corresponding project priority concerns, design, and procurement cycles. In-tank evaporation appears to be feasible and ends in about FY 2002, well within the FY 2005 end date needed by waste volume projections.

3.7.4 Risk Analysis Alternative N3, Bottom Sludge Transfer

The other leading alternative, Bottom Sludge Transfer to AZ-101 (N3), scores a little lower on the value system and is really a default alternative to Alternatives 7b and 7a. Alternative N3 could be performed if for some reason the mixer pump in AY-102 became inoperable. Sludge could be transferred to AZ-101 using the bottom sludge transfer process.

The bottom sludge transfer process is highly dependent on timing, operation, and design of the C-106 retrieval system. For example, loss of the transfer pump in AY-102 at a critical time could allow the C-106 sludge to settle before the transfer pump could be replaced, causing significant reduction of the amount of C-106 sludge transferred to AZ-101. Assuming the bottom sludge transfer from AY-102 works as anticipated, Alternative N3 would provide from 105 to 135 Kgal of sludge to HLW disposal. This is about 60% of the sludge for feed to HLW vitrification obtained in the Planning Case (Alternative 5a). The schedule is about the same for Alternative N3 as it is for Alternative 7a.

Alternative N3 can be improved in the same way as was Alternative 7a, by changing to in-tank concentration instead of 242-A evaporator concentration. This would improve its overall value about 0.04 and make it the second best alternative overall.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the above decision analysis process, it is concluded that Alternative 7b, 75-hp Mixer Pump Replacement in AY-102 (using in-tank evaporation of AZ-102 supernate), is the preferred alternative. It provides adequate HLW feed to proposed disposal pilot plants in an acceptable time frame. It provides tank space. Risks are manageable. Alternatives to this base case are numerous.

Installing a 75-hp Mixer Pump in AY-102 and replacing the existing inoperable one gives operations increased control of the sludge transport process. The transport of C-106 solids to AZ-101 from AY-102 becomes much more effective than relying on other mixing or mass transfer equipment (ALCs or bottom sludge transfers). By providing a mixer in AY-102, this alternative provides an additional control and mass transfer device to process sludge and manage potential hot spots in tank AY-102.

The next best alternative (fallback) is the modified Alternative N3, Bottom Sludge Tranfer to AZ-101 and in-tank evaporation of AZ-102 supernate. Alternative N3 will transfer as much C-106 sludge from AY-102 to AZ-101 as possible, by using the bottom transfer system as the sludge settles. This alternative is a natural fallback if the mixer in AY-102 would become inoperable for any reason.

The following recommendations are made.

1. Modify the existing 75-hp mixer pump design in AY-102 and obtain the pump for the application. Any other burial equipment required to remove and dispose of the old pump should be designed and obtained. Some or all of this disposal equipment is available onsite. A pump for this application is also probably onsite. The pump will require redesign and modification. Depending on the requirement of HLW vitrification to have feed equal to that of Alternative N3, a back-up pump should be obtained to permit mixing in AY-102 if the new pump should become inoperable.

2. Initiate USQ evaluations for tank bump avoidance scenarios in AZ-101. At least two alternatives are available. One uses the mixer pumps in AZ-101 as mitigation devices. The other alternative uses increased annulus flow in AZ-101 as a tank bump mitigation device. Initially, about 75% of the heat load and sludge volume from C-106 could be used as a design basis.

3. Modify the design of Project W-320 slurry distributor for AY-102. The slurry distributor needs to be able to preferentially place solids in the immediate vicinity of the AY-102 transfer pump. The Project W-320 slurry distributor is ready for installation using the original design.

4. Sample AZ-101 and AZ-102 supernate and perform a boildown in the laboratory to ensure that precipitation will not occur before achievement of 6.5*M* to 7*M* sodium concentration. Also, evaluate the potential need for a USQ for modifying the 5*M* sodium OSD for aging waste supernate. Start evaporation of the AZ-102 aging waste supernate as soon as possible after confirming that precipitation will be limited.

5. Revise criticality prevention specifications to allow consolidation of waste to AZ-101.

6. Revise/modify tank heat-up rates of <1.6 °C/day (<3 °F/day) as given in the IOSR. Mixer pumps need to be able to be run long enough to mix and transport waste, and to release/move hot spots in the sludge, especially in tank AZ-101.

7. Planning for this base case should be implemented immediately. This should include flowsheet revisions and modifications in the planned recovery of C-106 sludge. These modifications may include a settle/decant process in tank AZ-101 instead of tank AY-102.

5.0 REFERENCES

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7.0 GLOSSARY

7.1 ABBREVIATIONS AND ACRONYMS

ALC	air-lift circulator
AWT	aging waste tank
DOE	U.S. Department of Energy
DSSF	double-shell slurry feed
DST	double-shell tank
F&R	functions and requirements
FY	fiscal year
HLW	high-level waste
IOSR	Interim Operational Safety Requirements
LLW	low-level waste
NCAW	neutralized current acid waste
OSD	operating specification documentation
OSR	operating safety requirements
PUREX	plutonium uranium reduction and extraction
REDOX	reduction and oxidation
SAR	safety analysis report
SST	single-shell tank
TCR	Tank Characterization Report
TOC	total organic carbon
TRU	transuranic
TWRS	Tank Waste Remediation System
USQ	unresolved safety question

7.2 DEFINITIONS

Aging Waste. High-level, first-cycle solvent extraction waste from the Plutonium-Uranium Extraction Plant, following evaporative concentration, denitration, and neutralization. Also called neutralized current acid waste.

Bottom decant. A transfer of solids in a slurry using only the deep well turbine transfer pump in AY-102. A slurry may be released in the tank above the pump to assist in the transfer. Transfers of solids occur without mobilization of the sludge by other means, such as a mixer pump.

Caustic Leaching. Use of caustic solution to dissolve sludge components. Components targeted for separation by caustic washing include aluminum, chromium, and phosphorus. This is one part of the enhanced sludge-washing process.

Decant. To pour or drain off a liquid without disturbing the sediment.

Double-Shell Slurry Feed (DSSF). Waste concentrated just before reaching the sodium aluminate saturation boundary (usually of 6.5 to 7 molar hydroxide) in the evaporator without exceeding receiver tank composition limits. The DSSF is not as concentrated as double-shell slurry.

Evaporation. To draw moisture from, leaving a concentrated solution or solids portion.

In-Tank Processing. Performance of processing within existing Hanford Site double-shell tanks.

Leaching. The process of removing a solute from a solid by using a liquid solvent.

Low-Level Waste. Any gaseous, liquid, or solid waste that contains radioactivity and is not classified as high-level waste, transuranic waste, or spent nuclear fuel or 11e(2) byproduct material as defined by DOE Order 5820.2A, *Radioactive Waste Management* (DOE 1988).

Mixing Sludge. An operation that combines or blends the waste before slurry transfer.

Sludge. Water-insoluble solids that settle and accumulate at the bottom of a storage tank at the Hanford Site. Solids are formed by precipitation or self-concentration, and are metal hydroxides and oxides precipitated during sodium hydroxide additions to waste.

Sludge Washing. Operation that uses weak caustic to dissolve the readily soluble solids (sodium salts) and dilute the concentration of dissolved salts in the interstitial liquid. This operation minimizes the quantity of salts going to the high-level waste (HLW) vitrification processes, thus minimizing the volume of HLW produced. Weak caustic is used to inhibit corrosion during the washing process. (Also known as water washing.)

Slurry. A combination of suspended solids in a liquid, usually requires a moving liquid to keep the solids suspended.

Slurry Transfer. Moving of solid waste slurry with liquid from one point to another.

Solids Settling. An operation in which the solids settle from a slurry after being transferred into a tank.

Tank Bump. A tank pressurization caused by rapid steam generation.

Total Organic Carbon. A measure value of the amount of carbon from organic compounds in a sample.

Transfers. Removal of supernate or solids slurry from one tank to another.

Transuranic. Period 7 elements having an atomic number of 93 or greater, i.e., elements that are heavier than uranium in the periodic table.

Transuranic Waste. Without regard to source or form, waste that is contaminated with alpha-emitting transuranic radionuclides with half-lives >20 years and concentration >100 nCi/g at the time of assay.

Vitrification. A method of immobilizing radioactive waste for eventual disposal in a geologic repository. Involves adding waste and chemical components to a heated vessel and melting it into a glass.

Wash. To cleanse of particulate constituents through the use of a liquid, usually water.

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APPENDIX A

COST ESTIMATES

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APPENDIX A

COST ESTIMATES

The following cost estimates are based on the operating scenarios outlined in the main text in Section 3.5.2.2.

NEUTRALIZED CURRENT ACID WASTE CONSOLIDATION COST ESTIMATING

Waste Transfers

Routing setup: Costs related to transferring waste were obtained from tank farm operations representatives D. Sparks and W. F. Zuroff. The first phase of establishing a transfer route would be to install the required jumpers. Because the major portion of the transfers to be made consists of moving solids and concentrated waste, it was assumed that new, rigid jumpers would be fabricated and installed in the designated process pits.

The field resources required to support process pit entries for jumper and pump installations are assumed to include the following tasks: (1) 1 day for setup, (2) 1 day for installation, and (3) 1 day for area cleanup. The staff hours/personnel support are as follows: riggers/60 staff hours, fitters/8 staff hours, electricians/8 staff hours, health physics technicians/ 48 staff hours, operators/96 staff hours, and Quality Control/8 staff hours. For estimating purposes, it was assumed that the average liquidation rate was $50/h, including program adders. Therefore, the average cost for a pit entry equates to $11,400.

The assumptions do not assume that a confinement tent will be required for each pit entry.

For the duration of the transfer operation, it is assumed that two tank farm operations personnel would monitor the activity 24 hours a day.

Waste sample: For each transfer, it was assumed that a waste sample will be required. The unit cost for the sample is $70,000. This cost covers field support for removing the sample from the tank, transporting the sample to the laboratory, and conducting the laboratory analysis.

Transfer rate: It was assumed that the average transfer rate is 100 gpm*. All transfers are assumed to be operated 24 hours a day, and therefore range in duration from 4 to 14 days.

*See the Conversion Table in front matter of document.

EVAPORATION (242-A EVAPORATOR)

For concentration of supernate waste and decanted sludge-wash solutions, it is assumed that the cost is $5.54/gal of throughput. This value was obtained from T. W. Seifert of Tank Waste Remediation System Tank Farm Processing.

REROUTING OF PROJECT W-320 PIPELINES TO AZ-101 OR AZ-102

Capital cost estimates were prepared for rerouting Project W-320 waste transfer lines to waste tanks AZ-101 and AZ-102. The estimates were developed using the project cost estimate. It was assumed that all construction scope, with the exception of installing the AY-102 in-tank equipment, had been completed for Project W-320. It also was assumed that the transfer system had not been activated and therefore tieing into the transfer system would not be a hot tie-in activity; thus, no burnout would be incurred.

The ICF Kaiser Hanford Company estimates (N3093/Z372SAB2 and N3093/Z372SAA1), found at the end of Appendix A, cover the scope of rerouting the transfer lines. These estimates assumed that the waste transfer system would be tied into at a location west of the AZ Tank Farm and north of the AY Tank Farm.

PROJECT W-211/INITIAL WASTE RETRIEVAL SYSTEMS

Cost estimates for installation of initial retrieval systems in the AZ-102, AY-101, and/or the AY-102 tanks were obtained from Project W-211 documentation. The current planning case for Project W-211 assumed that retrieval systems for the aforementioned tanks would not be achieved until fiscal year (FY) 2006 or 2007, and in these cases, the systems depended on the installation of a mixer system in AN-103. This dependency is due to the sharing of the control system building, the transformer supply system, and the caustic supply system. To meet the schedule need dates for consolidation, it is necessary to accelerate the installation of the AZ-102 system to FY 2000; therefore, ICF Kaiser Hanford Company estimate Z2372SAG1 based on Project W-211 for AN-103 was used. It was then assumed that the systems to be provided for either AY-101 or AY-102 would be constructed next and therefore would be able to share common systems as planned by Project W-211.

Other assumptions are listed in the following individual cost estimate summaries.

UNRESOLVED SAFETY QUESTIONS (USQ)

Costs for the alternatives were estimated by discussions with personnel in the Safety Analysis group (K. O. Fein and W. G. Farley among others), and by discussions with G. T. MacLean for the technical analysis. The following estimates were made based on the following assumptions.

- The (proposed interim operating safety requirements [IOSR]) safety envelope of 102 cm (40 in.) of solids could be extended by analysis to significantly higher sludge levels, as long as the heat content of the sludge was within the 300,000 Btu/h heat limit.

- Both the 102-cm (40-in.) solids limit and the 300,000 Btu/h limit could be extended beyond existing (proposed IOSR) limits, especially if at least two mixer pumps were installed in the tank as mitigating features to prevent tank bumps.

- A major USQ evaluation requires at least one significant technical evaluation, including calculations, to resolve. It probably has a "yes" answer to one of the eight questions on the USQ form. This issue will be somewhat difficult to resolve and may not be resolvable as desired.

- A minor USQ evaluation is one that does not require a significant technical evaluation. It probably does not involve an answer of "yes" to any of the questions on the USQ form. This issue will be relatively easy to resolve.

- The rough order of magnitude (ROM) cost of a major USQ was estimated to be $300,000 and that of a minor USQ about $100,000. This was based on current chargeout rates.

- The ROM cost of a typical extensive sludge sample compositional and chemical analysis was estimated to be $200,000. This analysis includes a large sample for wash and leach, and slurry transfer testing. The cost estimate was derived from a discussion with Operations staff and G. T. MacLean.

See Tables A-1a, A-1b, and A-2 for numbers of minor and major USQs and their costs.

OPERATING PROCEDURE COST ESTIMATE (December 7, 1995)

Operating Procedures

Enabling assumptions used to develop cost estimates for the transfer procedures are as follows.

The transfer procedures are included in a Tank Farm plant operating procedure. In general, the procedure provides information such as purpose, scope, definition of terms used, assignment of responsibilities, safety issues related to the transfer, radiation and contamination control issues, quality assurance issues, general information about the transfer, limits and

Table A-1a. Maximize Tank Safety: Non-Tank Bump Safety Issues Requiring Unresolved Safety Questions.

Scenario	Tank heat-up rate <3 F/day ISOR	Airlift circulator operation OSR/OSD	Criticality <0.05 g Pu/ gal OSD	Criticality <200 g Pu/ transfer OSD	Criticality <50 kg Pu/ tank OSD	5M sodium rule OSD	90-day rule OSD	Hydroxide conc. OSD	Mixing NCAW with other wastes DQO	Total estimated cost ($K)
0a	Major	Minor	Minor	Minor	Major	--	--	Minor	Minor	1,100
0b	Major	Minor	Minor	Minor	Major	Minor	--	Minor	Minor	1,200
1a	Major	Minor	Minor	Minor	Major	Minor	Minor	Minor	Minor	1,300
1b	Major	Minor	Minor	Minor	Major	--	Minor	--	Minor	1,100
2	Major	Minor	Minor	Minor	Major	Minor	--	Minor	Minor	1,200
3	Major	Minor	Minor	Minor	Major	Minor	Minor	Minor	Minor	1,300
4	Major	Minor	Minor	Minor	Major	--	Minor	--	Minor	1,100
5a	Major	Minor	Minor	Minor	Major	--	Minor	--	Minor	1,100
5b	Major	Minor	Minor	Minor	Major	--	Minor	--	Minor	1,100
5c	Major	Minor	Minor	Minor	Major	--	Minor	--	Minor	1,100
6	Major	Minor	Minor	Minor	Major	--	Minor	--	Minor	1,100
7a	Major	Minor	Minor	Minor	Major	Minor	Minor	Minor	Minor	1,300
7b	Major	Minor	Minor	Minor	Major	Minor	Minor	Minor	Minor	1,300

Notes:
1. Assume that an issue only needs to be addressed once. The resolution then applies to all other aging waste tank operations.
2. Major safety issues are assumed to require three times the resources needed to resolve as minor issues.
3. Tank bump USQs are not included (addressed separately).

DQO = Data quality objective
IOSR = Interim operational safety requirements
NCAW = Neutralized current acid waste
OSD = Operating specification documentation
OSR = Operating safety requirement

SUMMARY COST ESTIMATE FOR USQ ANALYSIS

USQ Cost Evaluation

Table A-1b. Maximize Tank Safety: Non-Tank Bump Safety Issues Requiring Unresolved Safety Questions.

Alternative	Evaporator accident,* >6 Ci/gal	Shielding limit exceeded on transfer lines, > 6 Ci/gal	Shielding limit exceeded at 242-A,* >3 Ci/gal	Cost from Tables A-1a, and A-1 ($M)	Cost from this table ($M)	Total cost, Tables A-1a and A-1b ($M)
0a	--	--	--	1.1	0	1.1
0b	--	--	--	1.2	0	1.2
1a	Major	Minor (2)	Minor (2)	1.3	0.7	2
1b	Major	Minor (2)	Minor (2)	1.1	0.7	1.8
2	Major	Minor (2)	Minor (2)	1.2	0.7	1.9
3	Major	Minor (2)	Minor (2)	1.3	0.7	2
4	Major	Minor (2)	Minor (2)	1.1	0.7	1.8
5a	Major	Minor (2)	Minor (2)	1.1	0.7	1.8
5b	Major	Minor (2)	Minor (2)	1.1	0.7	1.8
5c	Major	Minor (2)	Minor (2)	1.1	0.7	1.8
6	Major	Minor (2)	Minor (2)	1.1	0.7	1.8
7a	Major	Minor	Minor	1.3	0.7	2.0
7b	Major	--	--	1.3	0.0	1.3

*Accident scenario derived from WHC-SD-WM-SAR-023, Rev. 2, 242-A Evaporator/Crystallizer Final Safety Analysis Report, H. Aguirre, Jr., Westinghouse Hanford Company, Richland, Washington, 1995 (see Table 4-11 and Chapter 9, and Section 6.7.2.2 for this shielding limit).

Table A-2. Tank Bump Unresolved Safety Questions and Miscellaneous.

Alternative	Sludge height IOSR, >101 cm (40 in.) (not including AY-102)	Sludge heat content IOSR, >306 KBtu/h	7M Na process test, OSD, $200K/test	Sludge sampling required, $200K/sample and test	Total cost this table ($M)	Total cost all USQs and process test and samples ($M)
0a	--	--	--	--	0	1.1
0b	--	--	2	--	0.4	2.3
1a	Major	--	1	--	0.5	2.5
1b	Major (2)	Major	0	--	0.7	2.5
2	--	--	2	--	0.4	2.3
3	Minor, >101 cm (40 in.) when fluffed	--	1	--	0.3	2.3
4	Major (2)	Major	0	--	0.9	2.7
5a	Major (3)	Major	0	--	1.2	3.0
5b	Major (4)	Major	0	--	1.5	3.3
5c	Major (4)	Major	0	1	1.7	3.5
6	Major (5)	Major (2)	0	1	2.1	3.9
7a	Major (1)	Major (1)	1	0	0.8	2.8
7b	Major (1)	Major (1)	1	0	0.8	2.1

IOSR = Interim operational safety requirements
OSD = Operating specification documentation
USQ = Unresolved safety question

precautions, record keeping of the waste transferred, prerequisites to the transfer, and the transfer procedure. Within the transfer procedure, information is provided for performing transfer valving and pit box cover check, flushing of transfer lines and pumps, and post-transfer valving. Also within the transfer procedure are a transfer control checklist, transfer datasheets, cover installation inspection checklist, temperature monitoring datasheets, a valve position checklist, and a history signature sheet.

From discussions with D. W. Reberger, it takes approximately 1 month to develop a transfer procedure with a schematic of the transfer route. Representatives from the following organizations are involved in the development and approval of a transfer procedure: Plant Engineering, Procedure Development, Operations, and Quality Assurance. The Engineering organization needs about 80 hours to develop the transfer route, procedure writers need about 40 hours to write the procedure, Operations needs about 12 hours to walk down the transfer route, and Quality Assurance needs about 40 hours to review the transfer procedure.

The cost for the time involved by each organization was found in Soft Reporting. It was found that engineering time would cost approximately $50/h, the procedure writer would cost about $52/h, Operations would cost about $48/h, and Quality Assurance would cost about $49/h.

The number of transfers required for each alternative was taken from Section 3.5.2.2 of the main text. The enabling assumption used to determine the number of transfers was that a new transfer procedure would be required for all transfers into and out of the double-shell tanks.

To determine development costs of a transfer procedure, the cost for the organizations involved was summed, with a total of $8,616. To be conservative, the amount was rounded up to $9,000. To determine development costs for the transfer procedures for each alternative, the number of procedures required was multiplied by $9,000 (see Table A-3).

Table A-3. Cost Estimates for Required Operating Procedures.

Alternative	Number of transfers required per alternative	Cost
Includes wash and leach steps		
0a	10	$90,000
0b	11	$99,000
1a	17	$153,000
1b	20	$180,000
2	15	$135,000
3	18	$162,000
4	22	$198,000
5a	24	$216,000
5b	31	$279,000
5c	28	$252,000
6	30	$270,000
7	18	$162,000
Excludes wash and leach steps		
N1a	12	$108,000*
N1b	13	$117,000*
2	11	$99,000*
N3	13	$117,000*
N4	13	$117,000*
N5a	15	$135,000*
7	13	$117,000*

NOTE: The cost for the C-106 >>> AY-102 transfer procedure should be addressed by Project W-320. If this is true, every alternative with this transfer (Alternatives 0a, 0b, 2, 3, 5a, 5b, 5c, and 6) will be $9,000 less than the cost stated in this table.

*Cost estimate has not been updated to reflect cost reductions for non-leach and wash.

Table A-4. Estimates for Transfer Procedures (Generic).

Job function	Time required	Rate per hour	Cost
Engineering	2 weeks = 80 h	$50	$4,000
Procedure writer	1 week = 40 h	$52	$2,080
Operations review	12 h	$48	$576
Quality assurance review	1 week = 40 h	$49	$1,960
Total cost per transfer procedure = $8,616 >>> $9,000			

Other procedures that may apply to the Neutralized Current Acid Waste/ C-106 consolidation are as follows:

- TO-200-610, "Specific Transfer Procedure 101-AZ to 102-AZ"
- TO-250-550, "Transfer from 204-AR to 102-AY"
- .TO-200-030, "Operate AY & AZ Air-Lift Circulators"
- TO-020-705, "Flush Salt Well Jet Pump Systems and Transfer Lines"
- OSD-T-151-00030, "Operating Specifications for Watch List Tanks"
- OSD-T-151-00007, "Operating Specifications for 241-AN, AP, AW, AY, and AZ"
- 2E22013, "Heat Trace Control Test for 241-AY & AZ Tank Farms."

Rigid Jumper Requirement

A rigid jumper is required when transferring solids, transferring caustic for leaching operations, or when transferring double-shell slurry feed (DSSF). C. E. Jensen developed a spread sheet that depicts the tank (central pump pits and sluice pits) and the valve pits used for each transfer in each alternative. The spread sheet also shows the location of non-rigid jumpers in the various transfer routes. From this spread sheet, the number of new rigid jumpers was determined (see Table A-5).

ENABLING ASSUMPTIONS:

1. Valve pits A-A, A-B, AX-A, AX-B, AW-A, and AW-B will require two new rigid jumpers each. This implies that each alternative will require the installation of at least 12 jumpers.

2. The origin of DSSF in Alternatives 1a, 5a, 5b, 5c, and 6 is undetermined and could come from the AN, AP, or AW tank farms. For this reason, jumper installation in the AN valve pit was considered. Two rigid jumpers would be required in the AN-A and AN-B valve pits (four total) if DSSF is transferred from the AN Farm.

3. The existing transfer pump in tank AY-102 is operational and will be used.

4. Installation of the mixer pump system in AZ-101 is accounted for in Project W-151.

5. Installation of mixer pumps, transfer pumps, and decant pumps requires the installation of one jumper per pump.

6. The AY Farm requires four mixer pumps and one transfer pump, and the AZ Farm requires two mixer pumps and one transfer pump.

7. The number of jumpers installed does not necessarily equal the number of pit entries required for each alternative.

Table A-5. Jumper Installation Required for Neutralized Current Acid Waste Transfer Scenarios (Including Wash and Leach Steps).

Alternative Number	Number of new rigid jumpers requiring installation (see Section 3.4.2 of main text for details on transfer routes)	Location of jumper installation
0a	15	241-A-A VP, 241-A-B VP, 241-AX-A VP, 241-AX-B VP, 241-AW-A VP, 241-AW-B VP, decant pump 101-AZ, 101-AZ 01A central pump pit, 102-AZ 02A central pump pit
0b	15	241-A-A VP, 241-A-B VP, 241-AX-A VP, 241-AX-B VP, 241-AW-A VP, 241-AW-B VP, decant pump 101-AZ, 101-AZ 01A central pump pit, 102-AZ 02A central pump pit
1a	20	241-A-A VP, 241-A-B VP, 241-AX-A VP, 241-AX-B VP, 241-AW-A VP, 241-AW-B VP, 241-AN-A VP, 241-AN-B VP, decant pumps AZ-101 and -102, 101-AZ 01A central pump pit, 102-AZ 02A central pump pit
1b	18	241-A-A VP, 241-A-B VP, 241-AX-A VP, 241-AX-B VP, 241-AW-A VP, 241-AW-B VP, 1 decant pump 101-AZ, 101-AZ 01A central pump pit, 102-AZ 02A central pump pit, 2 mixer pumps and 1 transfer pump 102-AZ
2	20	241-A-A VP, 241-A-B VP, 241-AX-A VP, 241-AX-B VP, 241-AW-A VP, 241-AW-B VP, 1 decant pump 101-AZ, 101-AZ 01A central pump pit, 102-AZ 02A central pump pit, 4 mixer pumps and 1 transfer pump 102-AY
3	16	241-A-A VP, 241-A-B VP, 241-AX-A VP, 241-AX-B VP, 241-AW-A VP, 241-AW-B VP, 1 decant pump 101-AZ, 1 decant pump 102-AZ, 101-AZ 01A central pump pit, 102-AZ 02A central pump pit
4	18	241-A-A VP, 241-A-B VP, 241-AX-A VP, 241-AX-B VP, 241-AW-A VP, 241-AW-B VP, 1 decant pump 101-AZ, 101-AZ 01A central pump pit, 102-AZ 02A central pump pit, 2 mixer pumps and 1 transfer pump 102-AZ
5a	22	241-A-A VP, 241-A-B VP, 241-AX-A VP, 241-AX-B VP, 241-AW-A VP, 241-AW-B VP, 241-AN-A VP, 241-AN-B VP, 1 decant pump 101-AZ, 101-AZ 01A central pump pit, 102-AZ 02A central pump pit, 2 mixer pumps and 1 transfer pump 102-AZ
5b	27	241-A-A VP, 241-A-B VP, 241-AX-A VP, 241-AX-B VP, 241-AW-A VP, 241-AW-B VP, 241-AN-A VP, 241-AN-B VP, 2 mixer pumps and 1 transfer pump 102-AZ, 4 mixer pumps and 1 transfer pump 102-AY, 1 decant pump 101-AZ, 101-AZ 01A central pump pit, 102-AZ 02A central pump pit

Table A-5. Jumper Installation Required for Neutralized Current Acid Waste Transfer Scenarios (Including Wash and Leach Steps).

Alternative Number	Number of new rigid jumpers requiring installation (see Section 3.4.2 of main text for details on transfer routes)	Location of jumper installation
5c	27	241-A-A VP, 241-A-B VP, 241-AX-A VP, 241-AX-B VP, 241-AW-A VP, 241-AW-B VP, 241-AN-A VP, 241-AN-B VP, 2 mixer pumps and 1 transfer pump 102-AZ, 4 mixer pumps and 1 transfer pump 101-AY, 1 decant pump 101-AZ, 101-AZ 01A central pump pit, 102-AZ 02A central pump pit
6	30	241-A-A VP, 241-A-B VP, 241-AX-A VP, 241-AX-B VP, 241-AW-A VP, 241-AW-B VP, 241-AN-A VP, 241-AN-B VP, 4 mixer pumps and 1 transfer pump 101-AY, 4 mixer pumps and 1 transfer pump 102-AY, 1 decant pump 101-AZ, 1 decant pump 102-AZ, 101-AZ 01A central pump pit, 102-AZ 02A central pump pit
7	17	241-A-A VP, 241-A-B VP, 241-AX-A VP, 241-AX-B VP, 241-AW-A VP, 241-AW-B VP, 1 decant pump 101-AZ, 1 decant pump 102-AZ, mixer pump 102-AY, 101-AZ 01A central pump pit, 102-AZ 02A central pump pit

The enabling assumptions used to determine the number of new, rigid jumpers required for each alternative are:

1. To provide flexibility in transferring the waste, the following valve pits will have two rigid jumpers installed: 241-A-A, 241-A-B, 241-AX-A, 241-AX-B, 241-AW-A, and 241-AW-B.

2. Jumper installation was considered for the 241-AN valve pits for Alternatives 1a, 5a, 5b, 5c, and 6 because the origin of DSSF was undetermined for these alternatives at the time of development of the number of rigid jumpers required. The DSSF could come from either the AN, AP, or AW Tank Farms. Two rigid jumpers would be installed in the 241-AN-A and 241-AN-B valve pits.

3. Installation of mixer pumps, transfer pumps, and decant pumps requires the installation of one rigid jumper per pump.

4. When a mixer system is called out in Section 3.5.2.2 of the main text, the AY Tank Farm requires four mixer pumps and one transfer pump, and the AZ Tank Farm requires two mixer pumps and one transfer pump.

5. Installation of the mixer pump system in AZ-101 is accounted for in Project W-151.

6. The existing transfer pump in tank AY-102 is operational and will be used.

7. The number of rigid jumpers installed does not necessarily equal the number of pit entries required for each alternative.

Routings

Figure A-1 provides a depiction of the existing A Farm Complex waste transfer system. The waste routings shown are transfer lines that are currently considered to be regulatory compliant, e.g., pipe-in-pipe, with leak detection. The system consists of underground piping constructed of nominal 2-in. and 3-in. primary lines. The 2-in. lines are referred to as Slurry lines (SL) and the 3-in. lines are referred to as Supernatant lines (SN).

The current system supports transfers related to SST saltwell pumping, 242-A evaporator operations, and miscellaneous waste transfers from Hanford Site facilities.

Establishing routes to support the consolidation of the NCAW will have to be integrated with the aforementioned tank farm waste transfers and therefore a dedicated routing has not been established. Future studies may be required to identify, design, and fabricate jumpers to support NCAW consolidation and other waste transfers. The goal should be to provide required flexibility in the routes to support all waste transfers and minimize the need for pit entries to change the route setup, e.g., jumper change-outs.

Readiness Review

The U.S. Department of Energy (DOE) Order 5480.31, *Startup and Restart of Nuclear Facilities Operational Readiness Review and Readiness Assessments* (DOE 1993), establishes the requirements for operational readiness reviews. Westinghouse Hanford Company implements the DOE Order with WHC-CM-1-5, *Standard Operating Practices*, Section 1.2, "Operational Readiness Reviews."

The purpose of the operational readiness review is to ensure the adequacy of facilities, equipment, personnel, and administrative systems before the startup or restart of nuclear facilities. The scope and level of approval authority of the readiness review process are determined by the magnitude of the hazards involved and the complexity of the operating facility.

Generally, routine operations and startup from planned maintenance and routine replacement of equipment do not require an operational readiness review. Operations outside the scope of previous DOE approvals and agreements may require a readiness review or at least concurrence from the DOE that a readiness review is not required.

Projects W-151, W-320, and W-211 are associated with consolidation of material in the AY and AZ Tank Farms. Each of these projects has readiness review included as a project activity. The readiness review is effectively completed before the equipment and instrumentation associated with the project are turned over to Operations.

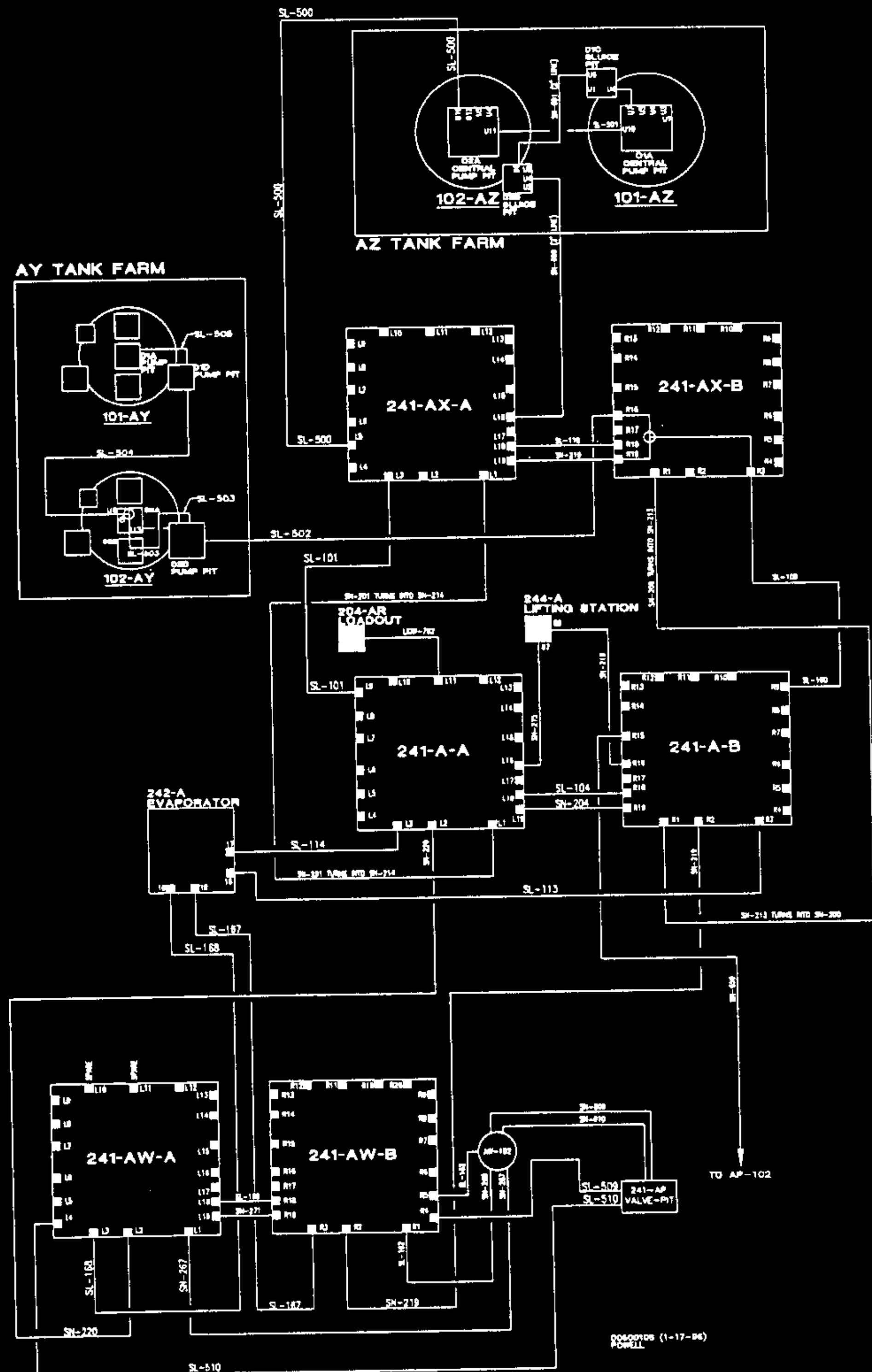
<u>Project W-151</u>

Project W-151 adds mixer pumps to AZ-101. Project W-151 also includes the following:

- Two mixer pumps

Figure A-1. A Farm Complex Transfer Lines.

A FARM COMPLEX WASTE TRANSFER SYSTEM



- Portable substation power, control, and monitoring equipment for operation of the two pumps and necessary ancillary equipment

- An electrical substation with the capacity to supply eight mixer pumps and associated equipment

- A mixer pump operation and speed control facility at the AZ Tank Farm.

Project W-320

Project W-320 adds the waste retrieval sluicing system to C-106. The solids in C-106 are sluiced to AY-102 and the liquid is recycled.

Project W-320 adds the following to C-106:

- Two slicers
- A slurry pump
- A heel pump
- A viewing system
- Probes
- A ventilation system
- Jumpers/valve actuators.

Project W-320 adds the following to AY-102:

- Supernatant pump
- Distributor
- Probes
- Valve actuators.

The project also adds the fluid transfer lines between tanks and miscellaneous wiring.

Project W-211

Project W-211 adds mixing pumps and retrieval systems to ten double-shell tanks in SY, AN, AP, AY, and AZ Tank Farms. The mixing pumps installed in AZ-102 in 2000 will be the first to be used to support aging waste activities. The pumps will facilitate the leaching and washing of solids in AZ-102. Two other tanks may receive retrieval systems before AZ-102. The retrieval systems are tentatively scheduled for SY-102 in 1998 and AW-105 in 1999. Project W-211 includes the following:

- Sludge mobilization assemblies (mixer pumps)

- An operator station for each tank

- Instrumentation to meet installation and operating needs

- Internal tank upgrades to add structural strength to withstand jet forces

- Transfer pumps

- Utilities
- Pump pits, riser extensions, and cover blocks as needed
- Flush and dilution capability
- Video monitoring.

Other projects

In addition, other projects will affect the consolidation activities. These other projects include Project W-030, Tank Farm Ventilation Upgrade, and Project W-314, the Tank Farm Restoration Upgrades. Each of these projects will have an operational readiness review scheduled as part of the project activities.

Costs and schedules

Operational readiness reviews for projects are generally conducted in the last 6 to 12 months of the project and completed before the project-provided equipment is turned over to operations. Costs for readiness review will vary somewhat from project to project depending on the complexity of the affected operations and the magnitude of potential hazards. As an example, the cost for the operational readiness review for the installation of a Project W-211 retrieval system in one tank is an estimated $600,000. This cost is included as part of the project cost and should be typical for the retrieval systems and mixing systems in each tank.

Assumption for Aging Waste Consolidation

Readiness reviews are included as an integral part of all projects related to aging waste consolidation. Routine and ongoing tank farm operations comprise the remainder of the activities associated with aging waste consolidation.

An overall readiness review for solids consolidation is recommended if Alternatives 3, 5a, 5b, 5c, 6, or 7 are chosen for implementation. Any of these alternatives results in a larger volume of solids in one tank. The resulting volume of solids may result in additional cooling requirements or other operating and retrieval concerns beyond the other alternatives. The cost of an overall readiness review is an estimated $500,000 for a review that requires between 6 and 12 months to complete.

REFERENCES

Aguirre, Jr., H., 1995, *242-A Evaporator/Crystallizer Final Safety Analysis Report*, WHC-SD-WM-SAR-023, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

DOE, 1993, *Startup and Restart of Nuclear Facilities Operational Readiness Review and Readiness Assessments*, DOE Order 5480.31, U.S. Department of Energy, Washington, D.C.

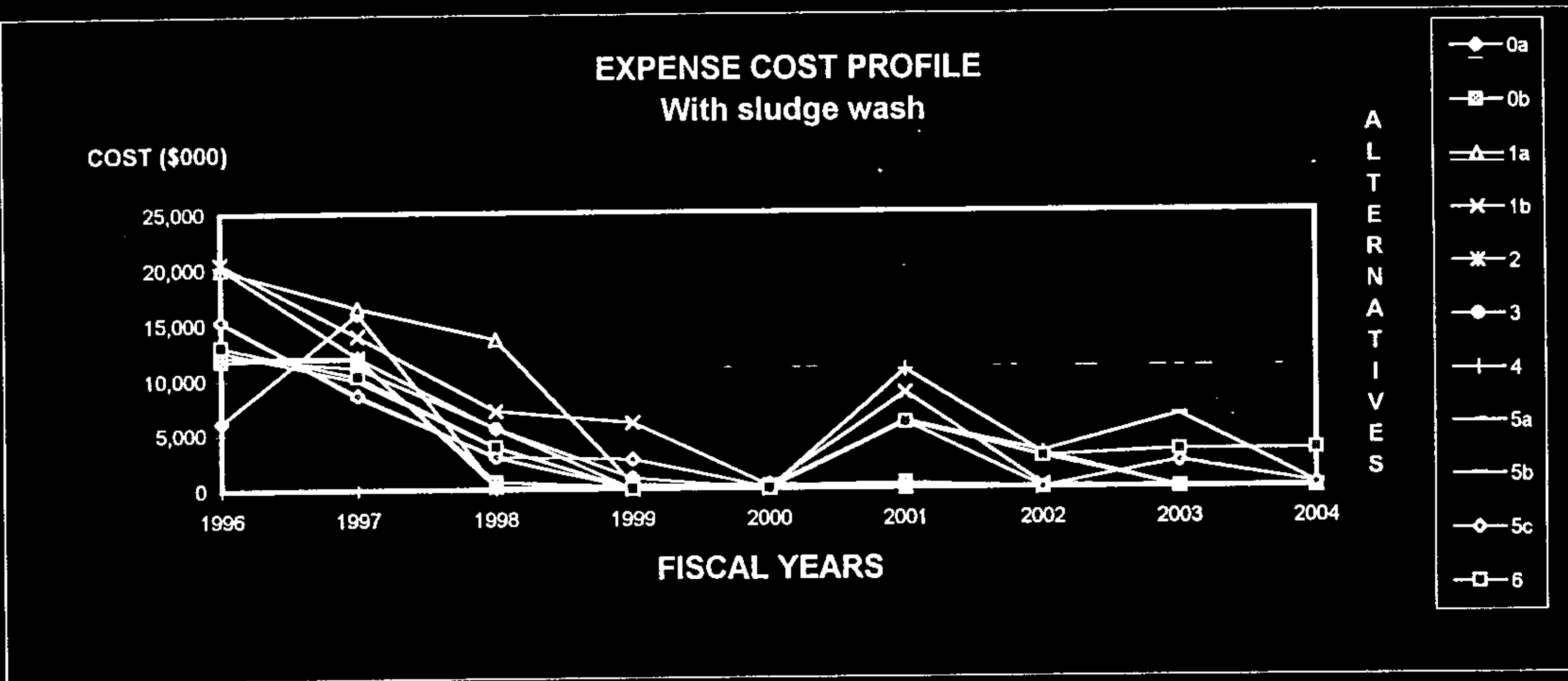
WHC-CM-1-5, *Standard Operating Practices*, Westinghouse Hanford Company, Richland, Washington.

GLOSSARY

ABBREVIATIONS AND ACRONYMS

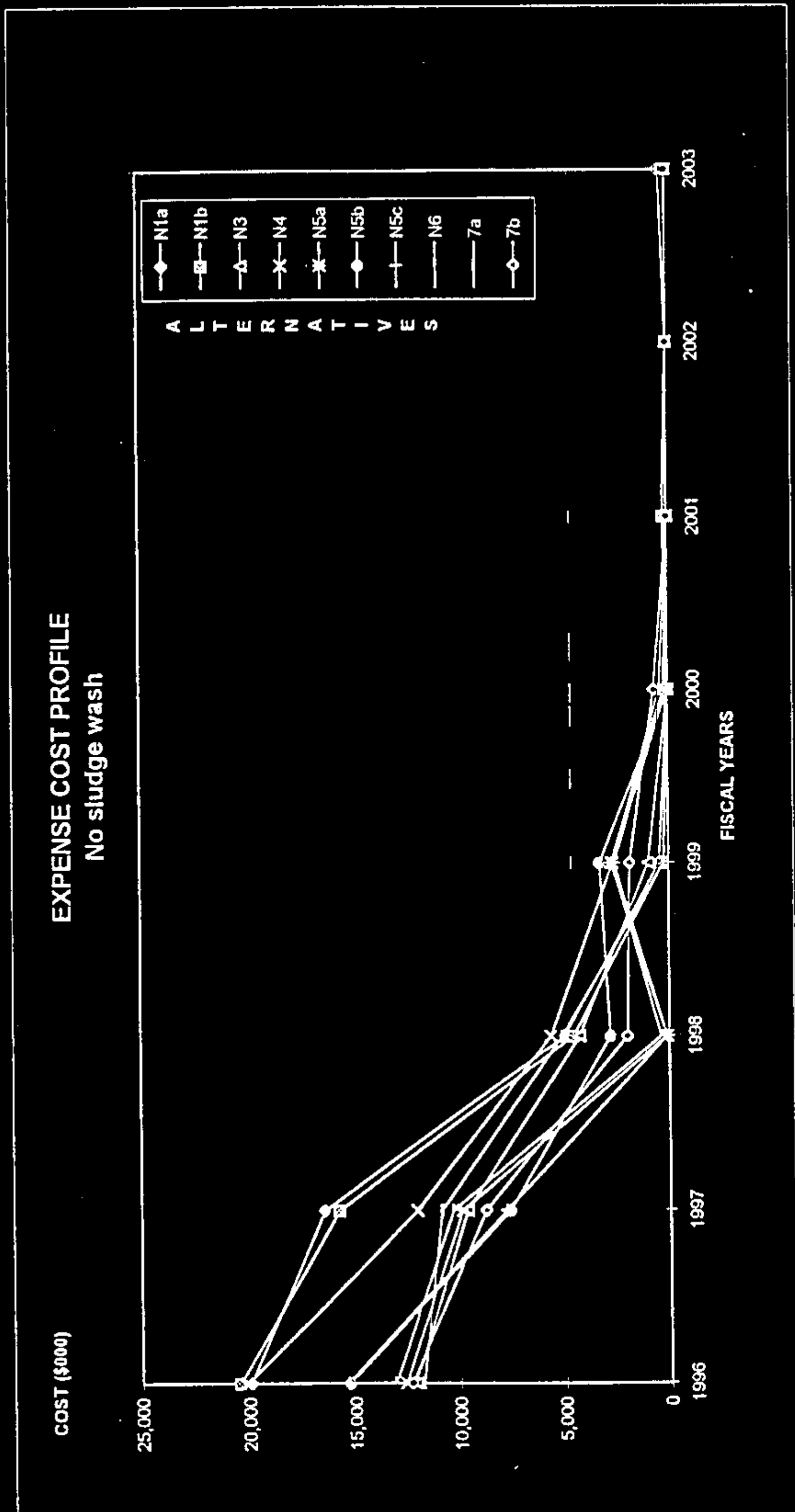
DOE	U.S. Department of Energy
DQO	data quality objective
DSSF	double-shell slurry feed
FY	fiscal year
IOSR	interim operating safety requirement
NCAW	neutralized current acid waste
OSD	operating specification documentation
OSR	operating safety requirement
ROM	rough order of magnitude
USQ	unresolved safety question

Figure A-2. Expense Cost Profile with Sludge Wash.



	1996	1997	1998	1999	2000	2001	2002	2003	2004
0a	6,125	15,995	250	250	390	0	0	0	0
0b	11,720	11,859	675	250	250	450	0	0	0
1a	19,970	16,462	13,587	470	0	0	0	0	0
1b	20,483	13,939	7,138	5,980	200	8,655	200	0	0
2	12,120	12,000	200	0	0	0	0	0	0
3	12,151	11,079	5,524	963	0	0	0	0	0
4	20,187	12,041	5,500	0	0	10,695	3,050	0	0
5a	12,628	9,868	3,800	0	200	6,000	2,740	0	0
5b	15,290	8,420	2,850	0	0	6,100	3,200	6,550	300
5c	15,376	8,606	2,950	2,680	70	5,900	0	2,300	300
6	13,045	10,255	3,850	0	0	5,900	2,780	3,340	3,370

Figure A-3. Expense Cost Profile without Sludge Wash.



	1996	1997	1998	1999	2000	2001	2002	2003
N1a	19,947	16,439	4,932	470	0	0	0	0
N1b	20,452	15,744	4,532	270	0	200	0	0
N3	12,129	9,604	4,238	987	0	0	0	0
N4	20,147	12,001	5,600	2,650	400	0	0	0
N5a	12,588	9,828	100	2,740	200	0	0	0
N5b	15,290	7,570	2,780	3,270	0	0	0	300
N5c	15,376	7,756	100	2,580	70	0	0	300
N6	13,085	10,265	380	2,670	0	0	0	0
7a	11,729	10,818	5,082	229	0	0	0	0
7b	12,303	8,740	1,989	1,860	667	0	0	0

ICF KAISER HANFORD COMPANY ESTIMATES

ALTERNATIVE 0a
DO NOTHING

Operating Costs (Expense and CENRTC)		CAPITAL ($000)	EXPENSE ($000)
Tank bump USQs and miscellaneous safety issues			1,100
Transfer procedure preparation			90
Transfer AY-101 supernate to AP-101 (existing pump) (850 Kgal)	(a)(e)		4,800
Install AZ-101 decant system	(b)	400	400
Decant/transfer AZ-101 supernate to AY-101 (900 Kgal)	(a)		135
Transfer AY-102 supernate to AZ-101 (existing pump) (750 Kgal)	(a)		135
In-tank process test AZ-101	(c)		5,050
Sluice C-106 solids to AY-102 (800 Kgal)	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW	(a)		100
Decant/transfer AZ-101 (AY-102 supernate) to AW Tank Farm (750 Kgal)	(e)		4,300
Transfer AY-101 (AZ-101 supernate) to AZ-101 (900 Kgal)	(a)		100
Transfer concentrated 5M Na at AW to AY-102 (900 Kgal)	(a)		100
In-tank concentration of AZ-102 (400 Kgal)	(f)		1,000
Transfer concentrated 5M Na at AW to AZ-102 (400 Kgal/2 transfers)	(a)		200
Transfer concentrated 5M Na at AW to AY-101 (850 Kgal)	(a)		100
TOTAL COST		400	23,010

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer.

In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 5 to 6 years for AZ-102.

ALTERNATIVE 0b
MINIMAL CASE

Operating Costs (Expense and CENRTC)		CAPITAL ($000)	EXPENSE ($000)
Tank bump USQs and miscellaneous safety issues			2,300
Transfer procedure preparation			99
Transfer AY-101 supernate to AP-101 (existing pump) (850 Kgal)	(a)(e)		4,800
Install AZ-101 decant system	(b)	400	400
Decant/transfer AZ-101 supernate to AY-101 (900 Kgal)	(a)		135
Transfer AY-102 supernate to AZ-101 (existing pump) (750 Kgal)	(a)		135
In-tank process test AZ-101	(c)		5,050
Sluice C-106 solids to AY-102 (800 Kgal)	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW Tank Farm	(a)		100
Decant/transfer AZ-101 (AY-102 supernate) to AW Tank Farm (750 Kgal)	(e)		4,300
Transfer AY-101 (AZ-101 supernate) to AZ-101 (900 Kgal)	(a)		100
In-tank concentration of AZ-101 (concentrate to 7M Na) (250 Kgal)	(f)		635
In-tank concentration of AZ-102 (concentrate to 7M Na) (500 Kgal)	(f)		1,250
Transfer concentrated 7M Na at AW to AZ-101 (250 Kgal)	(a)		100
Transfer concentrated 7M Na at AW to AY-102 (900 Kgal)	(a)		100
Transfer concentrated 7M Na at AW to AZ-102 (400 Kgal/2 transfers)	(a)		200
Transfer concentrated 7M Na at AW to AY-101 (850 Kgal)	(a)		100
TOTAL COST		400	25,204

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer.

In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 1 to 2 years for AZ-101 and 5 to 6 years for AZ-102.

ALTERNATIVE 1a
Reroute W-320 pipelines from C-106 to AZ-101; C-106 solids sluiced to AZ-101

Project (Capital)		CAPITAL ($000)	EXPENSE ($000)
Reroute W-320 pipelines to AZ-101 (Construction complete 04/97)			
Engineering (Title II & III)			3,650
Project Management			940
Construction			10,550
Other project costs			1,220
Operating Costs (Expense and CENRTC)			
Tank bump USQs and miscellaneous safety issues			2,500
Transfer procedure preparation			153
Transfer AY-101 supernate to AP-101 (existing pump) (850 Kgal)	(a)(e)		4,800
Install AZ-101 decant system	(b)	400	400
Decant/transfer AZ-101 supernate to AY-101 (900 Kgal)	(a)	400	135
Transfer AY-102 supernate to AZ-101 (existing pump) (750 Kgal)	(a)		135
In-tank process test AZ-101	(c)		5,050
Sluice C-106 solids to AZ-101 (800 Kgal)	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW Tank Farm	(a)		100
Install decant pump in AZ-102	(b)		400
Decant/transfer AZ-102; 450 Kgal of supernate to AW-102	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Decant/transfer AY-101 (AZ-101 supernate) to AY-102 (850 Kgal)	(a)		100
In-tank concentrate AY-102 (250 Kgal) (2 transfers)	(g)		800
Transfer AW-106 to AY-102 (150 Kgal)	(g)		70
Decant/transfer AZ-102 450 Kgal of supernate to AW-102	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Transfer AW-106 to AY-102 (150 Kgal)	(g)		70
Transfer AW (DSSF type A) to AZ-102 (500 Kgal)	(a)		100
Transfer AW (DSSF) to AY-101 (950 Kgal)	(a)		100
Caustic leach and wash AZ-101 solids (5 transfers)	(h)		8,655
TOTAL COST		800	50,488

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer.

In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 1 to 2 years for AZ-101.

(h) For caustic leaching and washing of AZ-101, it is assumed that four transfers will be performed:
*One transfer of 250 Kgal of caustic from 204-AR to AZ-101
*One transfer of caustic supernate out of 250 Kgal to AW for evaporation at 242-A at $5.54/gal
*Two transfers of 800 Kgal dilute liquid to AZ-101
*One transfer of 800 Kgal to AW for evaporation at 242-A at $5.54/gal.

ALTERNATIVE N1a
Reroute W-320 pipelines from C-106 to AZ-101; C-106 solids sluiced to AZ-101

Project (Capital)		CAPITAL ($000)	EXPENSE ($000)
Reroute W-320 pipelines to AZ-101 (Construction complete 04/97)			
Engineering (Title II & III)			3,650
Project Management			940
Construction			10,550
Other project costs			1,220
Operating Costs (Expense and CENRTC)			
Tank bump USQs and miscellaneous safety issues			2,500
Transfer procedure preparation			108
Transfer AY-101 supernate to AP-101 (existing pump) (850 Kgal)	(a)(e)		4,800
Install AZ-101 decant system	(b)	400	400
Decant/transfer AZ-101 supernate to AY-101 (900 Kgal)	(a)		135
Transfer AY-102 supernate to AZ-101 (existing pump) (750 Kgal)	(a)		135
In-tank process test AZ-101	(c)		5,050
Sluice C-106 solids to AZ-101 (800 Kgal)	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW Tank Farm	(a)		100
Install decant pump in AZ-102	(b)	400	400
Decant/transfer AZ-102; 450 Kgal of supernate to AW-102	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Decant/transfer AY-101 (AZ-101 supernate) to AY-102 (850 Kgal)	(a)		100
In-tank concentrate AY-102 (250 Kgal) (2 transfers)	(f)		800
Transfer AW-106 to AY-102 (150 Kgal)	(g)		70
Decant/transfer AZ-102; 450 Kgal of supernate to AW-102	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Transfer AW-106 to AY-102 (150 Kgal)	(g)		70
Transfer AW (DSSF type A) to AZ-102 (500 Kgal)	(a)		100
Transfer AW (DSSF) to AY-101 (950 Kgal)	(a)		100
TOTAL COST		800	41,788

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer.

In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 1 to 2 years for AZ-101.

ALTERNATIVE 1b
Reroute W-320 pipelines from C-106 to AZ-101; C-106 solids sluiced to AZ-101. Transfer AZ-102 solids to AZ-101.

Project (Capital)		CAPITAL ($000)	EXPENSE ($000)
Reroute W-320 pipelines to AZ-101 (Construction complete 12/97)			
Engineering (Title II & III)			3,650
Project Management			940
Construction			10,550
Other project costs			1,220
W-211 Initial Waste Retrieval System/AZ-102 (Construction complete 09/00)			
Engineering (Title II & III)		5,160	
Project Management		1,820	
Construction		16,120	
Other project costs		3,020	
Operating Costs (Expense and CENRTC)			
Tank bump USQs and miscellaneous safety issues			2,500
Transfer procedure preparation			180
Transfer AY-101 supernate to AP-101 (existing pump) (850 Kgal)	(a)(e)		4,800
Install AZ-101 decant system	(b)	400	400
Decant/transfer AZ-101 supernate to AY-101 (900 Kgal)	(a)		135
Transfer AY-102 supernate to AZ-101 (existing pump) (750 Kgal)	(a)		135
In-tank process test AZ-101	(c)		5,050
Decant/transfer AY-101 (AZ-101 supernate) back to AY-102 (875 Kgal)	(a)		100
Sluice C-106 solids to AZ-101 (800 Kgal)	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW Tank Farm	(a)		100
Install decant pump in AZ-102	(b)	400	400
Decant/transfer AZ-102; 450 Kgal of supernate to AW-102	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Wash AZ-102 and decant to AP T.F. (3 transfers)	(h)		8,655
Caustic leach and wash AZ-101, transfer supernate to AP T.F. (4 transfers)	(h)		6,680
Mobilize and transfer AZ-102 solids to AZ-101	(a)		100
Decant/transfer AY-101 supernate (AZ-101 concentrated supernate) to AZ-102	(a)		100
Decant/transfer AZ-102; 450 Kgal of supernate to AW-102	(g)		80
Transfer AW-106 to AZ-102 (50 Kgal)	(g)		70
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Transfer AW-106 to AZ-102 (50 Kgal)	(g)		70
Transfer AW (DSSF type A) to AY-101 (850 Kgal)	(a)		100
Transfer AW (DSSF) to AY-102 (800 Kgal)	(a)		100
TOTAL COST		26,920	56,595

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer. In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 1 to 2 years for AZ-102.

(h) For caustic leaching and washing of AZ-101, it is assumed that four transfers will be performed.
*One transfer of 400 Kgal of caustic from 204-AR to AZ-101
*One transfer of caustic supernate out of 400 Kgal to AW for evaporation at 242-A evaporator at $5.54/gal
*One transfer of 500 Kgal dilute liquid to AZ-101
*One transfer of 100 Kgal to AW for evaporation at 242-A evaporator at $5.54/gal.
For washing of AZ-102 it is assumed that 3 transfers will be performed:
*Two transfers of 300 Kgal dilute liquid to AZ-102
*One transfer of 300 Kgal to AW for evaporation at 242-A evaporator at $5.54/gal.

ALTERNATIVE N1b
Reroute W-320 pipelines from C-106 to AZ-101; C-106 solids sluiced to AZ-101. Transfer AZ-102 solids to AZ-101.

Project (Capital)		CAPITAL ($000)	EXPENSE ($000)
Reroute W-320 pipelines to AZ-101 {Construction complete 12/97}			
Engineering (Title II & III)			3,650
Project Management			940
Construction			10,550
Other project costs			1,220
W-211 Initial Waste Retrieval System/AZ-102 {Construction complete 09/00}			
Engineering (Title II & III)		5,160	
Project Management		1,820	
Construction		16,120	
Other project costs		3,020	
Operating Costs (Expense and CENTRC)			
Tank Bump USQs and miscellaneous safety issues			2,500
Transfer procedure preparation			117
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}	(a)(e)		4,800
Install AZ-101 decant system	(b)	400	400
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}	(a)		135
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}	(a)		135
In-tank process test AZ-101	(c)		5,050
Decant/transfer AY-101 (AZ-101 supernate) back to AY-102 {875 Kgal}	(a)		100
Sluice C-106 solids to AZ-101 {800 Kgal}	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW Tank Farm	(a)		100
Install decant pump in AZ-102	(b)	400	400
Decant/transfer AZ-102 450 Kgal of supernate to AW-102	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2500
Mobilize and transfer AZ-102 solids to AZ-101	(a)		100
Decant/transfer AY-101 supernate (AZ-101 concentrated supernate) to AZ-102	(a)		100
Decant/transfer AZ-102 450 Kgal of supernate to AW-102	(g)		80
Transfer AW-106 to AZ-102 {50 Kgal}	(g)		70
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2500
Transfer AW-106 to AZ-102 {50 Kgal}	(g)		70
Transfer AW (DSSF type A) to AY-101 {850 Kgal}	(a)		100
Transfer AW (DSSF) to AY-102 {800 Kgal}	(a)		100
TOTAL COST		26,920	41,197

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer.

In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 1 to 2 years for AZ-102.

ALTERNATIVE 2
Transfer C-106 solids sluiced into AY-102.

Operating Costs (Expense and CENTRC)		CAPITAL ($000)	Expense ($000)
Tank bump USQs and miscellaneous safety issues			2,300
Transfer procedure preparation			99
Transfer AY-101 supernate to AP-101 (existing pump) (850 Kgal)	(a)(e)		4,800
Install AZ-101 decant system	(b)	400	400
Decant/transfer AZ-101 supernate to AY-101 (900 Kgal)	(a)		135
Transfer AY-102 supernate to AZ-101 (existing pump) (904 Kgal)	(a)		135
In-tank process test AZ-101	(c)		5,050
Sluice C-106 solids to AY-102 (800 Kgal)	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW Tank Farm	(a)		100
Install AZ-102 decant system	(b)	400	400
Decant/transfer AZ-102, 450 Kgal of supernate to AW-102	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Transfer AW-106 to AY-102 (150 Kgal)	(g)		70
Decant/transfer AZ-102, 450 Kgal of supernate to AW-102	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Transfer AW-106 to AY-102 (150 Kgal)	(g)		70
Transfer AW (7M Na) to AZ-102 (900 Kgal)	(a)		100
Transfer AW (7M Na) to AZ-101 (900 Kgal)	(a)		100
TOTAL COST		800	24,319

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer.

In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 1 to 2 years for AY-101.

ALTERNATIVE 3
Transfer C-106 solids sluiced into AY-102 and immediately transfer the solids into tank AZ-101.

Operating Costs (Expense and CENRTC)		CAPITAL ($000)	EXPENSE ($000)
Tank bump USQs and miscellaneous safety issues			2,300
Transfer procedure preparation			162
Transfer AY-101 supernate to AP-101 (existing pump) (850 Kgal)	(a)(e)		4,800
Install AZ-101 decant system	(b)	400	400
Decant/transfer AZ-101 supernate to AY-101 (900 Kgal)	(a)		135
Transfer AY-102 supernate to AZ-101 (existing pump) (750 Kgal)	(a)		135
In-tank process test AZ-101	(c)		5,050
Decant/transfer AZ-101 to AY-102	(a)		135
Sluice C-106 solids to AZ-101 (via AY-102) (800 Kgal)	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW Tank Farm	(a)		100
Caustic leach and wash AZ-101 (5 transfers)	(h)		2,716
Install decant system into AZ-102	(b)	400	400
Decant/transfer AZ-102 450 Kgal of supernate to AW-102	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Decant/transfer AZ-102 supernate (450 Kgal) to AW-102	(g)		80
Decant/transfer AY-101 (AZ-101 supernate) to AZ-102 (800 Kgal)	(a)		100
In-tank concentrate AZ-102 (250 Kgal condensate to AY-101)	(f)		2,385
Transfer AW-106 to AZ-102 (150 Kgal)	(g)		70
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Transfer AW-106 to AZ-102 (150 Kgal)	(g)		70
Transfer AW (7M Na) to AY-101 (850 Kgal)	(a)		100
Transfer AW (7M Na) to AY-102 (850 Kgal)	(a)		100
TOTAL COST		800	29,718

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer.

In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 1 to 2 years for AZ-102.

(h) For caustic leaching and washing of AZ-101, it is assumed that five transfers will be performed.
*One transfer of 100 Kgal of caustic from 204-AR to AZ-101
*One transfer of caustic supernate of 100 Kgal to AW for evaporation at the 242-A evaporator at $5.54/gal
*Two transfers of 300 Kgal dilute liquid to AZ-101
*One transfer of 300 Kgal to AW for evaporation at the 242-A evaporator at $5.54/gal.

ALTERNATIVE N3
Transfer C-106 solids sluiced into AY-102 and immediately transfer the solids into tank AZ-101.

Operating Costs (Expense and CENRTC)		CAPITAL ($000)	EXPENSE ($000)
Tank bump USQs and miscellaneous safety issues			2,300
Transfer procedure preparation			117
Transfer AY-101 supernate to AP-101 (existing pump) (850 Kgal)	(a)(e)		4,800
Install AZ-101 decant system	(b)	400	400
Decant/transfer AZ-101 supernate to AY-101 (900 Kgal)	(a)		135
Transfer AY-102 supernate to AZ-101 (existing pump) (750 Kgal)	(a)		135
In-tank process test AZ-101	(c)		5,050
Decant/transfer AZ-101 to AY-102	(a)		135
Sluice C-106 solids to AZ-101 (via AY-102) (800 Kgal)	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW Tank Farm	(a)		100
Install decant system into AZ-102	(b)	400	400
Decant/transfer AZ-102 450 Kgal of supernate to AW-102	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Decant/transfer AZ-102 supernate (450 Kgal) to AW-102	(g)		80
Decant/transfer AY-101 (AZ-101 supernate) to AZ-102 (800 Kgal)	(a)		100
In-tank concentrate AZ-102 (250 Kgal condensate to AY-101)	(f)		2,385
Transfer AW-106 to AZ-102 (150 Kgal)	(g)		70
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Transfer AW-106 to AZ-102 (150 Kgal)	(g)		70
Transfer AW (7M Na) to AY-101 (850 Kgal)	(a)		100
Transfer AW (7M Na) to AY-102 (850 Kgal)	(a)		100
TOTAL COST		800	26,957

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer.

In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 1 to 2 years for AZ-102.

ALTERNATIVE 4
Reroute W-320 pipelines from C-106 to AZ-102.
Transfer AZ-101 solids to AZ-102.

Project (Capital)		CAPITAL ($000)	EXPENSE ($000)
W-211 Initial Waste Retrieval System/AZ-102 {Construction complete 09/00}			
Engineering (Title II & III)		5,160	
Project Management		1,820	
Construction		16,120	
Other project costs		3,020	
Reroute W-320 pipelines to AZ-102 {Construction complete 12/97}			
Engineering (Title II & III)			3,650
Project Management			940
Construction			9,940
Other project costs			1,220
Operating Costs (Expense and CENRTC)			
Tank bump USQs and miscellaneous safety issues			2,700
Transfer procedure preparation			198
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}	(a)(e)		4,800
Install AZ-101 decant system	(b)	400	400
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}	(a)		135
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}	(a)		135
In-tank process test AZ-101	(c)		5,050
Install AZ-102 decant system	(b)	400	400
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102	(g)		80
Sluice C-106 solids to AZ-102 {800 Kgal}	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW Tank Farm	(a)		100
Caustic leach and wash AZ-102 (6 transfers to AP)	(h)		9,187
Wash AZ-101 and decant to AP T. F. (3 transfers)	(h)		1,408
Mobilize and transfer AZ-101 solids to AZ-102	(a)		100
Transfer AW-106 to AZ-101 {150 Kgal}	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Transfer AW-106 to AZ-101 {150 Kgal}	(g)		70
Transfer AZ-102 (AZ-101 supernate) to AZ-101	(a)		100
Transfer AY -102 supernate to AP Tank Farm	(a)		100
Transfer AW (DSSF) to AY-102	(a)		100
Transfer AW (7M Na) to AY-101	(a)		100
TOTAL COST		26,920	51,473

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer.

In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 1 to 2 years for AZ-101.

(h) For washing of AZ-101, it is assumed that three transfers will be performed:
-Two transfers of 200 Kgal dilute liquid to AZ-101
-One transfer of 200 Kgal to AW for evaporation at the 242-A evaporator at $5.54/gal.
For caustic leaching and washing of AZ-102, it is assumed that six transfers will be performed:
-One transfer of 500 Kgal of waste
-One transfer of 250 Kgal of caustic from 204-AR to AZ-101
-One transfer of caustic supernate of 250 Kgal to AW for evaporation at the 242-A evaporator at $5.54/gal
-Two transfers of 800 Kgal dilute liquid to AZ-102
-One transfer of 800 Kgal to AW for evaporation at the 242-A evaporator at $5.54/gal.

ALTERNATIVE N4
Reroute W-320 pipelines from C-106 to AZ-102. Transfer AZ-101 solids to AZ-102.

Project (Capital)		CAPITAL ($000)	EXPENSE ($000)
W-211 Initial Waste Retrieval System/AZ-102 (Construction complete 09/00)			
Engineering (Title II & III)		5,160	
Project Management		1,820	
Construction		16,120	
Other project costs		3,020	
Reroute W-320 Pipelines to AZ-102			
Engineering (Title II & III)			3,650
Project Management			940
Construction			9,940
Other project costs			1,220
Operating Costs (Expense and CENRTC)			
Tank bump USQs and miscellaneous safety issues			2,700
Transfer procedure preparation			117
Transfer AY-101 supernate to AP-101 (existing pump) (850 Kgal)	(a)(e)		4,800
Install AZ-101 decant system	(b)	400	400
Decant/transfer AZ-101 supernate to AY-101 (900 Kgal)	(a)		135
Transfer AY-102 supernate to AZ-101 (existing pump) (750 Kgal)	(a)		135
In-tank process test AZ-101	(c)		5,050
Install AZ-102 decant system	(b)	400	400
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102	(g)		80
Sluice C-106 solids to AZ-102 (800 Kgal)	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW Tank Farm	(a)		100
Mobilize and transfer AZ-101 solids to AZ-102	(a)		100
Transfer AW-106 to AZ-101 (150 Kgal)	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Transfer AW-106 to AZ-101 (150 Kgal)	(g)		70
Transfer AZ-102 (AZ-101 supernate) to AZ-101	(a)		100
Transfer AY -102 supernate to AP Tank Farm	(a)		100
Transfer AW (DSSF) to AY-102	(a)		100
Transfer AW (7M Na) to AY-101	(a)		100
TOTAL COST		26,920	40,797

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer.

In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 1 to 2 years for AZ-101.

ALTERNATIVE 5a
Consolidation of AZ Tank Farm solids in tank AZ-102.

Project (Capital)		CAPITAL ($000)	EXPENSE ($000)
W-211 Initial Waste Retrieval System/AZ-102 (Construction complete 09/00)			
Engineering (Title II & III)		5,160	
Project Management		1,820	
Construction		16,120	
Other project costs		3,020	
Operating Costs (Expense and CENRTC)			
Tank bump USQs and miscellaneous safety issues			3,000
Transfer procedure preparation			216
Transfer AY-101 supernate to AP-101 (existing pump) (850 Kgal)	(a)(e)		4,800
Install AZ-101 decant system	(b)	400	400
Decant/transfer AZ-101 supernate to AY-101 (900 Kgal)	(a)		135
Transfer AY-102 supernate to AZ-101 (existing pump) (750 Kgal)	(a)		135
In-tank process test AZ-101	(c)		5,050
Install AZ-102 decant system	(b)	400	400
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102	(g)		80
Mobilize and transfer AZ-101 solids to AZ-102 (800 Kgal)	(a)		100
Sluice C-106 solids to AZ-101 (via AY-102) (800 Kgal)	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW Tank Farm	(a)		100
Bottom decant/transfer AY-102 to AZ-101 (575 Kgal)	(a)		100
Caustic leach and wash AZ-101 (contains C-106 solids) (5 transfers)	(h)		3,800
Wash AZ-102 (4 transfers)	(h)		5,900
Mobilize and transfer AZ-101 solids to AZ-102 (600 Kgal)	(a)		100
Decant/transfer AY-101 supernate to AZ-101 (700 Kgal)	(a)		100
Transfer AW-106 to AZ-101 (150 Kgal)	(g)		70
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Transfer AW-106 to AZ-101 (150 Kgal)	(g)		70
Transfer AW (7M Na) to AY-102 (850 Kgal)	(a)		100
Transfer AW (7M Na) to AY-101 (950 Kgal)	(a)		100
TOTAL COST		26,920	35,236

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer.

In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 1 to 2 years for AZ-101.

(h) For caustic leaching and washing of AZ-101, it is assumed that five transfers will be performed:
*One transfer of 100 Kgal of caustic from 204-AR to AZ-101
*One transfer of 100 Kgal of caustic supernate to AW for evaporation at the 242-A evaporator at $5.54/gal
*Two transfers of 500 Kgal dilute liquid to AZ-101
*One transfer of 500 Kgal to AW for evaporation at the 242-A evaporator at $5.54/gal.
For washing of AZ-102, it is assumed that four transfers will be performed:
*Two transfers of 500 Kgal dilute liquid to AZ-102
*Two transfers of 500 Kgal to AW for evaporation at the 242-A evaporator at $5.54/gal.

ALTERNATIVE N5a
Consolidation of AZ Tank Farm solids in tank AZ-102.

Project (Capital)		CAPITAL ($000)	EXPENSE ($000)
W-211 Initial Waste Retrieval System/AZ-102 (Construction complete 09/00)			
Engineering (Title II & III)		5,160	
Project Management		1,820	
Construction		16,120	
Other project costs		3,020	
Operating Costs (Expense and CENRTC)			
Tank bump USQs and miscellaneous safety issues			3,000
Transfer procedure preparation			135
Transfer AY-101 supernate to AP-101 (existing pump) (850 Kgal)	(a)(e)		4,800
Install AZ-101 decant system	(b)	400	400
Decant/transfer AZ-101 supernate to AY-101 (900 Kgal)	(a)		135
Transfer AY-102 supernate to AZ-101 (existing pump) (750 Kgal)	(a)		135
In-tank process test AZ-101	(c)		5,050
Install AZ-102 decant system	(b)	400	400
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102	(g)		80
Mobilize and transfer AZ-101 solids to AZ-102 (800 Kgal)	(a)		100
Sluice C-106 solids to AZ-101 (via AY-102) (800 Kgal)	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW Tank Farm	(a)		100
Bottom decant/transfer AY-102 to AZ-101 (575 Kgal)	(a)		100
Mobilize and transfer AZ-101 solids to AZ-102 (600 Kgal)	(a)		100
Decant/transfer AY-101 supernate to AZ-101 (700 Kgal)	(a)		100
Transfer AW-106 to AZ-101 (150 Kgal)	(g)		70
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Transfer AW-106 to AZ-101 (150 Kgal)	(g)		70
Transfer AW (7M Na) to AY-102 (850 Kgal)	(a)		100
Transfer AW (7M Na) to AY-101 (950 Kgal)	(a)		100
TOTAL COST		26,920	25,455

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer.

In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 1 to 2 years for AZ-101.

ALTERNATIVE 5b
Consolidation of AY-102 and AZ Tank Farm solids in tank AZ-102.

Project (Capital)		CAPITAL ($000)	EXPENSE ($000)
W-211 Initial Waste Retrieval System/AZ-102 (Construction complete 09/00)			
Engineering (Title II & III)		5,160	
Project Management		1,820	
Construction		16,120	
Other project costs		3,020	
W-211 Initial Waste Retrieval System/AY-102 (Construction complete 08/02)			
Engineering (Title II & III)		5,420	
Project Management		1,960	
Construction		20,890	
Other project costs		3,020	
Operating Costs (Expense and CENRTC)			
Tank bump USQs and miscellaneous safety issues			3,300
Transfer procedure preparation			279
Transfer AY-101 supernate to AP-101 (existing pump) (850 Kgal)	(a)(e)		4,800
Install AZ-101 decant system	(b)	400	400
Decant/transfer AZ-101 supernate to AY-101 (900 Kgal)	(a)		135
Transfer AY-102 supernate to AZ-101 (existing pump) (750 Kgal)	(a)		135
In-tank process test AZ-101	(c)		5,050
Install AZ-102 decant system	(b)	400	400
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102	(g)		80
Mobilize and transfer AZ-101 solids to AZ-102 (600 Kgal)	(a)		100
Sluice C-106 solids to AZ-101 (via AY-102) (800 Kgal)	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW Tank Farm	(a)		100
Bottom decant/transfer AY-102 to AZ-101 (575 Kgal)	(a)		100
Caustic leach and wash AZ-101 (contains C-106 solids) (5 transfers)	(h)		3,800
Wash AZ-102 (4 transfers)	(h)		5,900
Mobilize and transfer AZ-101 solids to AZ-102 (600 Kgal)	(a)		100
Decant/transfer AY-101 supernate to AZ-101 (700 Kgal)	(a)		100
Transfer AW-106 to AZ-101 (150 Kgal)	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Transfer AW-106 to AZ-101 (150 Kgal)	(g)		70
Decant AZ-102 supernate to AW (500 Kgal) (to be concentrated)	(e)		3,200
Caustic leach and wash AY-102 (5 transfers)	(h)		3,800
Mobilize and transfer AY-102 solids to AZ-102 (600 Kgal)	(a)		100
Transfer AW (7M Na) to AY-102 (950 Kgal)	(a)		100
Transfer AW (DSSF) to AY-101 (900 Kgal)	(a)		100
TOTAL COST		58,210	42,709

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer.

In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 5 to 6 years for AZ-102.

(h) For caustic leaching and washing of AZ-101, it is assumed that five transfers will be performed:
*One transfer of 100 Kgal of caustic from 204-AR to AZ-101
*One transfer of 100 Kgal of caustic supernate to AW for evaporation at the 242-A evaporator at $5.54/gal
*Two transfers of 500 Kgal dilute liquid to AZ-101
*One transfer of 500 Kgal to AW for evaporation at the 242-A evaporator at $5.54/gal.
For washing of AZ-102, it is assumed that four transfers will be performed:
*Two transfers of 500 Kgal dilute liquid to AZ-102
*Two transfers of 500 Kgal to AW for evaporation at the 242-A evaporator at $5.54/gal.
For caustic leaching and washing of AY-102, it is assumed that five transfers will be performed:
*One transfer of 100 Kgal of caustic from 204-AR to AY-102
*One transfer of 100 Kgal of caustic supernate to AW for evaporation at the 242-A evaporator at $5.54/gal
*Two transfers of 500 Kgal dilute liquid to AY-102
*One transfer of 500 Kgal to AW for evaporation at the 242-A evaporator at $5.54/gal.

ALTERNATIVE N5b
Consolidation of AY-102 and AZ Tank Farm solids in tank AZ-102.

Project (Capital)		CAPITAL ($000)	EXPENSE ($000)
W-211 Initial Waste Retrieval System/AZ-102 (Construction complete 09/00)			
Engineering (Title II & III)		5,160	
Project Management		1,820	
Construction		16,120	
Other project costs		3,020	
W-211 Initial Waste Retrieval System/AY-102 (Construction complete 08/02)			
Engineering (Title II & III)		5,420	
Project Management		1,960	
Construction		20,890	
Other project costs		3,020	
Operating Costs (Expense and CENRTC)			
Tank bump USQs and miscellaneous safety issues			3,300
Transfer procedure preparation			279
Transfer AY-101 supernate to AP-101 (existing pump) (850 Kgal)	(a)(e)		4,800
Install AZ-101 decant system Decant/transfer AZ-101 supernate to AY-101 (900 Kgal)	(b) (a)	400	400 135
Transfer AY-102 supernate to AZ-101 (existing pump) (750 Kgal)	(a)		135
In-tank process test AZ-101	(c)		5,050
Install AZ-102 decant system Decant/transfer AZ-102 (450 Kgal) supernate to AW-102	(b) (g)	400	400 80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102	(g)		80
Mobilize and transfer AZ-101 solids to AZ-102 (600 Kgal)	(a)		100
Sluice C-106 solids to AZ-101 (via AY-102) (800 Kgal)	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 800 Kgal to AW Tank Farm	(a)		100
Bottom decant/transfer AY-102 to AZ-101 (575 Kgal)	(a)		100
Mobilize and transfer AZ-101 solids to AZ-102 (600 Kgal)	(a)		100
Decant/transfer AY-101 supernate to AZ-101 (700 Kgal)	(a)		100
Transfer AW-106 to AZ-101 (150 Kgal)	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Transfer AW-106 to AZ-101 (150 Kgal)	(g)		70
Decant AZ-102 supernate to AW (500 Kgal) (to be concentrated)	(e)		3,200
Mobilize and transfer AY-102 solids to AZ-102 (600 Kgal)	(a)		100
Transfer AW (7M Na) to AY-102 (950 Kgal)	(a)		100
Transfer AW (DSSF) to AY-101 (900 Kgal)	(a)		100
TOTAL COST		58,210	29,209

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer.

In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 5 to 6 years for AZ-102.

ALTERNATIVE 5c
Consolidation of AY-101 and AZ Tank Farm solids in tank AZ-102.

Project (Capital)		CAPITAL ($000)	EXPENSE ($000)
W-211 Initial Waste Retrieval System/AZ-102 (Construction complete 09/00)			
Engineering (Title II & III)		5,160	
Project Management		1,820	
Construction		16,120	
Other project costs		3,020	
W-211 Initial Waste Retrieval System/AY-101 (Construction complete 08/02)			
Engineering (Title II & III)		5,420	
Project Management		1,960	
Construction		20,890	
Other project costs		3,020	
Operating Costs (Expense and CENRTC)			
Tank bump USQs and miscellaneous safety issues			3,500
Transfer procedure preparation			252
Transfer AY-101 supernate to AP-101 (existing pump) (850 Kgal)	(a)(e)		4,800
Install AZ-101 decant system	(b)	400	400
Decant/transfer AZ-101 supernate to AY-101 (900 Kgal)	(a)		135
Transfer AY-102 supernate to AZ-101 (existing pump) (750 Kgal)	(a)		135
In-tank process test AZ-101	(c)		5,050
Install AZ-102 decant system	(b)	400	400
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102	(g)		80
Mobilize and transfer AZ-101 solids to AZ-102	(a)		100
Sluice C-106 solids to AZ-101 (800 Kgal)	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW Tank Farm	(A)		100
Bottom decant/transfer AY-102 to AZ-101 (575 Kgal)	(a)		100
Caustic leach and wash AZ-101 (contains C-106 solids) (5 transfers)	(h)		3,800
Wash AZ-102 (4 transfers)	(h)		5,900
Mobilize and transfer AZ-101 solids to AZ-102 (600 Kgal)	(a)		100
Decant/transfer AY-101 (AZ-101 supernate) to AZ-101 (700 Kgal)	(a)		100
Wash AY-101 (3 transfers)	(h)		2,300
Mobilize and transfer AY-101 solids to AZ-102 (500 Kgal)	(a)		100
Transfer AW-106 to AZ-101 (150 Kgal)	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Transfer AW-106 to AZ-101 (150 Kgal)	(g)		70
Transfer AW (DSSF) to AY-101 (950 Kgal)	(a)		100
Transfer AW (7M Na) to AY-102 (850 Kgal)	(a)		100
TOTAL COST		58,210	38,182

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer.

In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 5 to 6 years for AZ-102.

(h) For caustic leaching and washing of AZ-101, it is assumed that five transfers will be performed:
*One transfer of 100 Kgal of caustic from 204-AR to AZ-101
*One transfer of 100 Kgal caustic supernate to AW for evaporation at the 242-A evaporator at $5.54/gal
*Two transfers of 500 Kgal dilute liquid to AZ-101
*One transfer of 500 Kgal to AW for evaporation at the 242-A evaporator at $5.54/gal.
For washing of AZ-102, it is assumed that four transfers will be performed:
*Two transfers of 500 Kgal dilute liquid to AZ-102
*Two transfer of 500 Kgal to AW for evaporation at the 242-A evaporator at $5.54/gal.
For washing of AY-101, it is assumed that three transfers will be performed:
*Two transfers of 400 Kgal dilute liquid to AY-101
*One transfer of 400 Kgal to AW for evaporation at 242-A evaporator at $5.54/gal.

ALTERNATIVE N5c
Consolidation of AY-101 and AZ Tank Farm solids in tank AZ-102.

Project (Capital)		CAPITAL ($000)	EXPENSE ($000)
W-211 Initial Waste Retrieval System/AZ-102 {Construction complete 09/00}			
Engineering (Title II & III)		5,160	
Project Management		1,820	
Construction		16,120	
Other project costs		3,020	
W-211 Initial Waste Retrieval System/AY-101 {Construction complete 08/02}			
Engineering (Title II & III)		5,420	
Project Management		1,960	
Construction		20,890	
Other project costs		3,020	
Operating Costs (Expense and CENRTC)			
Tank bump USQs and miscellaneous safety issues			3,500
Transfer procedure preparation			252
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}	(a)(e)		4,800
Install AZ-101 decant system	(b)	400	400
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}	(a)		135
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}	(a)		135
In-tank process test AZ-101	(c)		5,050
Install AZ-102 decant system	(b)	400	400
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102	(g)		80
Mobilize and transfer AZ-101 solids to AZ-102	(a)		100
Sluice C-106 solids to AZ-101 {800 Kgal}	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW Tank Farm	(a)		100
Bottom decant/transfer AY-102 to AZ-101 {575 Kgal}	(a)		100
Mobilize and transfer AZ-101 solids to AZ-102 {600 Kgal}	(a)		100
Decant/transfer AY-101 (AZ-101 supernate) to AZ-101 {700 Kgal}	(a)		100
Mobilize and transfer AY-101 solids to AZ-102 {500 Kgal}	(a)		100
Transfer AW-106 to AZ-101 {150 Kgal}	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Transfer AW-106 to AZ-101 {150 Kgal}	(g)		70
Transfer AW (DSSF) to AY-101 {950 Kgal}	(a)		100
Transfer AW (7M Na) to AY-102 {850 Kgal}	(a)		100
TOTAL COST		58,210	26,182

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer.

In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 5 to 6 years for AZ-102.

ALTERNATIVE 6
Consolidation of AZ Tank Farm solids in tank AZ-102.

Project (Capital)		CAPITAL ($000)	EXPENSE ($000)
W-211 Initial Waste Retrieval System/AZ-102 (Construction complete 09/00)			
Engineering (Title II & III)		5,160	
Project Management		1,820	
Construction		16,120	
Other project costs		3,020	
W-211 initial Waste Retrieval System/AY-101 (Construction complete 08/02)			
Engineering (Title II & III)		5,420	
Project Management		1,960	
Construction		20,890	
Other project costs		3,020	
W-211 Initial Waste Retrieval System/AY-102 (Construction complete 12/02)			
Engineering (Title II & III)		5,420	
Project Management		1,960	
Construction		20,890	
Other project costs		3,020	
Operating Costs (Expense and CENRTC)			
Tank bump USQs and miscellaneous safety issues			3,900
Transfer procedure preparation			270
Transfer AY-101 supernate to AP-101 (existing pump) (850 Kgal)	(a)(e)		4,800
Install AZ-101 decant system	(b)	400	400
Decant/transfer AZ-101 supernate to AY-101 (900 Kgal)	(a)		135
Transfer AY-102 supernate to AZ-101 (existing pump) (750 Kgal)	(a)		135
In-tank process test AZ-101	(c)		5,050
Install AZ-102 decant system	(b)	400	400
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102	(g)		80
Mobilize and transfer AZ-101 solids to AZ-102 (600 Kgal)	(a)		100
Sluice C-106 solids to AZ-101 (via AY-102) (800 Kgal)	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW Tank Farm	(a)		100
Bottom decant/transfer AY-102 to AZ-101 (575 Kgal)	(a)		100
Caustic leach and wash AZ-101 (contains C-106 solids) (5 transfers)	(h)		3,800
Wash AZ-102 (4 transfers)	(h)		5,900
Mobilize and transfer AZ-101 solids to AZ-102 (600 Kgal)	(a)		100
Decant/transfer AY-101 (AZ-101 supernate) to AZ-101 (700 Kgal)	(a)		100
Transfer AW-106 to AZ-101 (150 Kgal)	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Transfer AW-106 to AZ-101 (150 Kgal)	(g)		70
Dilute waste from AP T.F. to AY-101 (400 Kgal)	(a)		100
Mobilize and transfer AY-101 solids to AY-102 (500 Kgal)	(a)		100
Caustic leach and wash AY-102 (6 transfers)	(h)		6,140
Mobilize and transfer AY-102 solids to AZ-102 (800 Kgal)	(a)		100
Transfer AW (DSSF) to AY-102 (950 Kgal)	(a)		100
Transfer AW (DSSF) to AY-101 (950 Kgal)	(a)		100
TOTAL COST		89,500	42,640

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer.

In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 5 to 6 years for AZ-102.

(h) For caustic leaching and washing of AZ-101, it is assumed that five transfers will be performed:
*One transfer of 100 Kgal of caustic from 204-AR to AZ-101
*One transfer of caustic supernate out of 100 Kgal to AW for evaporation at the 242-A evaporator at $5.54/gal
*Two transfers of 500 Kgal dilute liquid to AZ-101
*One transfer of 500 Kgal to AW for evaporation at the 242-A evaporator at $5.54/gal.
For washing of AZ-102, it is assumed that four transfers will be performed:
*Two transfers of 500 Kgal dilute liquid to AZ-102
*Two transfers of 500 Kgal to AW for evaporation at the 242-A evaporator at $5.54/gal.
For caustic leaching and washing of AY-102, it is assumed that six transfers will be performed:
*One transfer of 100 Kgal of caustic from 204-AR to AY-102
*One transfer of caustic supernate out of 100 Kgal to AW for evaporation at the 242-A evaporator at $5.54/gal
*Two transfers of 750 Kgal dilute liquid to AY-102
*One transfer of 750 Kgal to AW for evaporation at the 242-A evaporator at $5.54/gal
*One transfer of 150 Kgal to AW for evaporation at the 242-A evaporator at $5.54/gal.

ALTERNATIVE N6
Consolidation of AZ tank farm solids in tank AZ-102.

Project (Capital)		CAPITAL ($000)	EXPENSE ($000)
W-211 Initial Waste Retrieval System/AZ-102 (Construction complete 09/00)			
Engineering (Title II & III)		5,160	
Project Management		1,820	
Construction		16,120	
Other project costs		3,020	
W-211 initial Waste Retrieval System/AY-101 (Construction complete 08/02)			
Engineering (Title II & III)		5,420	
Project Management		1,960	
Construction		20,890	
Other project costs		3,020	
W-211 Initial Waste Retrieval System/AY-102 (Construction complete 12/02)			
Engineering (Title II & III)		5,420	
Project Management		1,960	
Construction		20,890	
Other project costs		3,020	
Operating Costs (Expense and CENRTC)			
Tank bump USQs and miscellaneous safety issues			3,900
Transfer procedure preparation			270
Transfer AY-101 supernate to AP-101 (existing pump) (850 Kgal)	(a)(e)		4,800
Install AZ-101 decant system	(b)	400	400
Decant/transfer AZ-101 supernate to AY-101 (900 Kgal)	(a)		135
Transfer AY-102 supernate to AZ-101 (existing pump) (750 Kgal)	(a)		135
In-tank process test AZ-101	(c)		5,050
Install AZ-102 decant system	(b)	400	400
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102	(g)		80
Mobilize and transfer AZ-101 solids to AZ-102 (600 Kgal)	(a)		100
Sluice C-106 solids to AZ-101 (via AY-102) (800 Kgal)	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW Tank Farm	(a)		100
Bottom decant/transfer AY-102 to AZ-101 (575 Kgal)	(a)		100
Mobilize and transfer AZ-101 solids to AZ-102 (600 Kgal)	(a)		100
Decant/transfer AY-101 (AZ-101 supernate) to AZ-101 (700 Kgal)	(a)		100
Transfer AW-106 to AZ-101 (150 Kgal)	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Transfer AW-106 to AZ-101 (150 Kgal)	(g)		70
Dilute waste from AP T.F. to AY-101 (400 Kgal)	(a)		100
Mobilize and transfer AY-101 solids to AY-102 (500 Kgal)	(a)		100
Mobilize and transfer AY-102 solids to AZ-102 (800 Kgal)	(a)		100
Transfer AW (DSSF) to AY-102 (950 Kgal)	(a)		100
Transfer AW (DSSF) to AY-101 (950 Kgal)	(a)		100
TOTAL COST		89,500	26,800

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer.

In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 5 to 6 years for AZ-102.

ALTERNATIVE 7a
Transfer C-106 solids sluiced into AY-102 and immediately transfer the solids into tank AZ-101.

Operating Costs (Expense and CENRTC)		CAPITAL ($000)	EXPENSE ($000)
Tank bump USQs and miscellaneous safety issues			2,300
Transfer procedure preparation			117
Transfer AY-101 supernate to AP-101 (existing pump) (850 Kgal)	(a)(e)		4,800
Install AZ-101 decant system	(b)	400	400
Decant/transfer AZ-101 supernate to AY-101 (900 Kgal)	(a)		135
Transfer AY-102 supernate to AZ-101 (existing pump) (750 Kgal)	(a)		135
In-tank process test AZ-101	(c)		5,050
Decant/transfer AZ-101 to AY-102	(a)		135
Replace 75-hp mixer pump in AY-102	(h)		1,000
Sluice C-106 solids to AZ-101 (via AY-102) (800 Kgal)	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW Tank Farm	(a)		100
Install decant system into AZ-102	(b)	400	400
Decant/transfer AZ-102 supernate (450 Kgal) to AW-102	(g)		80
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Decant/transfer AZ-102 supernate (450 Kgal) to AW-102	(g)		80
Decant/transfer AY-101 (AZ-101 supernate) to AZ-102 (800 Kgal)	(a)		100
In-tank concentrate AZ-101 (250 Kgal condensate to AY-101)	(f)		2,385
Transfer AW-106 to AZ-102 (150 Kgal)	(g)		70
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106	(e)		2,500
Transfer AW-106 to AZ-102 (150 Kgal)	(g)		70
Transfer AW (7M Na) to AY-101 (850 Kgal)	(a)		100
Transfer AW (7M Na) to AY-102 (850 Kgal)	(a)		100
TOTAL COST		800	27,957

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer.

In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 1 to 2 years for AZ-102.

(h) The current 75-hp mixer pump has failed and needs to be replaced. The unit cost for a new mixer pump is estimated to be $350K. The cost to remove the failed mixer, place it into a burial container, and disposal of the pump as solid waste is $650K. These values include the procurement of the burial container, labor for removal, transport of container to solid waste, and the burial cost.

ALTERNATIVE 7b
Transfer C-106 solids sluiced into AY-102 and immediately transfer the solids into tank AZ-101.

Operating Costs (Expense and CENRTC)		CAPITAL ($000)	EXPENSE ($000)
Tank bump USQs and miscellaneous safety issues			2,300
Transfer procedure preparation			117
Transfer AY-101 supernate to AP-101 (existing pump) (850 Kgal)	(a)(e)		4,800
Install AZ-101 decant system	(b)	400	400
Decant/transfer AZ-101 supernate to AY-101 (900 Kgal)	(a)		135
Transfer AY-102 supernate to AZ-101 (existing pump) (750 Kgal)	(a)		135
In-tank process test AZ-101	(c)		5,050
Decant/transfer AZ-101 to AY-102	(a)		135
Replace 75-hp mixer pump in AY-102	(h)		1,000
Sluice C-106 solids to AZ-101 (via AY-102) (800 Kgal)	(d)		5,400
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW Tank Farm	(a)		100
Install decant system into AZ-102	(b)	400	400
Decant/transfer AY-101 (AZ-101 supernate) to AZ-102 (800 Kgal)	(a)		100
In-tank concentrate AZ-101 (250 Kgal condensate to AY-101)	(f)		2,385
In-tank concentrate AZ-102 (500 Kgal) to dilute receiver	(f)		2,900
Transfer AW (7M Na) to AY-101 (850 Kgal)	(a)		100
Transfer AW (7M Na) to AY-102 (850 Kgal)	(a)		100
TOTAL COST		800	25,557

NOTE: See footnotes (a) through (h) starting on page A-48.

(f) In-tank concentration in any of the aging waste tanks is assumed to be accomplished with the existing ventilation system (W-030). Accomplishment of this task will require shutdown of the individual tank condensers and running the ventilation system chiller condenser system at an increased rate. The chiller condenser system routes the collected condensate to catch tank 241-AZ-151. Pumping of the catch tank is a routine 12-Kgal transfer.

In order to pump out catch tank AZ-151 the waste is transferred through line 4605 to diversion box 241-AZ-152. The waste is then routed through line D-602 to the AZ-102-02A pump pit, and through SL-500 to the AX-A valve pit. The waste can either be routed to AW or AP Tank Farms to be staged for evaporation at the 242-A evaporator or be routed to a dilute waste DST receiver tank such as AY-101. It is assumed this operation would last approximately 1 to 2 years for AZ-101. It is assumed this operation would last approximately 5 to 6 years for AZ-102.

(h) The current 75-hp mixer pump has failed and needs to be replaced. The unit cost for a new mixer pump is estimated to be $350K. The cost to remove the failed mixer, place it into a burial container, and disposal of the pump as solid waste is $650K. These values include the procurement of the burial container, labor for removal, transport of container to solid waste, and the burial cost.

FOOTNOTES

(a) Assumes that one waste sample is required before each transfer at a cost of $70K.

Setup of a waste transfer route requires entering into existing process pits and making jumper changes. Each pit entry is assumed to cost approximately $10K for field personnel support. It is assumed that rigid jumpers will be constructed to provide the greatest routing flexibility for all transfers required to support the alternative implementation; therefore, it is assumed that the initial routing setups will incur the greatest cost burden to install the routes. To support this philosophy, it is assumed that two rigid jumpers will be installed in the AX and A valve pits to support waste transfers to and from the AW and AP Tank Farms.

The cost for workforce support of a transfer is assumed to be two employees per 24-hour period at a cost of $2.4K.
It is assumed that all transfers are accomplished at a pumping rate of 100 gal/min.

Average time span for waste transfers is approximately 5 days: each day is assumed to be a 24-hour period. For a conservative approach, it is assumed that each transfer will cost approximately $135K. Therefore, the initial setup of a route is $135K and return transfers are estimated to be $100K.

(b) Cost for installation of a decant pump system including instrumentation, controllers, installation, and project management. These costs were obtained from the W-151 process test management team.

(c) It is assumed per internal memo 73520-95-032, Process Design, to G. A. Meyer from G. T. MacLean, Westinghouse Hanford Company, Richland, Washington, September 6, 1995, that the AZ-101 process test will be performed in FY96 (5/96-8/96). The costs include installation of equipment not included in Project W-151. Additionally, the costs cover labor that will be required to support the testing of mixer pumps and the transfer of waste as discussed in the aforementioned letter.

(d) It is assumed by Project W-320 that sluicing of C-106 will require approximately 2 years to perform. This time frame includes operator training, sluicing operation, and D&D for the operating system. The total cost is estimated to be $5.4M. Performance period and cost information was provided by the W-320 management team via cc:Mail from T. Shaw.

(e) This waste will be concentrated in the 242-A evaporator at an estimated cost of $5.54/gal of throughput. Cost per gallon estimate was provided via cc:Mail by T. W. Seifert.

(f) Refer to specific note with Alternative.

(g) Transfer of supernate waste is estimated using the following assumptions:

- One sample will be required for each transfer at $70K each
- One day (24-hours) support by two personnel is estimated to be $2.4K
- The transfer rate is assumed to be 100 gal/min.
- The duration for the various transfers is:
  - 450,000 gal -- 3 days
  - 50,00 gal -- 8 hours
- Additionally, it is assumed that no pit entries will be required to set up the route.

(h) Refer to specific note with Alternative.

GENERAL NOTE:
Volumes are estimated to the nearest 50,000 gal.

DEFINITION OF TERMS

CENRTC	Capital equipment not related to construction
D&D	Decontamination and decommissioning
DSSF	Double-shell slurry feed
DST	Double-shell tank
FY	Fiscal year
USQ	Unresolved safety question

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APPENDIX B

SCHEDULE

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APPENDIX B

SCHEDULE

Schedules

Schedules contain the major operational steps in each alternative such as liquid and solids transfers between tanks. The schedules also include other major activities such as concentration of liquids, and in-tank operations such as leaching and washing.

Project schedules have a significant impact on the schedules for each alternative. The projects for installing initial retrieval systems (mixer pumps and retrieval systems) have the biggest impact on each of those alternatives which include retrieval and transfer of solids. In addition to retrieval and transfer of solids, mixing systems are essential to those alternatives which include in-tank washing and leaching.

Detailed schedules for each alternative may be found at the end of this appendix.

Assumptions

Existing project schedules were used to determine the schedule for equipment installation. In some projects, flexibility in the sequence of events is possible if decisions are made well in advance of implementation. In particular, Project W-211 installs mixer pump systems in several tanks. In each alternative, Project W-211 installs mixer pumps in tanks SY-102 and AW-105 before installing mixer pump systems in any of the AY and AZ tanks. After the first two tanks are installed, the order of mixer pump installation is determined by choosing the tanks that will result in the earliest completion of the operations within the alternative. The time between installation of mixer pump systems in each tank is about 1 year.

Project W-320 installs the retrieval system in tank C-106. This system is designed to retrieve the solids from C-106 into AY-102. Changing from AY-102 to some other receiver tank will change the project completion date between 7 to 12 months from the existing late fiscal year (FY) 1996 completion date.

Project W-151 is scheduled to complete installation of a mixer pump system into tank AZ-101 in FY 1996. Changing this project to put the mixer pumps into another tank is unfeasible at this late date.

Retrieval of solids from C-106 requires 3 to 4 months. Mixer pump transfer of solids from one double-shell tank to another requires about 2 months. Decanting liquid from one tank to another requires about 1 month. Leaching of solids requires about 6 months. Washing of solids requires about 4 months.

Concentration of supernate in Evaporator 242-A does not impact schedules in the AZ and AY Tank Farms because the evaporator is expected to have excess capacity during periods of waste consolidation.

Alternatives 5a, 5b and 5c

Alternatives 5a, 5b, and 5c are similar to the planning alternative (5a) (Bacon 1995). Transfers depend on the installation or availability of pumps and transfer routes. Many of these transfer systems are provided by projects, and project completion becomes the enabling action required before many of the transfers can be initiated. The physical transfer of waste from one tank to another requires up to 2 weeks. The time allotted to transfers in the schedules is longer to accommodate sampling and analysis of solutions before transfer as well as other operating, maintenance, and process control support activities which are a part of each transfer.

Based on the projected operating schedule of Project W-320, sluicing of C-106 solids to AZ-101 via AY-102 will require as long as 9 months to complete. Other activities requiring longer schedules include leaching and washing processes which require up to 9 months to complete. Washing of solids without leaching requires a minimum of 3 months.

Alternatives 1a and 1b

Alternatives 1a and 1b change the receiver of C-106 retrieved waste from AY-102 to AZ-101. Rerouting the transfer lines from C-106 to AZ-101 requires 7 to 12 months. All subsequent related activities also will be delayed.

In Alternative 1a, in-tank concentration of AZ-101 supernate in AY-102 requires about 24 months.

Alternative 3

In Alternative 3, in-tank concentration of supernate in AZ-102 requires about 20 months.

Alternative 4

Alternative 4 is similar to Alternative 1 except the receiver of C-106-retrieved waste is AZ-102. Leaching and washing in AZ-102 occurs after the installation of the mixer system in FY 2001.

Alternative 6

Alternative 6 is similar to Alternatives 5a, 5b, and 5c. In Alternative 6, the additional steps of combining, leaching, and washing the solids in tanks AY-101 and AY-102 add about 17 months to the overall schedule.

Comparison of Schedules of Alternatives

The schedule for each alternative is compared to the desired completion date. The desired completion date is 2001 for having the solids consolidated and ready to feed to disposal processes. The earliest completion date is 1998 for completing Alternative 2. This completion date is given a scale of 100%.

Completion in 2001 is given a value of 85%. The latest completion date is 2004 for Alternatives 5b, 5c, and 6. This completion date is given a value of 0%. Other values are Alternatives 1a, 3, and 7 completed in 1999 with a value of 95%. Alternative 0a is given a completion date of 2000 and a value of 90%. Alternatives 0b and 5a are given a completion date of 2001 and a value of 85%. Alternatives 1b and 4 are given a completion date of 2002 and a value of 56%. Other alternative end points (the "N" alternatives) are shown at the end of this appendix. In general, the "N" alternatives finish more quickly than do their non-N namesakes because of the deletion of caustic leaching.

REFERENCES

Bacon, R. F., 1995, *Double-Shell Tank Waste Consolidation and Retrieval Planning Base Case* (internal memo 73510-95-017 to C. A. Augustine et al., August 29), Westinghouse Hanford Company, Richland, Washington.

Schedules

The following schedules at the end of this appendix are target schedules. Many of the activities for waste transfers reflect a time duration of up to 3 months; in most of the cases, the actual transfer will last 5 to 14 days. Therefore, the time frames represented should consider that the activity takes place within the 3-month window identified.

The schedules also assume that jumpers required to make up the routes to support a transfer are available or can be fabricated before the transfer is required. Many of the jumpers are in the planning stage.

Alternative 0a	FY96	FY97	FY98	FY99	FY00	FY01
Tank bump USQs and miscellaneous safety issues						
Transfer procedure preparations						
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}						
Install AZ-101 decant system						
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}						
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}						
In-tank process test AZ-101						
Sluice C-106 solids to AY-102 {800 Kgal}						
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW						
Decant/transfer AZ-101 (AY-102 supernate) to AW Tank Farm {750 Kgal}						
Transfer AY-101 (AZ-101 supernate) to AZ-101 {900 Kgal}						
Transfer concentrated 5M Na at AW to AY-102 {900 Kgal}						
In-tank concentration of AZ-102 {400 Kgal}						
Transfer concentrated 5<u>M</u> Na at AW to AZ-102 {400 Kgal/2 transfers}						
Transfer concentrated 5<u>M</u> Na at AW to AY-101 {850 Kgal}						
Decant pump operational						
	AZ-101	AZ-102	AW-103			
Mixer pump systems operational						
	AZ-101		SY-102	AW-105	AZ-102	
	(W-151)		(W-211)	(W-211)	(W-211)	
COST PROFILE						
EXPENSE	6,125	15,995	250	250	390	0
CAPITAL	400	0	0	0	0	0
TOTAL ($000)	6,525	15,995	250	250	390	0

Alternative 0b	***FY96***	***FY97***	***FY98***	***FY99***	***FY00***	***FY01***
Tank bump USQs and miscellanous safety issues						
Transfer procedure preparations						
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}						
Install AZ-101 decant system						
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}						
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}						
In-tank process test AZ-101						
Sluice C-106 solids to AY-102 {800 Kgal}						
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW						
Decant/transfer AZ-101 (AY-102 supernate) to AW Tank Farm {750 Kgal}						
Transfer AY-101 (AZ-101 supernate) to AZ-101 {900 Kgal}						
In-tank concentration of AZ-101 (concentrate to 7M Na) {250 Kgal}						
In-tank concentration of AZ-102 (concentrate to 7M Na) {500 Kgal}						
Transfer concentrated 7M Na at AW to AZ-101 {250 Kgal}						
Transfer concentrated 7M Na at AW to AY-102 {900 Kgal}						
Transfer concentrated 7M Na at AW to AZ-102 {400 Kgal/2 transfers}						
Transfer concentrated 7M Na at AW to AY-101 {850 Kgal}						
Decant pump operational						
	AZ-101	AZ-102	AW-103			
Mixer pump systems operational						
	AZ-101 (W-151)		SY-102 (W-211)	AW-105 (W-211)	AZ-102 (W-211)	
COST PROFILE						
EXPENSE	11,720	11,859	675	250	250	450
CAPITAL	400	0	0	0	0	0
TOTAL ($000)	12,120	11,859	675	250	250	450

Alternative 1a	FY96	FY97	FY98	FY99	FY00	FY01
REROUTE W-320 PIPELINES TO AZ-101 (construction complete 04/97)						
Tank bump USQs and miscellaneous safety issues						
Transfer procedure preparations						
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal.}						
Install AZ-101 decant system						
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal.}						
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal.}						
In-tank process test AZ-101						
Sluice C-106 solids to AZ-101 {800 Kgal.}						
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW						
Install decant pump in AZ-102						
Decant/transfer AZ-102; 450 Kgal. of supernate to AW-102						
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106						
Decant/transfer AY-101 (AZ-101 supernate) to AY-102 {850 Kgal.}						
In-tank concentrate AY-102 {250 Kgal}{2 transfers}						
Transfer AW-106 to AY-102 {150 Kgal}						
Decant/transfer AZ-102 450 K gallons of supernate to AW-102						
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator collect at AW-106						
Transfer AW-106 to AY-102 {150 Kgal.}						
Transfer AW (DSSF type A) to AZ-102 {500 Kgal.}						
Transfer AW (DSSF) to AY-101 {950 Kgal.}						
Caustic leach and wash AZ-101 solids (5 transfers)						
Decant pump operational	AZ-101	AZ-102	AW-103			
Mixer pump systems operational	AZ-101 (W-151)		SY-102 (W-211)	AW-105 (W-211)	AZ-102 (W-211)	
COST PROFILE						
EXPENSE	19,970	16,462	13,587	470	0	0
CAPITAL	800	0	0	0	0	0
TOTAL ($000)	20,770	16,462	13,587	470	0	0

Alternative N1a	FY96	FY97	FY98	FY99	FY00	FY01
REROUTE W-320 PIPELINES TO AZ-101 (construction complete 04/97)						
Tank bump USQs and miscellaneous safety issues						
Transfer procedure preparations						
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}						
Install AZ-101 decant system						
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}						
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}						
In-tank process test AZ-101						
Sluice C-106 solids to AZ-101 {800 Kgal}						
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW						
Install decant pump in AZ-102						
Decant/transfer AZ-102, evaporator; 450 Kgal of supernate to AW-102						
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator collect at AW-106						
Decant/transfer AY-101 (AZ-101 supernate) to AY-102 {850 Kgal}						
In-tank concentrate AY-102 {250 Kgal}{2 transfers}						
Transfer AW-106 to AY-102 {150 Kgal}						
Decant/transfer AZ-102; 450 Kgal of supernate to AW-102						
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator collect at AW-106						
Transfer AW-106 to AY-102 {150 Kgal}						
Transfer AW (DSSF type A) to AZ-102 {500 Kgal}						
Transfer AW (DSSF) to AY-101 {950 Kgal}						
Decant pump operational	AZ-101, AZ-102		AW-103			
Mixer pump systems operational	AZ-101 (W-151)		SY-102 (W-211)	AW-105 (W-211)	AZ-102 (W-211)	
COST PROFILE						
EXPENSE	19,947	16,439	4,932	470	0	0
CAPITAL	800	0	0	0	0	0
TOTAL ($000)	20,747	16,439	4,932	470	0	0

Alternative 1b	FY96	FY97	FY98	FY99	FY00	FY01	FY02
REROUTE W-320 PIPELINES to AZ-101 (construction complete 04/97)							
W-211/AZ-102 Initial Retrieval System - (construction complete 09/00)							
Tank bump USQs and miscellaneous safety issues							
Transfer procedure preparations							
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}							
Install AZ-101 decant system							
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}							
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}							
In-tank process test AZ-101							
Decant/transfer AY-101 (AZ-101 supernate) back to AY-102 {875 Kgal}							
Sluice C-106 solids to AZ-101 {800 Kgal}							
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW							
Install decant pump in AZ-102							
Decant/transfer AZ-102; 450 Kgal of supernate to AW-102							
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106							
Wash AZ-102 and decant to AP T.F. (3 transfers)							
Caustic leach and wash AZ-101, transfer supernate to AP T.F. (4 transfers)							
Mobilize and transfer AZ-102 solids to AZ-101							
Decant/transfer AY-101 supernate (AZ-101 concentrated supernate) to AZ-102							
Decant/transfer AZ-102; 450 Kgal of supernate to AW-102							
Transfer AW-106 to AZ-102 {50 Kgal}							
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106							
Transfer AW-106 to AZ-102 {50 Kgal}							
Transfer AW (DSSF type A) to AY-101 {850 Kgal}							
Transfer AW (DSSF) to AY-102 { 800 Kgal}							
Decant pump system operational							
AZ-101	AZ-102		AW-103				
Mixer pump system operational							
	AZ-101		SY-102		AW-105	AZ-102	
	(W-151)		(W-211)		(W-211)	(W-211)	
COST PROFILE							
EXPENSE	20,483	13,939	7,138	5,980	200	8,655	200
CAPITAL	2,116	1,316	7,116	10,026	6,346	0	0
TOTAL ($000)	22,599	15,255	14,254	16,006	6,546	8,655	200

Alternative N1b	FY96	FY97	FY98	FY99	FY00	FY01	FY02
REROUTE W-320 PIPELINES to AZ-101 (construction complete 04/97)							
W-211/AZ-102 Initial Retrieval System - (construction complete 09/00)							
Tank Bump USQ's and Miscellaneous Safety Issues							
Transfer Procedure Preparations							
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}							
Install AZ-101 decant system							
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}							
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}							
In-tank process test AZ-101							
Decant/transfer AY-101 (AZ-101 supernate) back to AY-102 {875 Kgal}							
Sluice C-106 solids to AZ-101 {800 Kgal}							
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW							
Install decant pump in AZ-102							
Decant/transfer AZ-102 450 Kgal of supernate to AW-102							
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106							
Mobilize and transfer AZ-102 solids to AZ-101							
Decant/transfer AY-101 supernate (AZ-101 concentrated supernate)to AZ-102							
Decant/transfer AZ-102 450 Kgal of supernate to AW-102							
Transfer AW-106 to AZ-102 {50 Kgal}							
Concentrate AW-102 (AZ-102 supernate) at 242-AA collect at AW-106							
Transfer AW-106 to AZ-102 {50 Kgal}							
Transfer AW (DSSF type A) to AY-101 {850 Kgal}							
Transfer AW (DSSF) to AY-102 { 800 Kgal}							
Decant pump system operational							
AZ-101	AZ-102		AW-103				
Mixer pump system operational							
	AZ-101		SY-102		AW-105	AZ-102	
	(W-151)		(W-211)		(W-211)	(W-211)	
COST PROFILE							
EXPENSE	20,452	15,744	4,532	270	0	200	0
CAPITAL	2,116	1,316	7,116	10,026	6,346	0	0
TOTAL ($000)	22,568	17,060	11,648	10,296	6,346	200	0

Alternative 2	FY96	FY97	FY98	FY99	FY00	FY01
Tank bump USQs and miscellaneous safety issues						
Transfer procedure preparations						
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}						
Install AZ-101 decant system						
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}						
Transfer AY-102 supernate to AZ-101 (existing pump) {904 Kgal}						
In-tank process test AZ-101						
Sluice C-106 solids to AY-102 {800 Kgal}						
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW						
Install AZ-102 decant system						
Decant/transfer AZ-102, 450 Kgal of supernate to AW-102						
Concentrate AW-102 (AZ-102 supernate) at 242-A evaporator; collect at AW-106						
Transfer AW-106 to AY-102 {150 Kgal}						
Decant/transfer AZ-102, 450 Kgal of supernate to AW-102						
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106						
Transfer AW-106 to AY-102 {150 Kgal}						
Transfer AW (7M Na) to AZ-102 {900 Kgal}						
Transfer AW (7M Na) to AZ-101 {900 Kgal}						
Decant pump operational						
	AZ-101	AZ-102	AW-103			
Mixer pump systems operational						
	AZ-101					
	(W-151)			SY-102	AW-105	AZ-102
				(W-211)	(W-211)	(W-211)
COST PROFILE						
EXPENSE	12,120	12,000	200	0	0	0
CAPITAL	800	0	0	0	0	0
TOTAL ($000)	12,920	12,000	200	0	0	0

Alternative 3	FY96	FY97	FY98	FY99	FY00	FY01
Tank bump USQ's and miscellaneous safety issues						
Transfer procedure preparations						
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}						
Install AZ-101 decant system						
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}						
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}						
In-tank process test AZ-101						
Decant /transfer AZ-101 to AY-102						
Sluice C-106 solids to AZ-101 (via AY-102) {800 Kgal}						
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW						
Caustic leach and wash AZ-101 (5 transfers)						
Install decant system into AZ-102						
Decant/transfer AZ-102 450 Kgal of supernate to AW-102						
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106						
Decant/transfer AZ-102 supernate (450 Kgal) to AW-102						
Decant/transfer AY-101 (AZ-101 supernate) to AZ-102 {800Kgal}						
In-tank concentrate AZ-102 {250 Kgal condensate to AY-101}						
Transfer AW-106 to AZ-102 {150 Kgal}						
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106						
Transfer AW-106 to AZ-102 {150 Kgal}						
Transfer AW (7M Na) to AY-101 {850 Kgal}						
Transfer AW (7M Na) to AY-102 {850 Kgal}						
Decant pump system operatinal						
	AZ-101 AZ-102		AW-103			
Mixer pump system operational						
	AZ-101		SY-102	AW-105		AZ-102
	(W-151)		(W-211)	(W-211)		(W-211)
COST PROFILE						
EXPENSE	12,151	11,079	5,524	963	0	0
CAPITAL	800	0	0	0	0	0
TOTAL ($000)	12,951	11,079	5,524	963	0	0

Alternative N3	FY96	FY97	FY98	FY99	FY00	FY01
Tank bump USQ's and miscellaneous safety issues						
Transfer procedure preparations						
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}						
Install AZ-101 decant system						
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}						
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}						
In-tank process test AZ-101						
Decant /transfer AZ-101 to AY-102						
Sluice C-106 solids to AZ-101 (via AY-102) {800 Kgal}						
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW						
Install decant system into AZ-102						
Decant/transfer AZ-102 450 Kgal of supernate to AW-102						
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106						
Decant/transfer AZ-102 supernate (450 Kgal) to AW-102						
Decant/transfer AY-101 (AZ-101 supernate) to AZ-102 {800Kgal}						
In-tank concentrate AZ-102 {250 Kgal condensate to AY-101}						
Transfer AW-106 to AZ-102 {150 Kgal}						
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106						
Transfer AW-106 to AZ-102 {150 Kgal}						
Transfer AW (7M Na) to AY-101 {850 Kgal}						
Transfer AW (7M Na) to AY-102 {850 Kgal}						
Decant pump system operatinal						
	AZ-101	AZ-102	AW-103			
Mixer pump system operational						
	AZ-101		SY-102	AW-105	AZ-102	
	(W-151)		(W-211)	(W-211)	(W-211)	
COST PROFILE						
EXPENSE	12,129	9,604	4,238	987	0	0
CAPITAL	800	0	0	0	0	0
TOTAL ($000)	12,929	9,604	4,238	987	0	0

Alternative 4	FY96	FY97	FY98	FY99	FY00	FY01	FY02
REROUTE W-320 PIPELINES to AZ-102 (construction complete 10/97)							
W-211/AZ-102 Initial Retrieval System (construction complete 09/00)							
Tank bump USQ's and miscellaneous safety issues							
Transfer procedure preparation							
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}							
Install AZ-101 decant system							
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}							
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}							
In-tank process test AZ-101							
Install AZ-102 decant system							
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102							
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106							
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102							
Sluice C-106 solids to AZ-102 {800 Kgal}							
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW							
Caustic leach and wash AZ-102 (6 transfers to AP)							
Wash AZ-101 and decant to AP T. F. (3 transfers)							
Mobilize and transfer AZ-101 solids to AZ-102							
Transfer AW-106 to AZ-101 {150 Kgal}							
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106							
Transfer AW-106 to AZ-101 {150 Kgal}							
Transfer AZ-102 (AZ-101 supernate) to AZ-101							
Transfer AY -102 supernate to AP tank farm							
Transfer AW (DSSF) to AY-102							
Transfer AW (7<u>M</u> Na) to AY-101							
Decant pump system operatinal	AZ-101	AZ-102	AW-103				
Mixer pump system operational	AZ-101 (W-151)		SY-102 (W-211)	AW-105 (W-211)		AZ-102 (W-211)	
COST PROFILE							
EXPENSE	20,187	12,041	5,500	0	0	10,695	3,050
CAPITAL	2,116	1,316	7,116	10,026	6,346	0	0
TOTAL ($000)	22,303	13,357	12,616	10,026	6,346	10,695	3,050

Alternative N4	FY96	FY97	FY98	FY99	FY00	FY01	FY02
W-211/AZ-102 Initial Retrieval System (construction complete 09/00)							
REROUTE W-320 PIPELINES to AZ-102 (construction complete 10/97)							
Tank bump USQ's and miscellaneous safety issues							
Transfer procedure preparation							
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}							
Install AZ-101 decant system							
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}							
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}							
In-tank process test AZ-101							
Install AZ-102 decant system							
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102							
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106							
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102							
Sluice C-106 solids to AZ-102 {800 Kgal}							
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW							
Mobilize and transfer AZ-101 solids to AZ-102							
Transfer AW-106 to AZ-101 {150 Kgal}							
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106							
Transfer AW-106 to AZ-101 {150 Kgal}							
Transfer AZ-102 (AZ-101 supernate) to AZ-101							
Transfer AY -102 supernate to AP tank farm							
Transfer AW (DSSF) to AY-102							
Transfer AW (7M Na) to AY-101							
Decant pump system operatinal							
	AZ-101 AZ-102		AW-103				
Mixer pump system operational							
	AZ-101		SY-102	AW-105	AZ-102		
	(W-151)		(W-211)	(W-211)	(W-211)		
COST PROFILE							
EXPENSE	20,147	12,001	5,600	2,650	400	0	0
CAPITAL	2,116	1,316	7,116	10,026	6,346	0	0
TOTAL ($000)	22,263	13,317	12,716	12,676	6,746	0	0

Alternative 5a	FY96	FY97	FY98	FY99	FY00	FY01	FY02
W-211/AZ-102 Initial Retrieval System (construction complete 09/00)							
Tank bump USQ's and miscellaneous safety issues							
Transfer procedure preparation							
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}							
Install AZ-101 decant system							
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}							
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}							
In-tank process test AZ-101							
Install AZ-102 decant system							
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102							
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106							
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102							
Mobilize and transfer AZ-101 solids to AZ-102 {800 Kgal}							
Sluice C-106 solids to AZ-101 (via AY-102) {800 Kgal}							
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW							
Bottom decant/transfer AY-102 to AZ-101 {575 Kgal}							
Caustic leach and wash AZ-101 (contains C-106 solids) (5 transfers)							
Wash AZ-102 (4 transfer)							
Mobilize and transfer AZ-101 solids to AZ-102 {600 Kgal}							
Decant /transfer AY-101 supernate to AZ-101 {700 Kgal}							
Transfer AW-106 to AZ-101 {150 Kgal}							
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106							
Transfer AW-106 to AZ-101 {150 Kgal}							
Transfer AW (7M Na) to AY-102 {850 Kgal}							
Transfer AW (7M Na) to AY-101 {950 Kgal}							
Decant pump system operational	AZ-101	AZ-102	AW-103				
Mixer pump system operational	AZ-101 (W-151)		SY-102 (W-211)		AW-105 (W-211)	AZ-102 (W-211)	
COST PROFILE							
EXPENSE	12,528	9,968	3,800	0	200	6,000	2,740
CAPTIAL	2,116	1,316	7,116	10,026	6,346	0	0
TOTAL ($000)	14,644	11,284	10,916	10,026	6,546	6,000	2,740

Alternative N5a	FY96	FY97	FY98	FY99	FY00	FY01	FY02
W-211/AZ-102 Initial Retrieval System (construction complete 09/00)							
Tank bump USQ's and miscellaneous safety issues							
Transfer procedure preparation							
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}							
Install AZ-101 decant system							
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}							
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}							
In-tank process test AZ-101							
Install AZ-102 decant system							
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102							
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106							
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102							
Mobilize and transfer AZ-101 solids to AZ-102 {800 Kgal}							
Sluice C-106 solids to AZ-101 (via AY-102) {800 Kgal}							
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW							
Bottom decant/transfer AY-102 to AZ-101 {575 Kgal}							
Mobilize and transfer AZ-101 solids to AZ-102 {600 Kgal}							
Decant /transfer AY-101 supernate to AZ-101 {700 Kgal}							
Transfer AW-106 to AZ-101 {150 Kgal}							
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106							
Transfer AW-106 to AZ-101 {150 Kgal}							
Transfer AW (7M Na) to AY-102 {850 Kgal}							
Transfer AW (7M Na) to AY-101 {950 Kgal}							
Decant pump system operational	AZ-101	AZ-102	AW-103				
Mixer pump system operational	AZ-101 (W-151)		SY-102 (W-211)		AW-105 (W-211)	AZ-102 (W-211)	
COST PROFILE							
EXPENSE	12,488	9,928	100	2,740	200	0	0
CAPTIAL	2,116	1,316	7,116	10,026	6,346	0	0
TOTAL ($000)	14,604	11,244	7,216	12,766	6,546	0	0

Alternative 5b	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04
W-211/AZ-102 Initial Retrieval System (construction complete 9/00)									
W-211/AY-102 Initial Retrieval System (construction complete 8/02)									
Tank bump USQ's and miscellaneous safety issues									
Transfer procedure preparation									
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}									
Install AZ-101 decant system									
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}									
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}									
In-tank process test AZ-101									
Install AZ-102 decant system									
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102									
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106									
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102									
Mobilize and transfer AZ-101 solids to AZ-102 {600 Kgal}									
Sluice C-106 solids to AZ-101(via AY-102) {800 Kgal}									
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW									
Bottom decant/transfer AY-102 to AZ-101 {575 Kgal}									
Caustic leach and wash AZ-101 (contains C-106 solids) (5 transfers)									
Wash AZ-102 (4 transfers)									
Mobilize and transfer AZ-101 solids to AZ-102 {600 Kgal}									
Decant/transfer AY-101 supernate to AZ-101 {700 Kgal}									
Transfer AW-106 to AZ-101 {150 Kgal}									
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106									
Transfer AW-106 to AZ-101 {150 Kgal}									
Decant AZ-102 supernate to AW {500 Kgal} (to be concentrated)									
Caustic leach and wash AY-102 (5 transfers)									
Mobilize and transfer AY-102 solids to AZ-102 {600 Kgal}									
Transfer AW (7M Na) to AY-102 {950 Kgal}									
Transfer AW (DSSF) to AY-101 {900 Kgal}									
Decant pump system operational									
	AZ-101	AZ-102	AW-103						
Mixer pump system operational									
	AZ-101		SY-102		AW-105	AZ-102	AY-102		
	(W-151)		(W-211)		(W-211)	(W-211)	(W-211)		
COST PROFILE									
EXPENSE	15,290	8,420	2,850	0	0	6,100	3,200	6,550	300
CAPITAL	2,346	1,546	12,342	15,022	11,922	8,656	6,376	0	0
TOTAL ($000)	17,636	9,966	15,192	15,322	11,922	14,756	9,576	6,550	300

Alternative N5b	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04
W-211/AZ-102 Initial Retrieval System (construction complete 09/00)									
W-211/AY-102 Initial Retrieval System (construction complete 08/02)									
Tank bump USQ's and miscellaneous safety issues									
Transfer procedure preparation									
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}									
Install AZ-101 decant system									
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}									
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}									
In-tank process test AZ-101									
Install AZ-102 decant system									
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102									
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106									
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102									
Mobilize and transfer AZ-101 solids to AZ-102 {600 Kgal}									
Sluice C-106 solids to AZ-101(via AY-102) {800 Kgal}									
Decant/transfer AY-102 (C-106 supernate) 800 Kgal to AW									
Bottom decant/transfer AY-102 to AZ-101 {575 Kgal}									
Mobilize and transfer AZ-101 solids to AZ-102 {600 Kgal}									
Decant/transfer AY-101 supernate to AZ-101 {700 Kgal}									
Transfer AW-106 to AZ-101 {150 Kgal}									
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106									
Transfer AW-106 to AZ-101 {150 Kgal}									
Decant AZ-102 supernate to AW {500 Kgal} (to be concentrated)									
Mobilize and transfer AY-102 solids to AZ-102 {600 Kgal}									
Transfer AW (7M Na) to AY-102 {950 Kgal}									
Transfer AW (DSSF) to AY-101 {900 Kgal}									
Decant pump system operational									
	AZ-101	AZ-102	AW-103						
Mixer pump system operational									
	AZ-101		SY-102		AW-105	AZ-102	AY-102		
	(W-151)		(W-211)		(W-211)	(W-211)	(W-211)		
COST PROFILE									
EXPENSE	15,290	7,570	2,780	3,270	0	0	0	300	0
CAPITAL	2,346	1,546	12,342	15,022	11,922	8,656	6,376	0	0
TOTAL ($000)	17,636	9,116	15,122	15,022	11,922	8,656	6,376	300	0

Alternative 5c	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04
W-211/AZ-102 Initial Retrieval System (construction complete 09/00)									
W-211/AY-101 Initial Retrieval System (construction complete 08/02)									
Tank bump USQ's and miscellaneous safety issues									
Transfer procedure preparations									
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}									
Install AZ-101 decant system									
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}									
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}									
In-tank process test AZ-101									
Install AZ-102 decant system									
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102									
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106									
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102									
Mobilize and transfer AZ-101 solids to AZ-102									
Sluice C-106 solids to AZ-101 {800 Kgal}									
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW									
Bottom decant/transfer AY-102 to AZ-101 {575 Kgal}									
Caustic leach and wash AZ-101 (contains C-106 solids) (5 transfers)									
Wash AZ-102 (4 transfers)									
Mobilize and transfer AZ-101 solids to AZ-102 {600 Kgal}									
Decant/transfer AY-101 (AZ-101 supernate) to AZ-101 {700 Kgal}									
Wash AY-101 (3 transfers)									
Mobilize and transfer AY-101 solids to AZ-102 {500 Kgal}									
Transfer AW-106 to AZ-101 {150 Kgal}									
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106									
Transfer AW-106 to AZ-101 {150 Kgal}									
Transfer AW (DSSF) to AY-101 {950 Kgal}									
Transfer AW (7M Na) to AY-102 {850 Kgal}									
Decant pump system operational									
	AZ-101	AZ-102	AW-102						
Mixer pump system operational									
	AZ-101		SY-102		AW-105	AZ-102	AY-101	AY102	
	(W151)		(W-211)		(W-211)	(W-211)	(W-211)	(W-211)	
COST PROFILE									
EXPENSE	15,376	8,606	2,950	2,680	70	5,900	0	2,300	300
CAPITAL	2,346	1,546	12,342	15,022	11,922	8,656	6,376	0	0
TOTAL	17,722	10,152	15,292	17,702	11,992	14,556	6,376	2,300	300

Alternative N5c	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04
W-211/AZ-102 Initial Retrieval System (construction complete 09/00)									
W-211/AY-101 Initial Retrieval System (construction complete 08/02)									
Tank bump USQ's and miscellaneous safety issues									
Transfer procedure preparations									
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}									
Install AZ-101 decant system									
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}									
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}									
In-tank process test AZ-101									
Install AZ-102 decant system									
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102									
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106									
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102									
Mobilize and transfer AZ-101 solids to AZ-102									
Sluice C-106 solids to AZ-101 {800 Kgal}									
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW									
Bottom decant/transfer AY-102 to AZ-101 {575 Kgal}									
Mobilize and transfer AZ-101 solids to AZ-102 {600 Kgal}									
Decant/transfer AY-101 (AZ-101 supernate) to AZ-101 {700 Kgal}									
Mobilize and transfer AY-101 solids to AZ-102 {500 Kgal}									
Transfer AW-106 to AZ-101 {150 Kgal}									
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106									
Transfer AW-106 to AZ-101 {150 Kgal}									
Transfer AW (DSSF) to AY-101 {950 Kgal}									
Transfer AW (7M Na) to AY-102 {850 Kgal}									
Decant pump system operational									
	AZ-101	AZ-102	AW-102						
Mixer pump system operational									
	AZ-101		SY-102		AW-105	AZ-102	AY-101	AY102	
	(W151)		(W-211)		(W-211)	(W-211)	(W-211)	(W-211)	
COST PROFILE									
EXPENSE	15,376	7,756	100	2,580	70	0	0	300	0
CAPITAL	2,346	1,546	12,342	15,022	11,922	8,656	6,376	0	0
TOTAL	17,722	9,302	12,442	17,602	11,992	8,656	6,376	300	0

Alternative 6	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04
W-211/AZ-102 Initial Retrieval System (construction complete 09/00)									
W-211/AY101 Initial Retrieval system (complete construction 08/02									
W-211/AY-102 Initial Retrieval System (construction complete 12/02)									
Tank bump USQ'a and miscellaneous safety issues									
Transfer procedure preparation									
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}									
Install AZ-101 decant system									
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}									
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}									
In-tank process test AZ-101									
Install AZ-102 decant system									
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102									
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106									
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102									
Mobilize and transfer AZ-101 solids to AZ-102 {600 Kgal}									
Sluice C-106 solids to AZ-101 (via AY-102) {800 Kgal}									
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW									
Bottom decant/transfer AY-102 to AZ-101 {575 Kgal}									
Caustic leach and wash AZ-101 (contains C-106 solids) (5 transfers)									
Wash AZ-102 (4 transfers)									
Mobilize and transfer AZ-101 solids to AZ-102{600 Kgal}									
Decant /transfer AY-101 (AZ-101 supernate) to AZ-101{700 Kgal}									
Transfer AW-106 to AZ-101 {150 Kgal}									
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106									
Transfer AW-106 to AZ-101 {150 Kgal}									
Dilute waste from AP T.F. to AY-101 {400 Kgal}									
Mobilize and transfer AY-101 solids to AY-102 {500 Kgal}									
Caustic leach and wash AY-102 (6 transfers)									
Mobilize and transfer AY-102 solids to AZ-102 {800 Kgal}									
Transfer AW (DSSF) to AY-102 {950 Kgal}									
Transfer AW (DSSF) to AY-101 {950 Kgal}									
Decant pump system operational									
	AZ-101 AZ-102		AW-102						
Mixer pump systems operatinal									
	AZ-101		SY-102	AW-105	AZ-102		AY-101	AY-102	
	(W-151)		(W-211)	(W-211)	(W-211)		(W-211)	(W-211)	
COST PROFILE									
EXPENSE	13,045	10,255	3,850	0	0	5,900	2,780	3,340	3,370
CAPITAL	2,346	1776	17798	20018	17498	17312	12752	0	0
TOTAL	15,391	12,031	21,648	20,018	17,498	23,212	15,532	3,340	3,370

Alternative N6	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04
W-211/AZ-102 Initial Retrieval System (construction complete 09/00)									
W-211/AY101 Initial Retrieval system (complete construction 08/02									
W-211/AY-102 Initial Retrieval System (construction complete 12/02)									
Tank bump USQ's and miscellaneous safety issues									
Transfer procedure preparation									
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}									
Install AZ-101 decant system									
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}									
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}									
In-tank process test AZ-101									
Install AZ-102 decant system									
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102									
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106									
Decant/transfer AZ-102 (450 Kgal) supernate to AW-102									
Mobilize and transfer AZ-101 solids to AZ-102 {600 Kgal}									
Sluice C-106 solids to AZ-101 (via AY-102) {800 Kgal}									
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW									
Bottom decant/transfer AY-102 to AZ-101 {575 Kgal}									
Mobilize and transfer AZ-101 solids to AZ-102{600 Kgal}									
Decant /transfer AY-101 (AZ-101 supernate) to AZ-101{700 Kgal}									
Transfer AW-106 to AZ-101 {150 Kgal}									
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106									
Transfer AW-106 to AZ-101 {150 Kgal}									
Dilute waste from AP T.F. to AY-101 {400 Kgal}									
Mobilize and transfer AY-101 solids to AY-102 {500 Kgal}									
Mobilize and transfer AY-102 solids to AZ-102 {800 Kgal}									
Transfer AW (DSSF) to AY-102 {950 Kgal}									
Transfer AW (DSSF) to AY-101 {950 Kgal}									
Decant pump system operational									
	AZ-101	AZ-102		AW-102					
Mixer pump systems operatinal									
	AZ-101		SY-102		AW-105	AZ-102	AY-101	AY-102	
	(W-151)		(W-211)		(W-211)	(W-211)	(W-211)	(W-211)	
COST PROFILE									
EXPENSE	13,085	10,265	380	2,670	0	0	0	400	0
CAPITAL	2,346	1776	17798	20018	17498	17312	12752	0	0
TOTAL	15,431	12,041	18,178	22,688	17,498	17,312	12,752	400	0

Alternative 7a	FY96	FY97	FY98	FY99	FY00	FY01
Tank bump USQ's and miscellaneous safety issues						
Transfer procedure preparations						
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}						
Install AZ-101 decant system						
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}						
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}						
In-tank process test AZ-101						
Decant /transfer AZ-101 to AY-102						
Replace 75 hp mixer pump in AY-102						
Sluice C-106 solids to AZ-101 (via AY-102) {800 Kgal}						
Decant/transfer AY-102 (C-106 supernate) 650 Kgal toAW						
Install decant system into AZ-102						
Decant/transfer AZ-102 supernate {450 Kgal} to AW-102						
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106						
Decant/transfer AZ-102 supernate {450 Kgal} to AW-102						
Decant/transfer AY-101 (AZ-101 supernate) to AZ-102 {800Kgal}						
In-tank concentrate AZ-101 {250 Kgal condensate to AY-101}						
Transfer AW-106 to AZ-102 {150 Kgal}						
Concentrate AW-102 (AZ-102 supernate) at 242-A collect at AW-106						
Transfer AW-106 to AZ-102 {150 Kgal}						
Transfer AW (7<u>M</u> Na) to AY-101 {850 Kgal}						
Transfer AW (7<u>M</u> Na) to AY-102 {850 Kgal}						
Decant pump system operatinal						
	AZ-101	AZ-102	AW-103			
Mixer pump system operational						
	AZ-101		SY-102	AW-105		AZ-102
	(W-151)		(W-211)	(W-211)		(W-211)
COST PROFILE						
EXPENSE	11,729	10,818	5,082	229	0	0
CAPITAL	800	0	0	0	0	0
TOTAL ($000)	12,529	10,818	5,082	229	0	0

Alternative 7b	FY96	FY97	FY98	FY99	FY00	FY01
Operating Costs (Expense and CENRTC)						
Tank bump USQ's and miscellaneous safety issues						
Transfer procedure preparations						
Transfer AY-101 supernate to AP-101 (existing pump) {850 Kgal}						
Install AZ-101 decant system						
Decant/transfer AZ-101 supernate to AY-101 {900 Kgal}						
Transfer AY-102 supernate to AZ-101 (existing pump) {750 Kgal}						
In-tank process test AZ-101						
Decant /transfer AZ-101 to AY-102						
Replace 75 hp mixer pump in AY-102						
Sluice C-106 solids to AZ-101 (via AY-102) {800 Kgal}						
Decant/transfer AY-102 (C-106 supernate) 650 Kgal to AW						
Install decant system into AZ-102						
Decant/transfer AY-101 (AZ-101 supernate) to AZ-102 {800Kgal}						
In-tank concentrate AZ-101 {250 Kgal condensate to AY-101}						
In-tank concentrate AZ-102 {500 Kgal} to dilute reciever						
Transfer AW (7M Na) to AY-101 {850 Kgal}						
Decant pump system operatinal						
	AZ-101	AZ-102	AW-103			
Mixer pump system operational						
	AZ-101		SY-102	AW-105	AZ-102	
	(W-151)		(W-211)	(W-211)	(W-211)	
COST PROFILE						
EXPENSE	#VALUE!	#VALUE!	722	599	548.55	0
CAPITAL	0	0	0	0	0	0
TOTAL ($000)	#VALUE!	#VALUE!	722	599	548.55	0

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APPENDIX C

SCALE EVALUATIONS

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APPENDIX C

SCALE EVALUATIONS

Input Data to Analysis

A computer program called Logical Decisions (Logical Decisions is a trademark of Logical Decisions) was used to calculate relationships and develop charts, figures, and tables. The inputs were made by Excel* spreadsheet and used the team-evaluated input. Table 3-3 in the main text is a listing of the program input. The alternatives are listed on the left, and the decision criteria are listed along the top. Individual scores for each alternative also are listed.

Scale Evaluations and Assumptions

The following evaluations give the assumptions and reasoning behind each decision criteria evaluation.

Personnel Risk Radiation Exposure

Enabling assumptions used to determine the expected radiation exposures for each alternative are as follows.

Radiation exposure is expected to occur when changing or installing jumpers, installing mixer systems, and taking grab samples. A mixer system will be required whenever solids are to be transferred or washed. One rigid jumper will be installed with the installation of each pump. The exposure from installing jumpers required for mixer systems is considered to be included in the exposure from installing the mixer system. No information was available for the radiation exposure expected from changing out the jumpers in the 241-AN valve pits. Therefore, an average of the exposures from the 241-A, 241-AX, and 241-AW valve pits was used.

One grab sample is required for each transfer. The sample will be taken in the tank from which the waste is being transferred, before the transfer. No information was available for the radiation exposure expected when taking grab samples from the AW Tank Farm, so a conservative estimate of 85 mrem was used.

Exposure from installing and removing pumps was calculated using the information contained in the cc:Mail** message generated by David Bullock, West Tank Farm Rad Control, to J. W. Lentsch for the calculated dose to remove

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*Excel is a trademark of Microsoft Corporation.

**cc:Mail is a trademark of cc:Mail, Inc.

the pump that is in 101-SY (November 10, 1995). T. R. Benegas estimates that 200 mrem total dose was expanded when the pump was inserted. This cc:Mail message is listed below.

Pump Exposure Evaluation:

Pump pull:

Crane operator	0.146*
Person in charge tent (4 people)	0.260*
Install tent (3 people)	0.051
Digital acquisition control system trailer (3 people)	0.045
2 nuclear power operators to close receiver	0.024
3 line handlers	0.064
2 roving health physics technicians (HPT)	0.060
TOTAL person rem	0.650

*NOTE: No shielding has been added for the crane operators. It is hoped their exposure will be reduced by one-half. Also, it is desirable to put up a shield wall in front of the person in charge tent and/or limit the number of people in it.

Column cutoff:

Welder	0.030
Boilermakers	0.146
Riggers (2)	0.046
HPT	0.020
TOTAL person rem	0.242

Shot loading--Steel shot, 5 minutes to fill per section; 1 minute to reposition trailer.

Operator on platform	0.151*
Rigger on platform	0.127*
Crane operator	0.014
Fork-lift operator	0.005
Truck driver	0.007
HPT	0.030
TOTAL person rem	0.333

*NOTE: A determination is being made regarding the possible dose savings resulting from placing as much lead on the platform as it can handle without modification.

Shot loading--Lead shot, 5 minutes to fill per section; 1 minute to reposition trailer.

Operator on platform	0.051
Rigger on platform	0.030
Crane operator	0.018
Forklift operator	0.005
Truck driver	0.010
HPT	0.030
TOTAL person rem	0.114

GRAND TOTAL

Pump pull	0.650
Column cutoff	0.242
Shot loading (steel)	0.333
Shot loading (lead)	0.144
TOTAL person rem	1.225

PERSONNEL RADIATION EXPOSURE ASSUMPTIONS

GRAB AND CORE SAMPLING

Personnel radiation exposures were estimated from typical radiation work permits (RWP) for grab and core sampling. An Operations crew is assigned for each operator. The calculated dose received by Operations personnel was determined from the radiation fields stated on the RWP multiplied by the average time required to take either a grab sample or a core sample, and the number of Operations personnel involved in the activity.

BACKGROUND RADIATION LEVELS

Background radiation levels were taken from representative surveys. The survey report numbers are as follows:

- No. 219582 Tank Farm
- No. 219490 Tank Farm
- No. 219405 Tank Farm.

Mixer-Pump Removal

Radiation exposure limits for mixer-pump removal were based on operations judgement and experience for that type of activity.

Three-Way Jumper Changeout

Radiation exposure limits for jumper changeout were based on operations judgement and experience for that type of activity. The following personnel are involved in a typical jumper changeout:

- 1 Rigger
- 1 HPT
- 1 Pipefitter

- 1 Quality control (QC) inspector
- 4 Nuclear power operators
- 1 Electrician.

A typical jumper changeout will take 2 hours to complete. It was assumed that the operators, the HPT, and the pipefitter would be involved during the entire 2 hours. The rigger and QC inspector will be involved for 15 minutes. The electrician will be involved for 1 hour. The exposure was computed from radiological survey reports for valve pits without cover blocks installed. The dose rates were deemed typical of what may be expected from the actual pit conditions. These numbers were added to yield total personnel exposure. The data in Table C-1 were used in the calculations.

Table C-1. Operational Exposure.

Grab sample exposure		
AP Tank Farm	85 mrem	
AY Tank Farm	5 mrem	
AZ Tank Farm	182 mrem	
Routine jumper changeout exposure		
Pit	Worst	Best
241 AA	675 mrem (46 cm [18 in.])	473 mrem (rail)
AX-B	4,050 mrem (contact)	2,700 mrem (46 cm [18 in.])
241 AW-AA	1,485 mrem (pit level)	608 mrem (rail)
Average background radiation rate		
AP Tank Farm	General area = <0.5 mrem/h	
AZ Tank Farm	Highest at contact = 22 mrem/h	
AY Tank Farm	101 = 18/8; 102 = 13/4	
	101 = 20/4; 102 = 8/2	
Legend --> mrem/h at contact/mrem/h at 30 cm (12 in.)		
Pulling pumps		
Best = 1,600 mrem	Worst = 3,000 mrem	
Core sampling exposure		
BX-109	0	
BY-108	293 mrem	
B-101	184 mrem	
B-106	120 mrem	
S-107	263 mrem	

OFFSITE PERSONNEL RISK

It was desirable to quantify offsite personnel risk to scale it against the alternatives. The accident scenario of leaks developing in new jumper connections was chosen as the most likely development to effect offsite receptors when transferring aging waste supernate and solids.

It was envisioned that the large supernate source term in aging waste tanks would cause significant effects offsite if the following scenario occurred. The cover blocks were inadvertently left off a diversion box or valve pit during installation of jumpers (NOTE: administrative operational safety requirements exist to prevent cover blocks from being left off). The high-curie content supernate in AZ-101 or AZ-102 is transferred to another tank but the newly installed jumpers develop one or more spray leaks. These spray leaks continue overnight until they are detected during the day or a leak detector trips and shuts down the transfer.

Similar spray release accidents were evaluated in WHC-SD-WM-SAR-065, *Draft - Tank Farm Accelerated Safety Analysis*, Section 3.4.2.3.2, "Spray Release from Waste Transfer System" (WHC 1995a). Spray release accidents resulted in unacceptable risks for onsite personnel when cover blocks were not in place. Radiological dose consequences to offsite personnel met risk acceptance guidelines, but it was unclear if the evaluation used AZ-101 or AZ-102 source terms. Therefore, the spray release accident scenario was chosen as the closest incident to being a significant offsite event that was available.

The following assumptions were make to scale offsite personnel risk.

- The number of jumper changes made are directly proportional to offsite personnel risk. The more jumper changes, the more potential chances for gasket failure, or misalignment of jumpers, causing spray releases.
- The more jumper changes, the greater the chances of leaving the cover blocks off the transfer box, which allows the leak source term to become airborne.
- One transfer box entry equaled one event, even if more than one jumper was installed. It did not matter if the jumper(s) installed had three or more connections; it was one event.

TANK BUMPS

The *Aging-Waste Safety Analysis Report*, WHC-SD-HS-SAR-010 (Squires 1991), describes "bumping" as the "sudden release of latent heat energy which had been contained in the radioactive liquid waste." When a tank bumps, the following events are likely to occur.

- The tank pressurizes above 0.7 psig and steam is exhausted from the tank through the available openings.
- The area surrounding the tank becomes contaminated.

The safety analysis report continues, analyzing the accident as "acceptable" with a hazard level of moderate to high.

Scales

This safety scenario was chosen to be evaluated because consolidation of waste will tend to promote the conditions that cause tank bumps: increased heat and sludge levels. When sludge levels get too high (about 76 cm [30 in.]) the airlift circulators become inoperable. Figure 3-3 in the main text shows the scale and the limits of the evaluations. Existing limits of 102 cm (40 in.) of sludge and 302 KBtu are listed on the sheets as the right lower aging waste tank limit. Proposed Project W-320 limits are listed as 140 cm (55 in.) of sludge and about 140 KBtu/h heat load. A line was drawn between these two points to indicate the slope of an approximately equal point on the right and left sides of the diagonal center of the figure. Then the lowest point of the alternatives analyzed (Alternative 3--leached) of 76 cm (30 in.) and 230 KBtu/h was given a value of 100. The highest point analyzed (Alternative 6--unleached) of 394 cm (155 in.) and 510 KBtu/h was given a score of 0. A linear scale was set up as shown in Figure 3-3 to determine the possibility of a tank bump.

History of Tank Bumps

Tank bumping in aging waste tanks was first observed in the S Tank Farm in the 200 West Area. Before 1952, the heat content in aging waste tanks was dissipated to the ground without creating a boiling temperature in any tank. Measurable pressure variations were first observed in tank 104-S in 1953 which also coincided with temporary increases in condensate from the condensers. The pressure variations were small at first but increased in intensity and duration as the heat and sludge content of the aging waste tanks were increased.

The documented information of tank bumps suggests that all the following conditions are necessary for a tank bump to occur.

- The tank contains aging waste and is boiling.
- Heat generation of the aging waste is >1 million Btu/h.
- The airlift circulator(s) must be off, allowing the sludge to accumulate stored energy.
- The tank sludge temperature is 116 °C (240 °F).

For more history on tank bumps, see WHC-SD-WM-TA-021 (Bendixsen 1990) or WHC-SD-WM-TI-406 (Jo 1991).

Draft Interim Operational Safety Requirement (IOSR) Limits

Draft IOSRs (WHC 1995b) are as follows. They are derived from the accelerated safety analysis (WHC 1995a), and the sections in which they are found are referenced.

The following are limits on aging waste tanks:

- Tank bump - 3.4.2.1.7
- Temperatures - Limiting conditions for operation - I.3.2.1
  - Must be 17 °C (30 °F) below the local boiling point
    - -- sludge, ≤110 °C (230 °F)
    - -- liquids ≤93 °C (199 °F)
- Solids depth
  - ≤102 cm (40 in.)
- Heat load
  - Total heat load ≤302,641 Btu/h, AC 5.13
- Sludge temperature distribution
  - Sludge shall ≤20 m^3 (706 ft^3) (about 18,900 L [5,000 gal]) at the thermodynamic saturation temperature (about 110 °C [230 °F]), AC 5.16
- Total organic carbon (TOC) limits:
  - %TOC <4.5 + 0.17 (%H_2O), or %H_2O >20%, AC 5.11

Other unresolved safety question (USQ) requirements and evaluations are listed in Appendixes A and C, under USQ scales.

Waste Compatibility

Major and Minor USQs

The following definitions of major and minor USQs were used to specify the number of each in the evaluation.

- A major USQ evaluation requires at least one significant technical evaluation, including calculations, to resolve. It probably has a "yes" answer to one of the eight questions on the USQ form. This issue will be somewhat difficult to resolve and may not be resolvable as desired.
- A minor USQ evaluation is one that does not require a significant technical evaluation. It probably does not involve a "yes" answer to any of the questions on the USQ form. This issue will be relatively easy to resolve.

The scale chosen was linear, starting at the 0-equaling minimum amount of USQ for Alternative 0a, and increasing to the maximum for Alternative 6.

The USQ analysis is listed in Appendix A and was taken from the following operating specification documentation, IOSRs, etc.

WHC-SD-WM-OSR-018, *Tank Farms Interim Operational Safety Requirements* (WHC 1995b)

2.1 No SLs or LCSs

3.0 Limiting Conditions for Operations
- 3.1.1 AWF/DST Primary Tank Maximum WASTE Level
- 3.1.2 SST Maximum Waste Level
- 3.2.1 AWF Maximum WASTE Temperature
  - Sludge ≤110 °C (230 °F)
  - Liquid ≤93 °C (199 °F)
- 3.2.2 SST Maximum SLUDGE Temperature
- 3.2.3 DST Maximum WASTE Temperature
- 3.3.1 AWF/DST Minimum Vapor Space Pressure
- 3.3.2 SST Minimum Vapor Space Pressure

5.0 Administrative Controls
- 5.6 Organization
- 5.7 Procedures
- 5.8 Nuclear Criticality Safety
- 5.9 Source Inventory Control
- 5.10 Flammable Gas
  - Ventilation operable
- 5.11 WASTE Tank Organic Safety
  - %TOC, 4.5 + 0.17 (%H_2O), or
  - %H_2O >20
- 5.12 Requirement for Dome Load
- 5.13 Requirement for Heat Load
  - ≤88,695 W radiolytic and equipment
- 5.14 Requirement for Concrete Temperature Variance
  - For AWF tank, maximum of 19.4 °C/day (35 °F/day)
- 5.15 Requirement for WASTE Solids
  - <1 m (3 ft)
- 5.16 Requirement for SLUDGE Temperature Distribution
  - ≤20 m^3 (215 ft^3) at thermodynamic saturation temperature
- 5.17 Requirement for Transfer System Covers
- 5.19 Requirement for Transfer Line Leakage
- 5.20 Requirement for Exhaust Filtration

OSR-T-152-00002, Rev/Mod A-1 (WHC-SD-HS-SAR-010, Rev. 2 [Squires 1991]), *Aging-Waste Facility Operational Safety Requirements*, March 8, 1989.

- 11.4 Primary Vessel Hydrostatic Head
  - ≥-3 inches w.g.
- 11.5 Air-Lift Circulator Operation (Tank Bump)
  - ≥50 cfm if any waste temperatures are >93 °C (200 °F)
- 11.6 Primary Tank Leak Detection
- 11.7 Tank Pressurization
- 11.8 Waste Transfer Leak Detection

11.9 Gaseous Effluent
11.10 Liquid Effluent
- Diversion of steam condensate (steam coils)
- Radioactive liquid organic wastes

11.11 Spare Aging-Waste Tank
11.12 Fissile Material (Void)
11.13 Maximum Liquid Level
11.14 Chemical Composition
11.15 Temperature Control
- Heat-up rate shall be controlled so that the yield stress on the inside surface of the primary tank is not exceeded.

11.16-11.21 Void

OSD-T-151-00017, Rev D-6, *Operating Specifications for Aging-Waste Operations in 241-AY and 241-AZ* (Bergmann 1994).

17.2 Underground Aging-Waste Storage Tank Operations
- 17.2.1 Liquid Levels
- 17.2.2 Primary Tank Leak Detection
- 17.2.3 Hydrostatic Head
  - Minimum hydrostatic head = 0 in. W.G.
- 17.2.4 Dome Loading
- 17.2.5 Live Loads
- 17.2.6 Primary Tank Temperature
- 17.2.7 Concrete Temperature

17.3 Aging-Waste Transfer Operations
- 17.3.1 Waste Transfer Leak Detection

17.3.2 Composition of Transferred Waste
- Pu ≤200 g/batch
- Pu ≤0.05 g/gal
- For Pu >15 g, air-lift circulator of slurry distributor operating

17.3.3 90-day rule
- For >1,000 MTU of waste and >48 cm (19 in.) sludge, the maximum time between transfers is 90 days

17.4 Aging-Waste Storage Operations
- 17.4.1 Waste Composition
  - 17.4.1.1 Chemical Composition
    - 17.4.1.1.1 Criticality Prevention
      - Total Pu/tank <50 kg
      - Pu ≤1 g/L
    - 17.4.1.1.2 5*M* Na Rule
      - ≤5.5*M* Na in 101-AZ
      - ≤5.0*M* Na in other aging waste tanks
    - 17.4.1.1.3 Hydroxide
      - ≥0.01*M* for NO_3 <1 molar
      - ≥0.8*M* for NO_3 <3 molar
      - ≥1.0*M* for NO_2 + NO_3 >5.5 molar
    - 17.4.1.1.4 Corrosion Control

17.4.1.2 In-Tank Solids
- For solids >27 cm (10.7 in.), temperature of solids $\leq 1814.1/H_s$ + 110 °C (230 °F)

17.4.2 Steam Condensate

17.4.3 Liquid Organic Waste

17.4.4 Heat Content
- Maximum heat content for AWF = 4 million Btu/h

17.4.5 Waste Temperatures
- For solution temperatures <52 °C (125 °F) <5.6 °C/day (10 °F/day)
- For solution temperatures >52 °C (125 °F) <1.7 °C/day (3 °F/day) or 13.3 °C/day (24 °F/day) if temperature is kept constant within 1.7 °C (3 °F) for 8 days thereafter

17.4.6 Air-lift Circulator Operation
- Minimum of 50 cfm for waste temperature >93 °C (200 °F)

17.4.7 Vapor Space Pressure

17.4.8 Spare Aging-Waste Tank

17.4.9 Total Fuel Concentration
- 480 J/g

17.4.10 Ferrocyanide
- Cyanide max. 3.9 Wt%

17.4.11 Organic Salts
- TOC ≤3 wt% (dry basis)

17.4.12 Toxic Vapor
- <IDLH

17.4.13 Flammable Gases
- ≤20% LFL

Criticality

The criticality concerns of the proposed waste transfers among tanks AY-101, AY-102, AZ-101, and AZ-102, and the waste transfer from C-106 and AY-102, were reviewed.

The contents of the tanks were reviewed to determine plutonium inventories.

The existing solutions in each of the tanks contain trivial amounts of plutonium compared to the plutonium in the solids. The solutions may be used as slurry or sluicing media but will not redissolve or otherwise have a measurable effect on the redistribution or concentration of plutonium in the solids.

Measurable amounts of plutonium exist in the solids in each of the tanks. The estimated amounts of plutonium are as follows:

- AY-101 23.35 kg
- AY-102 8.64 kg

- AZ-101 19.25 kg
- AZ-102 27.19 kg

- C-106 97.5 kg.

The source of the inventory estimate for C-106 is WHC-SD-SQA-CSA-20363, *CSER 94-001 Criticality Safety of Single-Shell Waste Storage Tanks* (Rogers 1994). The source of the other estimates is WHC-SD-WM-TI-640, *Double-Shell Tanks Plutonium Inventory Assessment* (Tusler 1995). These estimates, which are based on the highest plutonium value in any tank sample, are considered the high estimates for the tanks. For criticality concerns, if the proposed transfers with these numbers are acceptable the actual safety margins are even greater because a conservative plutonium inventory has always been used for analyses.

Tank C-106

Tank C-106 contains about 746,000 L (197,000 gal) of solids. The criticality implications of transferring this waste into AY-102 were analyzed in WHC-SD-SQA-CSA-20363 (Rogers 1994). "A sizeable margin of criticality safety will be maintained throughout the process of transferring waste from tank C-106 to tank AY-102. No mechanism capable of causing criticality as the result of mixing these wastes has been found."

The high estimate of plutonium in C-106 solids is 0.127 g/L. This concentration is <5% of the minimum required to make plutonium critical under optimum conditions. In addition, the solids contain other materials that retard criticality. The iron-to-plutonium ratio is four times as large as the subcritical limit. The manganese-to-plutonium ratio is almost three times as large as the subcritical limit.

Tank AY-102

Tank AY-102 contains about 121,000 L (32,000 gal) of solids. The criticality implications of transferring C-106 waste into AY-102 were analyzed (Rogers 1994).

The high estimate of the plutonium in AY-102 solids is 0.072 g/L. This concentration is <3% of the minimum required to make plutonium critical under optimum conditions. In addition, the solids contain other materials that retard criticality. The iron-to-plutonium ratio is 9.8 times as large as the subcritical limit. The manganese-to-plutonium ratio is 5.1 times as large as the subcritical limit. Both boron and cadmium have concentrations high enough to ensure subcriticality for the plutonium in AY-102.

A slurry distributor is used to spread the incoming slurry over the surface of the waste in AY-102. For a criticality to occur, the plutonium would have to be concentrated at a factor >20 while at the same time not concentrating the iron, manganese, boron, and cadmium. In addition, the presence of hydrogenous compounds, such as water, would increase the required plutonium concentration by a factor of about 3. Because of these conditions, subcriticality is not dependent on the distribution of the wastes.

Tank AY-101

Tank AY-101 contains about 314,000 L (83,000 gal) of solids. The high estimate of plutonium in the solids is about 0.074 g/L. This plutonium concentration in the solids is essentially the same as in AY-102.

Tank AZ-101

Tank AZ-101 contains about 132,500 L (35,000 gal) of solids. The high estimate of plutonium in the solids is about 0.145 g/L.

Tank AZ-102

Tank AZ-102 contains about 360,000 L (95,000 gal) of solids. The high estimate of plutonium in the solids is about 0.076 g/L.

Specification Review

The criticality prevention specifications (Vail 1995) for double-shell tanks (DST) were reviewed. Transfers between tanks are not required to meet the solids-to-plutonium mass ratio applied to waste discharges from a generating facility. Tank waste meets the mass ratio before the transfer and no mechanism is available during waste transfer that changes the solids to plutonium mass ratio. For transfers into tanks with batches containing >200 g, the solids-to-plutonium ratio must be at least 1,000 and the plutonium concentration in the incoming stream must be <0.125 g/L. In the receiving tank, the tank-averaged solids-to-plutonium ratio for settled solids must be at least 5,000.

The solids-to-plutonium ratio estimates for the existing tank inventories are as follows:

Tank	Plutonium (g/L)	Solids-to-plutonium ratio
AY-101	0.074	16,200
AY-102	0.072	16,600
AZ-101	0.145	8,200
AZ-102	0.076	15,700
C-106	0.127	9,400

These ratios were determined using the most conservative assumptions regarding plutonium concentration and solids density, which result in the smallest solids-to-plutonium ratio. In every estimate, the solids-to-plutonium ratio is much >1,000 and >5,000.

The plutonium concentration of an incoming stream is expected to be much <0.125 g/L due to the dilution of the solids during the sluicing operation. The transfer of the C-106 waste was analyzed (Sederburg 1994).

An estimate also was made to determine the effect of washing the C-106 solids in AZ-101. As much as 40% of the solids could be removed by washing (MacLean 1995). None of the plutonium is assumed to be removed by washing. The conservatively calculated solids-to-plutonium ratio after washing is 5,755, assuming a plutonium concentration of 0.212 g/L and no retention of solids from the transfer of waste from AZ-101 to AZ-102.

Suggested Criticality Specification Revisions

The operating specifications also were reviewed (Bergmann 1994). As expected, these specifications are more conservative than the criticality prevention specifications. The planned consolidation operations would be affected by the criticality prevention, Section 17.4.1.1.1 of the operating specifications, which limits the amount of plutonium in an aging waste tank to 50 kg. This section would need to be changed or waived to transfer the contents of C-106 into any aging waste tank.

In the operating specifications, Section 17.3.2 limits the composition of transferred waste. This section limits the amount of plutonium per batch to 200 g and a concentration of 0.012 g/L. This section also would need to be changed or waived to transfer the contents of C-106 into any aging waste tank.

No actual criticality concerns exist for tank-to-tank transfers of waste because the minimum concentration of plutonium required to cause a criticality is 2.6 g/L in a very large volume (Sederburg 1994). The minimum plutonium concentration that can cause a criticality in a liquid system is about 7 g/L. No known mechanism exists that is capable of approaching possible criticality through concentration of plutonium in a receiver tank.

The specification documents must be revised and approved to reflect the acceptance of the planned transfers into and within the aging waste tanks.

OPERATIONAL RISK--COMPLEXITY OF OPERATIONS

UNIT OPERATIONS

The values for the number of unit operations for each transfer alternative were based on Section 3.5.2.2 of the main text.

Transfers to Concentrate High-Heat Waste (Major USQ)

For the purposes of this section, high-heat waste will be concentrated waste that is >6 Ci/gal. Most alternatives have transfers of AZ-102 waste that is concentrated to about 12 Ci/gal cesium-137 in the evaporator. The waste tanks and Evaporator 242-A have safety analysis report (SAR) limits of 6 Ci/gal. The evaporator has an accident scenario that is based on 6 Ci/gal.

The evaporator accident scenario will have to be reevaluated for this unit operation to proceed. It may require moving personnel from their normal work areas, or taking special, temporary precautions when in a specific area during evaporation. Finally, the accident scenario may be unacceptable and a limit lower than 12 Ci/gal may have to be set on evaporation of the solutions at 242-A. This would mean that the solution would have to be further concentrated in aging waste tanks when available concentration has been completed in the evaporator. This is possible with the aging waste condensate existing system through the A-417 catch tank.

It is also possible to in-tank evaporate with the new W-030 system by shutting down the condenser for the tank in question and operating the chiller at a higher capacity. Condensate collects in the 37,900-L (10,000-gal) AZ-151 catch tank and is transferred back to the aging waste tanks. (Also see "Number of Transfers" and "Number of Decant and Supernate Transfers" following this section.) Rice (1995) estimates the condensate rate needed to accomplish in-tank evaporation at several different operating conditions. This condensation rate was used to estimate durations of evaporation needed for in-tank evaporation in Alternatives 0a and 0b.

Waste transfer routes may have to have temporary warning signs installed for the two transfers that are anticipated from Evaporator 242-A receiver tank AW-106 to the aging waste tank farms. This transfer routing crosses roads that may have to be temporarily shut down. No unacceptable impacts are anticipated to the Site or personnel for these two 250-Kgal* short-term transfers. These temporary mitigation measures have been applied in previous years to transfers of aging waste solutions to B Plant.

Leaching and Washing

The number of leaching and washes was evaluated based on the number of times that the overall operation was performed, not the number of transfers it required. There are generally two washing operations for every leaching operation. Those three operations are counted as one leach and wash.

Sludge Mixing

Solids settling was accounted for each time a solid was allowed to settle in another tank, except for the transfer of C-106 to AZ-101 via AY-102. This operation did not require mixing of sludge. However, it was accounted for as two solid transfers.

NUMBER OF TRANSFERS

Solids Transfers

The number of solids transfers was determined to assign a scale to this type of operational risk. Slurry transfers will tend to plug lines and foul pumps if not correctly performed.

Decant and Transfer

Decant and transfer scales take into account all supernate transfers. They also take into account the condensate transfers for in-tank concentration. These condensate transfers are relatively small transfers,

*See the Conversion Table in front matter of document.

about 37,900 L (10,000 gal). Every five small transfers are counted as one big transfer. Decanting and transfer do not include liquid transfers from leaching and washing.

OPERATIONAL RISK--TANK EQUIPMENT MODIFICATIONS

Tank Drain Line

When the settled sludge volume exceeded 152 cm (60 in.) in any tank it was counted as potential concern with plugging tank drain lines. The aging waste tanks have pit drains that extend to 152 cm (60 in.) above the bottom of the aging waste tanks. It was thought that these drains would be plugged by settled solids above 152 cm (60 in.), and the drains would have to be modified.

Process Pits Modification

When rigid jumpers were installed or modified, the cover blocks above them would have to be modified due to the change of routing and addition of valves that invariably occur in rigid jumpers. The pit cover blocks would need to be repainted, holes drilled, and locking-valve actuator handles installed. This was considered to be part of the operational risk. The number of pits in which new jumpers were installed were determined for each alternative, and the number of pits to be modified was totaled.

TECHNOLOGY RISK

Number of DST Sludges to Mobilize

The number of DST sludges being mobilized is a concern because it is not well known how much of the total sludge will mobilize when mixed with mixer pumps. Reports from the Savannah River Site and from British Nuclear Fuels Ltd., as well as one-twelfth-scale pilot plant information, indicate that sludge is different in each tank. No two patterns of sludge removal are the same. So there is a risk that too little sludge will be suspended from mixing operations, and the estimated amount of sludge cannot be washed or transferred. Therefore, every time sludge was mixed to transfer or wash it was counted as one technology risk. This scale is the same as the "Number of mixing of sludges" measure above.

Bottom Decant Operation

Bottom decant refers to the transfer of C-106 settling slurry in SY-102 to another tank by a transfer pump without additional agitation. Bottom decant has not been performed before now, so it is uncertain how well it will work. It is estimated that about 50% of the total solids from C-106 will be transferred to the next aging waste tank. The results of this transfer are highly, operationally specific. Changes in timing, modification of Project W-320 operations and equipment, or breakdown of equipment or/and other delays can make a large difference in the amount of solids transferred. Therefore, the bottom decant was either necessary for a successful scenario or it was not used.

FEED PREPARATION PROCESS

Process Information

Number of DST Sludges Washed

How well DST sludges are washed will indicate the efficiency of the process. This information can be used to determine flowsheet values and size of equipment, and modify processes and determine compositional values for the final product. It is of great benefit to determine how well this process works with different types of waste in a full-size setting. The first information gathered is worth more than the rest of the information due to the absence of previous information. That is why the scales jump to 50% value on the first DST retrieved and decrease rapidly from there.

- 0% = 0 DSTs washed
- 50% = 1 DSTs washed
- 75% = 2 DSTs washed
- 90% = 3 DSTs washed
- 100% = 4 DSTs washed.

This scale assumes that AZ-101 has already performed its process test, which will determine similar information.

Number of DSTs Retrieved

Uncertainties exist concerning how well sludge can be retrieved from DSTs with proposed mixer pumps and transfer systems. The same reasoning as applicable to washing with DST sludge above, applies here. The scales are exactly the same.

- 0% = 0 DSTs retrieved
- 50% = 1 DSTs retrieved
- 75% = 2 DSTs retrieved
- 90% = 3 DSTs retrieved
- 100% = 4 DSTs retrieved.

Sludge Washing and Leaching

The purpose of sludge washing and caustic leaching is to reduce the amount of nonradioactive chemicals included with high-level waste (HLW) which must be converted to a high-integrity borosilicate glass and disposed of in a deep geological repository. Disposal costs for HLW are expected to far exceed that of low-level wastes (LLW).

Sludge washing is conducted to dissolve water-soluble salts and dilute the dissolved ions contained in the interstitial liquor of the sludge. In the present case of the high-heat sludges, there is no salt cake present in the sludge layer, but significant concentrations of soluble ions are present in the intersticial liquid (for instance, the sodium ion concentration may be as high as 5*M*). Sludge washing is expected to remove most sodium, potassium, sulfate, nitrate, nitrite, carbonate, hydroxide, and fluoride. Aluminum, phosphate, and chromium also will be removed to a lesser extent. The washing solution includes dilute concentrations of sodium hydroxide and sodium nitrite (approximately 0.01*M* each) to prevent corrosion of the carbon-steel tank walls. These dilute chemical concentrations will not significantly impact washing efficiencies. The removal of the soluble intersticial chemicals (water washing) is conservatively assumed not to reduce the volume of settled solids.

Leaching with higher concentrations of sodium hydroxide (3*M* to 6*M* sodium hydroxide) is performed to decrease the concentrations of aluminum, phosphate, and chromium in the sludge where this is required to minimize the volume of HLW glass produced. Caustic leaching should be performed at elevated temperatures (>50 °C [>122 °F]) to accelerate the dissolution of the aluminum, chromium, and phosphate.

Sludge washing and caustic leaching may be performed in the million-gallon aging waste tanks. The 300-hp mixer pumps installed for sludge retrieval operations will be used to suspend the sludge and mix it with the wash or leach solution.

Leaching with caustic will result in the dissolution of a portion of the sludge mass. Computer simulations with the Environmental Simulation Program for tank C-106 predict a 40% reduction in the mass of water-insoluble solids. Cognizant engineering personnel have estimated no reduction in AZ-101 sludge mass due to the already high hydroxide concentration and slightly lower aluminum content (30% mass reduction in water-insoluble solids) for the other sludges present in the aging waste tanks. The percent reduction in the volume of settled solids is assumed to be equivalent to the mass reduction of water-insoluble solids. Although this assumed volume reduction appears to be reasonable, it has not been proven by laboratory work. Calculations to determine sludge height have assumed that when sludge is caustic leached there is a 40% volume reduction for C-106 and a 30% volume reduction for sludge in AZ-102, AY-101, and AY-102.

Sludges contained in the aging waste tanks have been settling for several years and have slowly compacted to a density well above that of a freshly settled sludge. When disturbed by sluicing, pipeline transfer, or mixer pump operation, the resettled sludges will occupy a volume that is more than twice that of the compacted sludge. Laboratory experiments conducted on 1,989 core samples of the sludges in tanks AZ-101 and AZ-102 indicated an expansion factor of 2 to 2.25. Because sludges have continued to compact since that time, a more conservative expansion factor of 2.5 is possible. Calculations in this report used 2.25 as an expansion factor.

The volume of sludge in a batch washing or leaching must be limited. Low sludge volumes are inefficient in terms of processing time and the effective use of chemicals and wash water. However, high-sludge volumes create problems in effectively diluting and decanting intersticial liquors and consequently require multiple washes/decants. Cognizant engineering personnel consider 3 m (10 ft) of freshly settled solids (i.e., approximately one-third tank volume of fluffy solids) to be optimum and consider sludges heights above 6 m (20 ft) to be completely impractical. For rating purposes in this report, sludge heights of 3 m (10 ft) were given a 100% rating for processibility, decreasing linearly to 0% at heights of 0 and 6 m (20 ft).

For the sludges that did not have caustic leaching/water washing specified (0a, 0b, 2, 7, N1a, N1b, N3, N4, N5 [a, b, c] and N6), the potential for leaching and washing of the final resting settled sludge was evaluated under the topic "Fluffy Settled Solids." When solids had not been leached during movement through the tank farms, the solids could be leached if it was thought necessary before transfer to HLW vitrification. For example, in the alternatives in which final solids volume was over 6 m (20 ft) (N1b, N4, N5b, N5c, and N6) no value was assigned to this last alternative to leach and wash.

Water washing appears to reduce glass volume by reducing the sodium in the HLW glass. Two water washes have been assumed in the transfer scenarios.

Vienna and Hrma (1995) report that there is probably a negligible amount of reduction in glass volume when these particular sludges are caustic leached. The possible exception to this is that one of the two analyses of C-106 sludge showed some substantial glass volume reduction due to caustic leaching. This particular C-106 chemical analysis is generally not considered to be the more accurate of the two due to the poor ion balance. Overall, these results indicate that caustic leaching may not be warranted with this waste to reduce glass volume, but may have some benefit with demonstration of the technology. Assuming some benefit to caustic leaching, Alternatives 1a, 1b, 3, 4, 5 (a, b, and c), and 6 indicated caustic leaching of the sludge took place followed by water washing. A loss of up to 500 Kgal of tank space occurred as the result of the caustic leaching scenarios.

The decision to leach and wash will depend on the chemical composition of the sludge, composition after blending with other sludges, the vitrification process used, and the glass formulation. If leaching and washing do not reduce the volume of the vitrification product, there is no monetary advantage to leaching. A benefit of caustic leaching these wastes appears to lie in the demonstration of the technology.

Because it is not planned to caustic leach AZ-101, any caustic leaching done with full-sized equipment will be a better demonstration of the efficiency and the design. Therefore, the first DST leached was given a higher score than DSTs sludge-retrieved or DSTs sludge-washed.

Number of DSTs sludge leached:

- 0% = 0 DST sludge leached
- 60% = 1 DST sludge leached
- 90% = 2 DSTs sludge leached
- 100% = 3 DSTs sludge leached.

In this report, both caustic leaching and no caustic leaching scenarios were evaluated in order to illustrate the impacts of the unit operation.

Flexibility in Out-Year Processing

To determine flexibility in out-year processing, the number of tanks with mixer pumps was summed. This indicates that having more support equipment and mixer pumps in the tanks is considered good. A linear scale was used.

Fluffy Settled Solids

Fluffy settled solids are solids that have been agitated or mixed to disperse them. The number of feet of fluffy settled solids is critical when determining if it is worthwhile to wash or leach. Above 6 m (20 ft) of solids, the working space becomes limited and many decants and transfers are required to fill and empty the tank. The factor used to convert from compacted solids to fluffy settled solids was 2.5 as previously discussed in the caustic leaching scales. The potential for performing washing or leaching was determined in this evaluation; the sludge did not have to be leached or washed to have the final in-place potential to be washed and leached.

Therefore, the triangular scale in Figure 3-2 (see Section 3.0 of main text) was generated.

HLW Feed Available

The amount of HLW feed to vitrification is determined by the amount of feed in the tank(s) that have mixer pumps available. Because in every scenario the sludge is consolidated, the scale is simply the tank with the most volume of sludge that has a mixer pump.

It was assumed that the more sludge the more feed to HLW vitrification. This is not completely accurate because the composition of the sludge is critical to the formulation and final volume of the product. But it is an adequate, rough approximation for this analysis.

The evaluation scale was a "lazy S" curve of value versus volume with 50% value at about 155 Kgal sludge. This is approximately equal to that called for in Bacon (1995). See Figure 3-2 in Section 3.0 of main text.

Available Tank Space

<u>Assumptions</u>

The 5*M* or 7*M* sodium waste supernate used to fill tanks or supplement in-tank concentration efforts is assumed to be a low heat, clear, convective liquid that comes from Evaporator 242-A. This will be noncomplexed waste. Waste at 7*M* Na was chosen to be put on top of aging waste solids because it is generally considered to be free of particulate and can produce a clean, convective liquid with minimal precipitates (Powell 1995).

Sludge transfer ratios average 3:1 water to sludge by volume, as assumed by WHC-SD-WM-ER-029 (Koreski and Strode 1995).

Washing consolidated sludge takes about five times as much water as the volume of sludge it cleans (MacLean and Powell 1995). When available, washing of sludge is performed twice. Slurry transport also performs sludge washing if dilute liquid waste is used.

Caustic washing of sludge requires a volume of 50% sodium hydroxide equal to 82% of the volume of consolidated sludge (MacLean 1995) for C-106. Of all the sludge in aging waste tanks, it is anticipated that only C-106 sludge may need to be caustic leached to lower vitrification product volumes. In

Alternatives 1a, 1b, 3, 4, 5 (all), and 6, the alternatives were set up so a caustic leach is performed on C-106 solids when mixer pumps are available. No caustic leaching is performed in the other alternatives.

Sodium hydroxide has a specific gravity of 1.35 at 32% and 0 °C. The sodium hydroxide was assumed to be diluted before getting to the tank, from 50% to 32%, or about 60% dilution to ensure that the specific gravity limit of 1.35 was adhered to.

Observations

Caustic leaching had the most impact on tank space due to the volume of storage space used by the spent caustic solution. The other major effect was the concentration to only 5*M* sodium in the "do nothing" alternative, 0a.

SCHEDULE

Start Date of C-106

The start date of C-106 was based on best estimates of the cost estimator. The major factors that influenced the delay of the C-106 start date were as follows.

- Reroute of the Project W-320 pipeline to other aging waste tanks, Alternatives 1a, N1a, N1b, and 1b, caused the C-106 startup to be delayed to April 1997.
- For Alternatives 4 and N4, the reroute of the Project W-320 pipeline to AZ-102 may be complete by April 1997, but retrieval cannot start until October 1997. The C-106 retrieval will not be able to start up until after the AZ-102 supernate is removed from AZ-102. The second batch of AZ-102 supernate is staged to the AW Farm, but to avoid additional transfers of this high ^{137}Cs solution, we must wait on the evaporator to process the first 250-Kgal batch of waste to avoid putting more than 70 KBtu/h in feed tank AW-102. Processing the first batch of AZ-102 supernate is scheduled to take until September 1997, as noted on the Appendix A schedules for Alternatives 4 and N4.

Schedule

End Date of Waste Consolidation

Project schedules have a significant impact on the schedules for each alternative. The projects for installing mixer pumps and retrieval systems have the biggest impact on each of those alternatives which include retrieval and transfer of solids. In addition to retrieval and transfer of solids, mixing systems are essential to those alternatives which include in tank washing and leaching.

Existing project schedules were used to determine the schedule for equipment installation. In some projects, flexibility in the sequence of events is possible if decisions are made well in advance of implementation. In particular, Project W-211 installs mixer pump systems in several tanks. In each alternative, Project W-211 installs mixer pumps in tanks SY-102 and AW-105 before installing mixer pump systems in any of the AY and AZ tanks. The order of mixer pump installation after the first two tanks is determined by choosing the tanks for installation which will result in the earliest completion of the operations within the alternative. The time between installation of mixer pump systems in each tank is about 1 year.

Project W-320 installs the retrieval system in tank C-106. This system is designed to retrieve the solids from C-106 into AY-102. Changing from AY-102 to some other receiver tank will change the project completion date by 1 year or more from the existing late fiscal year (FY) 1996 completion.

Project W-151 is scheduled to complete installation of a mixer pump system into tank AZ-101 in FY 1996. Changing this project to put the mixer pumps into another tank is unfeasible at this late date.

Retrieval of solids from C-106 requires 3 to 4 months. Mixer pump transfer of solids from one DST to another requires about 2 months. Decanting liquid from one tank to another requires about 1 month. Leaching of solids requires about 6 months. Washing of solids requires about 4 months.

Scheduled Impacts of Projects

The W-030 Project to replace the existing aging waste ventilation system will be installing a 1.6 KBtu/h condenser for AZ-101 compared to 1 KBtu/h condensers on all other aging waste tanks. The consolidation could require movement of the condenser for another aging waste tank. This could happen if the heat generated by the pumps or the waste was great enough. If this occurred, it could delay Project W-030 by about 12 months. Scale evaluation indicated that in only one instance would this be necessary (Alternative 6). With more than 500 KBtu/h in tank AZ-102, this is more reasonable and will provide more flexibility than being in AZ-101. The scale is a 0- to 12-month delay.

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GLOSSARY

AWF	aging waste feed
DST	double-shell tank
HLW	high-level waste
HPT	health physics technician
IDLH	immediately dangerous to life or health
LFL	lower flammability limit
LLW	low-level waste
NPO	nuclear power operator
PIC	person in charge
QC	quality control
RWP	radiation work permit
SST	single-shell tank
TOC	total organic carbon
USQ	unreviewed safety question

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APPENDIX D

REVIEW COMMENT RECORDS

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REVIEW COMMENT RECORD (RCR)

1. Date	2. Review No.
January 2, 1996	1
3. Project No.	4. Page 1 of 2

5. Document Number(s)/Title(s)	6. Program/Project/ Building Number	7. Reviewer	8. Organization/Group	9. Location/Phone
WHC-SD-WM-ER-532 NCAW Consolidation Management Plan	241-AZ, -AY, -AW, -AP, -C-106, 242-A, 702-A	Katie A. White	Evaporator Project Plant Engineering/ Evaporator Project	MO268/2/200E 373-9329

17. Comment Submittal Approval:

Organization Manager (Optional)

10. Agreement with indicated comment disposition(s)

1/22/96 Date — K.A. White by phone [signature] Reviewer/Point of Contact

[signature] Author/Originator

11. CLOSED

1/22/96 Date — Reviewer/Point of Contact

[signature] Author/Originator

12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/ resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
1	Another Unresolved Safety Question (perhaps major) is that for 241-AP and 241-AW, the worst case accident scenario is based on a vapor space concentration of 1.5×10^{-6} Ci/ft^3. This value is derived from a maximum waste concentration of 6 Ci/gal. If you increase the concentration in the evaporator to 12 Ci/gal, you must analyze for at least pot dump potential in 241-AW-102. I believe that this should include re-evaluation of the tank farm worst case accident scenario.	KAW	Accept. Actual conduct of safety analyses is beyond the scope of this document. A major USQ (or two minors) is proposed to be added to the next revision of the analysis which would incorporate concerns with a vapor space accident as you describe. This accident would tend to make the 242-A evaporator even more undesirable as an aging waste supernate concentration alternative. It has been recommended that the primary method of concentration be in-tank, this comment would not change the current analysis result. The 242-A evaporator remains as a back up to in-tank concentration. Also see the attached Background and Discussion for more information.	

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12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
2	Another issue to be addressed is the heat load in the 241-AW and 241-AP tanks. Space to store all of the aging waste to be run through the evaporator and stored in 241-AW and 241-AP is limited and multiple tanks may be required to manage the heat load. I am not certain there will be that many empty tanks.	KAW	This analysis has in the cost estimate (Appendix A) and in the transfer summary that the transfer of AZ-102 supernate would be broken into two transfers, this is to avoid exceeding the 70 kbtu/hr limit in one tank in the AW tank farm. The schedule for the scenarios shows that the AZ-102 solution may be in the same (AW) tank farm, but never in the same tank. The tanks used the evaporator feed and slurry tanks. For risk reduction these tanks would need to be empty. The WVP shows that excess space is available during this time frame.	
3	241-AY-101 has now been added to the watchlist. Transfer of watchlist material is not routine.		Agree, but the tank was added to the watch list after the data cut off date of August, 1995, so it is not required to be reflected in this analysis. In practical terms this data cut off date allows us to finish the analysis without stopping every time something changes in the tank farms. Also, this tank may come off the watch list as fast as it went on. If it is still on the watch list by the time of the next revision we will include it in the analysis.	
4	Just a general comment. I believe you may have more luck evaporating the AZ supernate using the aging waste tanks steam coils than trying to rewrite all of the safety documentation for 242-A, 241-AW and 241-AP. I know the steam coils were disconnected because of unacceptable consequences, but I really think it would be easier in the long run to address the steam coil concerns than trying to increase the evaporator limits to four times the current limit.		The recommended evaporation option has been changed to in-tank as noted in comment 1. The current proposal is not to use steam coils but to let the tank supernate evaporate by its own heat load. This may take 5 to 6 years. No schedule problems exist with this.	

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Katie A. White, RCR Responce comment 1, (continued) - 1/15/96

Background and Discussion:

The concentration of the aging waste supernatant liquor to 111 GBq/L (12 Ci/gal) ^{137}Cs significantly and directly affects three aspects of safety analysis in the manner described by the reviewer. The first safety analysis affected by such concentration is that of shielding analysis in the evaporator; this management plan has considered such shielding analyses among minor USQs as criterion I.C.2.b.(6) in section 3.1.2.3. The second safety analysis affected by such concentration is that of an evaporator accident (criterion I.C.2.a.(1)) as a major USQ; such a USQ would be derived, at least in part, due to concerns of a pot dump and tank overpressurization. The third safety analysis affected by such a concentration is that of a ventilation failure of the AW tank farm; ventilation failure analyses are intimately tied to the operation of the air lift circulators (ALC) for the farm and should be recognized to be required to be a part of an ALC USQ.

Applicable safety analyses documents include WHC-SD-WM-SAR-016 for the tanks and -023 for the evaporator. It is recognized that WHC-SD-WM-SAR-023 shielding analysis generally does not exceed analysis for cesium activities in excess of 5/12 what is described in this management plan, as such, additional shielding analyses and shielding emplacement would be expected and/or required for execution of this work.

Although the AW farm overpressurization concern from a pot dump is a true concern to be evaluated as an anticipated event (historical), it is possible that the combined probability of a pot dump of >55 GBq/L (6 Ci/gal) near the end of the evaporation of this liquor may reduce overall probability below that of anticipated accidents (1 -> 10^{-2}) to that of the unlikely (10^{-2} -> 10^{-4}). In the analytical methods and guidance of WHC-CM-4-46, dose consequences 'considered' acceptable offsite/onsite for the categories of anticipated, unlikely, and extremely unlikely events are 5/25, and 50/250, and 100/1000 mSv (1mSv = 0.1 rem), respectively. In the safety analysis of overpressurization, the material concentrations of a vector of radionuclides were assigned vapor partition fractions in order to estimate vapor concentrations of the materials and thus derive a source term for dose consequence analysis. The vapor partition fraction used in -016 is approximately four times the maximum historically observed partition fractions in aging waste tanks with air lift circulators in operation. It is reasonable to believe that reanalysis of the event probability and consequences (not limited to radionuclides) will lead to the acceptance of the risks of proceeding with NCAW consolidation including supernatant liquor evaporation to 111 GBq/L.

The concern of ventilation failure of the AW farm is in many ways linked to the overpressurization analysis. In this accident analysis, filters loaded with material collected (a function of vapor space concentration) for some period of time are blown out releasing contaminants. Under the current dose consequence analyses for this bounding accident, for wastes with ^{137}Cs concentrations of 61 GBq/L (6.59 Ci/gal) onsite and offsite consequences are estimated to be 670 and 0.37 mSv and are considered acceptable risks. If all other accident parameters remained the same, the dose consequence

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of a bounding accident using 111 GBq/L wastes would double to onsite and offsite dose consequences to ~1340 mSv and 0.74 mSv, respectively. Current guidelines (WHC-CM-4-46) would find the onsite consequences of this accident to be unacceptable. However, reanalysis with reduction of excessive conservatism, as described in WHC-CM-4-46 (see also DOE Order 5480.23), should reasonably allow DOE to consider the risk of the accident scenario consequences surrounding this consolidation to be acceptable.

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1. Date	2. Review No.
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5. Document Number(s)/Title(s)	6. Program/Project/ Building Number	7. Reviewer	8. Organization/Group	9. Location/Phone
WHC-SD-WM-ER-532 / Draft Neutralized Current Acid Waste Consolidation Management Plan	WTPE	Brian Von Bargen	EPPE / Evaporator Plant Project	2750E/D196 373-1829

17. Comment Submittal Approval:

Organization Manager (Optional)

10. Agreement with indicated comment disposition(s)

1/22/96 Date — Reviewer/Point of Contact

Author/Originator — B. Von Bargen by phone

11. CLOSED

1/22/96 Date — Reviewer/Point of Contact

Author/Originator

12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/ resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
1	The Evaporator source term limits are given in Chapter 9 of the 242-A SAR. The limit for Cs-137 is 1500 uCi/ml (5.67 Ci/gal). This limit will be exceeded if the waste is processed through 242-A to the endpoint concentration described. No data has been provided for other radionuclides which also are limited in Chapter 9. Radionuclides data and projected concentrations for these other isotopes of concern should also be evaluated as these may also be restricting.	yes	The concentration of Cs137 will be above evaporator limits (rounded to 6 Ci/gal) as noted in the document. There may be other radionuclides that are above limits, but Cs137 is likely to be the most limiting, so it was chosen for review. This document does not perform all evaluations need to close issues, it indicates that there is an issue and evaluates it enough so that others can understand it, and it can be evaluated in the analysis. Document will be changed to indicate that other radionuclides (besides Cs137) may also be limiting.	
2	The Evaporator shielding limits are described in Chapter 8 of the 242-A SAR. This limit is given as 800 uCi/ml (3.0 Ci/gal). This limit will be exceeded if the waste is processed through 242-A to the endpoint concentration described.	yes	Agree, this issue is indicated by (2) minor USQ evaluations as noted in Appendix A, page A-6, Table A-2. No action required.	
	page 4, Table 1, the units for total organic carbon in the liquid are given as mgC/L. Based on the concentrations given, the units should be gC/L.		Accept, changed units.	

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12. Item	13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/resolve the discrepancy/problem indicated.)	14. Hold Point	15. Disposition (Provide justification if NOT accepted.)	16. Status
4	section 3.1.2.3, "A. Minimize personnel risk" - was exposure to laboratory personnel during sample handling and analysis evaluated? Also include evaporator process control samples along with the listed tank samples in "a.". With the increased level in exposure due to high Cs-137 (and possible other isotopes), item e. should be added which would be exposure to evaporator personnel during waste concentration operations.	yes	Accept, in talking with laboratory personnel (John Miller) they will receive on average 20 to 30 mrem/person during sample handling and analysis. Samples usually take 1 to 3 personnel to analyze. Using an average of 2 personnel, and 25 mrem and assuming about 10 samples/alternative (will vary)= 500 mrem This is less than the 2 significant figures used in the analysis. In the scales "Personnel Risk" extends from 14,000 to 23,000 mr, with the more involved scenarios having the higher dose. These exposure levels would not change the options chosen by the criteria. However, they will be added in the next revision of the document. To assure that this happens this RCR will be added to the document in an appendix.	

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