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Alternatives Generation and Analysis for the Phase I Intermediate Waste Feed Staging System Design Requirements

R. D. Cleghorn, J. D. Gelbraith, and T. B. Salzano (FDMF) Humated Hanford Corporation, Richland, WA 99352 U.S. Department of Energy Contract DE-ACO6-96RL-13200

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Abstract: This alternatives generation and analysis (AGA) addresses the question: What is the design basis for the facilities required to stage low-level waste (LLW) feed to the Phase I private contractors? Alternative designs for the intermediate waste feed staging system were developed, analyzed, and compared. Based on these analyses, this document recommends installing mixer pumps in the central pump pit of double-shall tanks 241-AP-102 and 241-AP-104. Also recommended is installing decant/transfer pumps at these tanks. These recommendations have clear advantages in that they provide a low shedule impact/risk and the highest operability of all the alternatives investigated. This revision incorporates comments from the decision board.

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ALTERNATIVES GENERATION AND ANALYSIS FOR THE PHASE I INTERMEDIATE WASTE FEED STAGING SYSTEM DESIGN REQUIREMENTS

January 1997

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GLOSSARY

Abbreviation, Acronym, or Term	Corresponding Term or Definition
ADA	Air Delivery Assembly
ADMP	Advanced Design Mixer Pump
AGA	Alternatives Generation and Analysis
ALARA	As Low As Reasonably Achievable
ALC	Air Lift Circulator
CDR	Conceptual Design Report
Caustic	Socharo Hydroxide
Constraint	Externally imposed requirements
Contractors' Tanks	The DST tanks given over to the private contractors for use as feed staging tanks in their processes
DAP	Double Accumulator Plate
Decant/Transfer Pump	A deep-well turbine transfer pump with an intake at an adjustable height (similar to the W-151 design) used to decant waste from DSTs
Detrament	Cost of exposure
Dilution Factor	The ratio of the staged feed volume to the original volume of the waste before retneval
DQO	Data Quality Objective
DST(s)	Double-shell tank(s) that contain mixed waste scheduled for retneval and processing during Phase I Privatization operations at the Hamford Site
Enabling Assumption	An assumption made to permit continued analysis where information concerning a decision, constraint, or requirement is lacking
Eqn	Equation
F&R	TWRS Functions and Requirements Document (Carpenter 1996)
Feed Envelope	See Modified RFP Food Envelope

GLOSSARY

Abbreviation, Acronym, pr Terin	Corresponding Term or Definition
Fixed-Intake Transfer Pump	A deep-well turbine pump with an intake at a fixed height used to transfer waste out of a tank
gibbaic	Sodium Aluminate, (NaAlO ₁)
G0C0	Government Owned / Contractor Operated
HEPA Filter	High-efficiency particulate art filter
Hanford Site	The Department of Energy's nuclear site located North of Richland, Washington
HLW	High-Jevel waste
HVAÇ	Heating, Venulation, and Air Conditioning
Insoluble Solids	Metal, metal oxide, and other insoluble compounds rusoluble in water or dilute caustic solutions (i ${\bf e}$, sludge)
LWFSS	Intermediate Waste Feed Staging System
IWFST(s)	A LLW Intermediate Waste Feed Staging Tank Same as staging tank in this document
LAW	Low-activity waste
LLW	Low-level waste
Mixer Pump	A 300-hp pump used to mobilize solids and mix waste in DSTs
Modified <i>RFP</i> Feed Envelope	A set of physical and chemical limits, defined by the <i>RFP</i> and by the <i>LLW Feed Staging Plan</i> , that must be met by a supernatant provided to the private contractors as feed
NGTP	New Generation Transfer Pump
Not-mixed	An IWFST mixing scenario in which the feed batch is not mixed and potentially has stratified supernatant layers
OSD	Operational Safety Document
OSR	Operational Safety Requirement
OWVP	Operational Waste Volume Projection

GLOSSARY

Abbreviation, Acronym, or Term	Corresponding Term or Definition
Phase 1	The first portion of the TWRS Privatization during which a proof-of-concept demonstration is performed and additional feed is processed using relatively small-scale processing facilities.
Phase II	The final portion of the TWRS Privatization during which full- scale production facilities are operated.
рнмс	Project Hanford Management Contractor
PLC	Programmable Logic Controller
PNNL	Pacific Northwest National Laboratory
Private Contractor(s)	Private companies involved in the Phase Privatization who are contracted to construct and operate a LAW immobilization facility at the Hanford Site.
Privatization	A business strategy in which private contractors provide the capital for building plants and treating waste. The private contractors assume much of the financial and technical risk.
PSAR	Preliminary Safety Analysis Report
RCRA	Resource Conservation and Recovery Act of 1976
Requirement	Internally imposed limits.
RFP	TWRS Privalization Request for Proposals (DOE-RL 1996)
RRŞD	Sodium Ratioed RSDs
RSD	Relative Standard Deviation
Sampling Number	The number of samples required to validate that a specific batch meets the feed envelope criteria.
Settled or Settleable Solids	Solids that will settle to the bottom of the tanks.
Simplifying Assumption	An assumption used to make calculations or analysis easier.
Sodium Ratio	The ratio of a chemical component concentration (in M) or radionuclide concentration (in Bq/L) to the sodium Concentration (in M).
Solida Entrainment	The entrainment of settled solids during retrieval and transfer from the source tanks or transfer from the staging tanks.

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Abbreviation, Acronym, or Term	Corresponding Term or Definition
Saluble Solids	Solids that can be dissolved in water of dilute caustic solutions, primarily salts of sodium.
Source Tanks	DSTs containing waste to be retrieved and used as feed during Phase I Privatization operations
Staging System	Intermediate Waste Feed Staging System or IWFST
Staging Tank	A I.L.W Intermediate Waste Feed Staging Tank or IWFST.
Stat Ratio	A measure of the proximity of the component's sodium ratio to feed envelope limit.
Stratified Layers	Two or more supernatants with different densities and chemical compositions which cause them to float one on top of the other without appreciable mixing between the layers.
TED	To Bo Determined
TECC	Total Estimated Construction Cost
πc	Total Inorganic Carbon
TOC	Total Organic Carbon
Transurartic Radionuclides	All the isotopes of americium, plotonium, and neptunium.
TRU	See transuranie radionuclides
TWRS	Tank Waste Remediation Systems
USQ	Unresolved Safety Question
Well-mixed	An IWFST mixing scenario in which the feed batch is mixed until homogeneous.
wk	Week
WTS	Waste Transfer System

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ALTERNATIVES GENERATION AND ANALYSIS FOR THE PHASE I INTERMEDIATE WASTE FEED STAGING SYSTEM DESIGN REQUIREMENTS

1.0 DECISION ANALYSIS SUMMARY

This alternatives generation and analysis (AGA) addresses the question What is the design basis for the facilities required to stage low level waste (LLW) feed to the Phase I private contractors?

Following the strategy laid out by the LLW Feed Staging Plan (Certa et al. 1996), the Double-Shelt Tank (DST) Waste Retneval System and the Tank Waste System will work together as a single system to stage batches of LLW. For the purposes of this study, the combined systems will be referred to as the Intermediate Waste Feed Staging System (IWFSS).

1.1 ALTERNATIVES GENERATION

The IWFSS is responsible for receiving waste from the retrieval function, staging the retrieved waste in batches, and transferring these feed batches to the private contractors. The IWFSS will use only some of the components of the DST Waste Retrieval System and the Tank Waste System. The subsystems under the DST Waste Retrieval System are the DST Waste oblization System (mixers and dissolution/dilution equipment) and the DST Waste Transfer System (transfer pumps). The subsystems of interest under the Tank Waste System are the Waste Transfer System (transfer pumps), pits, and transfer lines), the Intermediate Waste Feed Staging Tank (JWFST) Mixing System (if required), the IWFST Sampling System (if required) and the JWFST Ventilation System.

The issues and options for these systems affect each other, in particular, the IWFST Transfer Pump and the IWFST Mixing System Therefore, alternatives were generated that represent the combinations of options for the transfer pump and the mixing system. To each of these alternatives, the most appropriate options for the valve pit and the sampling and veotilation systems were added. Figure 1-1 shows how the options for these systems fit together into the alternatives.

Table 1-1 is a matrix listing the alternatives generated by this study versus the decision criteria. This table summarizes the differences between the alternatives

Figure 1-1. Intermediate Waste Feed Staging System Alternatives.

ALTERNATIVES	STUDY INF	LUENCE		31	UDY SCOPE		
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Intermediate Waste Feed Staging System Alternatives by Decision Criteria Matrix (Cont.)

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1.2 CONCLUSIONS

1.2.1 Benefits of Solids Entrainment Control at the Staging Tank Versus at the Source Tank

Alternatives 3 and 4 place control of solids entrainment at the staging tank whereas alternatives 7 and 8 have the solids entrainment control at the source tank. Because of this, Alternatives 7 and 8 can't control the following:

- Soluble solids (salts) that were not dissolved during retrieval and transfer or that
 precipitated while in the staging tank.
- Insoluble solids unintentionally entrained with the retrieved supernatant and/or supernatant slumics.
- Settleable, insoluble solids teleased from the inclusions of salt crystals that were transferred to the staging tank before dissolution.

Alternatives 3 and 4 have the advantage that they can control all of these solids. Also, with Alternatives 3 and 4, there is always the option to additionally control solids entrainment at the source tank. This can be determined on a tank by tank basis.

For Alternatives 7 and 8, the cost includes an additional \$5,100,000 incurred by the DST Wasts Retrieval System due to the "Control Solids Entrainment at Source Tank" requirement. This assumes that, for each source tank requiring solids entrainment control, the DST Waste Retrieval System installs a single decant/transfer pump; a 106.7-cm (42-in.) riser is extended to grade; a pump pit is constructed to house the decant/transfer pump; and transfer lines are constructed from the new pit to the central pump pit. This assumption makes Alternative 7 \$2.2 million more expensive than Alternative 3 and Alternative 3.4 million more expensive than Alternative 4. Without this assumption, Alternative 8 \$5.1 million more expensive than Alternative 4. Without this cost the same.

Because the settleable solids entrainment control at the staging tank gives the staging system a higher operability and a lower cost, it is recommended that the control of settleable solids entrainment be placed on the staging tanks.

1.2.2 Benefits of Mixing Versus Not Mixing

Alternative 5 (no mixer) is the only alternative where a mixing system is not put in the staging tanks. The capital cost for a mixer pump on-center, a mixer pump off-center, and a

pulsed-air system are \$6.7 million, \$6.4 million, and \$5.5 million, respectively (see Section 6.2.2.6) This is a maximum capital cost savings of \$6.7 million

If the staged waste is not actively mixed, the assumption of homogeneity cannot be made and the number of samples required to validate the feed batch increases. The increased operational cost due to increased sampling and analysis is \$5.98 million for the Phase I operational period (see Table 7-1).

The maximum capital cost savings of not installing a mixer pump system is nearly offset by the increased operational cost for increased sampling. Problems with settled solids accumulation, exacerbated by the lack of settled solids mobilization capabilities for solids removal, may increase the sampling cost even higher. A mixing system installed the staging tanks for Phase J could also have the same kind of operational cost savings during Phase II Also, because of the increased sampling, operator doses received are higher.

Because mixing the staged waste provides the staging system with higher operability, lower schedule impact/risk, and higher safety, mixing the staged waste is recommended

1.2.3 Benefits of Mixer Pomp Versus Pubed-Air Mixer

In contrast to Alternatives 3, 4, 7, and 8, Alternative 6 installs a single 91 4-cm (36-in) pulsed-air mixer in the staging tanks. The operability of this alternative is reduced because the pulsed-air mixer has not been demonstrated to be capable of mobilizing settled solids, which makes it more difficult to remove the settled solids. Also, the pulsed-air mixing system cannot be used to mobilize soluble solids to aid in solids dissolution and must rely on the Dissolution/Dilution System at the source tank to dissolve all the soluble solids and adjust the waste so that no solids precipitation will occur at the staging tank. The technical information to do thas is not currently available but is under development.

There is a capital cost savings associated with the pulsed-air mixer in the staging tank rather than a mixer pump. The pulsed-air mixer is \$1.2 million and \$0.9 million less expensive than a mixer pump on-center and off-center, respectively (see Sections 6.2.2.6, 6.2.3, and 6.2.4).

Because of the increased operability and decreased schedule impact/risk the mixer pumps provide, and despite the additional cost, it is recommended to use a mixer pump as the mixing system in the staging tank

1.2.4 Benefits of Mixer Pumps On-Center Versus Off-Center

Alternatives 4 and 8 are nearly identical to Alternatives 3 and 7, respectively, except that Alternatives 4 and 8 have their mixer pumps positioned off-center rather than at the center of the tank. This could dramatically reduce the staging system's ability to effectively mobilize the settled solids that accumulate in the staging tanks. This accumulation of settled solids in the

staging tank will be most pronounced in Alternatives 3 and 4 where the entrainment of solids is not controlled at the source tank

The only benefit of having the mixer pumps off-center is a decreased cost (capital) of \$2.0 million between Alternatives 3 and 4 and \$1.2 million between Alternatives 7 and 8 (see Sections 6.2.2.6, 6.2.3, and 6.2.4) Because of the increased operability and decreased schedule impact/nisk, using on-center mixer pumps in the staging tanks is recommended

1.3 DESIGN REQUIREMENTS RECOMMENDATIONS

Alternative 3 is the recommended alternative - It includes the following

- Solids entrainment control at the staging tank.
- A mixing system (rather than no mixing system).
- A mixer pump (rather than a pulsed-air mixer)
- An on-center mixer pump location (rather than off-center)

Clear advantages to this alternative are that it has the following

- Highest operability
- Low schedule impact/risk

It also ranks higher than or equal to other alternatives in safety and technical maturity and has a cost just above the average

1.4 DESIGN REQUIREMENTS DECISION

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This document does not contain a decision on this system. A new decision board will be convened in fiscal year 1997 to make a decision

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2.0 PROBLEM STATEMENT

This AGA process addresses the following question:

What is the design basis for the facilities required to stage LLW feed to Phase I private contractors?

The term "Phase I private contractors" refers to DOE's two-phased approach to the remediation of Hanford's tank waste. The Tank Waste Remediation System Mitsion Analysis (WHC 1996d) states that the mission of the Tank Waste Remediation System (TWRS) is to manage and immobilize for disposal Hanford radioactive waste in a safe, cost-effective, regulatory compliant, and environmentally sound manner. The physical systems required to perform the mission will be acquired through a combination of privately-owned/operated and government-owned/contractor operated (GOCO) resources in a two-phased acquisition strategy. During the first phase, GOCO resources will stage waste from DST as feed to the two private contractors. The private contractors will then demonstrate pretreatment of the LLW by separating radionuclides from the waste liquids and then immobilizing the resulting low-activity waste (LAW).

2.1 SOURCE DOCUMENTS

Section 3.0 provides details on the constraints and assumptions used for this analysis. To elaborate on the problem statement given above, this section will review the upper-level performance requirements described in three related documents: the TWRS Privatization Request for Proposals (RFP) (DOE-RL 1996), the Decision Document for Phase I Privatization Transfer System Needs (Galbraith et al. 1996) and the LLW Feed Staging Plan (Certa et al. 1996). The significance of each of these documents is discussed below.

2.1.1 Tank Waste Remediation System Privatization Request for Proposals

The TWRS Privatization Request for Proposals (RFP) (DOE-RL 1996) identifies the services that DOE will provide to the private LLW treatment contractors. This AOA specifically addresses the development of design requirements for a system that will enable DOE to stage sufficient quantities of waste feed and provide composition information before transfer to the private contractors. In accordance with the *RFP* (DOE RL 1996), operational control of DST 241-AP-106 and 241-AP-108 will be transferred to the private contractors for their use as feed tanks (contractors' tanks).

2.1.2 Decision Document for Phase I Privatization Transfer System Needs

The LLW Feed Staging Plan (Certa et al. 1996) recommended using the Indurect Staging -As Soon As Possible staging strategy that requires two intermediate waste feed staging tanks (IWFSTs or staging tanks) The term "intermediate" refers to the fact that DOE will use these tanks to stage the waste upstream from the feed tanks controlled by the private contractors. The LLW Feed Staging Plan (Certa et al. 1996) also recommended using DST 241-AP-102 and 241-AP-104 as the staging tanks. The decision to accept the recommended strategy and us: 241-AP-102 and 241-AP-104 as the staging tanks is documented in Decision Document for Phase I Privatization Transfer System Needs (Galbrauth et al. 1996).

2.1.3 Low-Level Waste Feed Staging Plan

The LLW Feed Staging Plan (Certa et al. 1996) incorporates the following assumptions regarding the proposed intermediate waste feed staging system

- The DOE, as represented by the Project Hanford Management Contractor (PHMC), will demonstrate that the delivered waste meets the compositional feed envelope enterns by sampling and analyzing the waste in the intermediate waste feed staging tanks
- The samples and the analysis of waste in the intermediate staging tanks will also satisfy regulatory requirements (if any) imposed on the PHMC before the transfer of the waste to the contractors' tank
- The PHMC contractor will provide the waste batch composition, before transfer to the contractors' tanks

Following the strategy laid out by the *LLW Feed Staging Plan* (Certa et al. 1996), the DST Waste Retrieval System (TWRS Architecture #132, TWRS Function #422) and the Tank Waste System (TWRS Architecture #11, TWRS Function #422) will work together as a single system to stage batches of LLW. For the purposes of this study, the combined systems will be referred to as the Intermediate Waste Feed Staging System (IWPSS)

2.2 COMPONENTS OF THE INTERMEDIATE WASTE FEED STAGING SYSTEM

In the TWRS Privatization Phase I Waste Feed Staging System (see Figure 2-1), supernatant and salt slurry waste will be retrieved from select DSTs (source tanks). The retrieved waste will be diluted and some or all of the soluble solids will be dissolved. The resulting waste will be transferred to a staging tank. Waste in the staging tanks will be transferred in batches (feed batches) to the private contractors' feed tanks (contractors' tanks). From these tanks, the private contractors will transfer the feed batches into their facilities for LLW pretreatment and LAW immobilization.

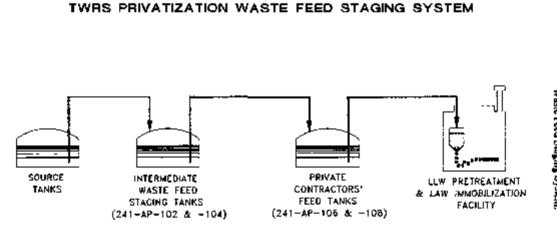


Figure 2-1. Tank Waste Remediation System Phase I Privatization Waste Feed Staging System.

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The IWFSS is responsible for receiving waste from the retrieval function, staging the retrieved waste in batches, and transferring these feed batches to the contractors' tanks. The IWFSS will use only some of the components of the DST Waste Retrieval and Tank Waste Systems. The systems of interest are shown on the architecture tree in Figure 2-2. The subsystems under the DST Waste Retrieval System are the DST Waste Mobilization System (mixers and dissolution/dilution equipment) and the DST Waste Transfer System (transfer pumps). The subsystems of interest under the Tank Waste System are the Waste Transfer System (transfer pumps, pits, and transfer lines), the IWFST Mixing System (if required), the IWFST Sampling System (if required) and the IWFST Ventilation System. Issues and options for each of these subsystems are discussed below.

2.2.1 Double-Shell Tank Weste Mobalization System

Some of the waste identified in the *LLW Feed Stoging Plan* (Certa et al. 1996) will require equipment that is designed to break up and dissolve soluble solids that are currently within the selected source tanks so that the waste can be pumped through the Waste Transfer System described in Section 2.2.2 below. For the purposes of this study, it is assumed that standardized mixers will be used only where it is necessary to achieve enough feed to meet the feed quantity requirements of the *LLW Feed Staging Plan* (Certa et al. 1996).

Because of issues with the release of flammable gases (i.e., hydrogen and ammonia), the DST Waste Retneval System may be required to mix the sludge before the supernatant in some tanks can be retneved. If this is the case, it is assumed an appropriately long settling period would be observed after shutting off the mixer pumps and before starting the decant/transfer pumps. Other objectives associated with a mixer, such as the terminal clean out of DSTs, are not within the scope of this analysis.

The LLW Feed Staging Plan (Certa et al. 1996) shows that most of the retrieved waste will require some dissolution of soluble solids and dilution of supernatants at the source tank to make the waste pumpable using standard tank farm equipment. This dissolution/dilution is intended to reduce the specific gravity and viscosity of the transferred waste that also complies with the Planmable Gas Rule in the Waste Compatibility Data Quality Objectives (DQO) (Fowler 1995). This will increase the turbulence in the transfer lines and reduce the potential for solids collecting and plugging the system. This system could also be used to dissolve all of the solids before the waste is transferred into the staging tanks and to adjust the supernatant composition to prevent precipitation in the staging tank.

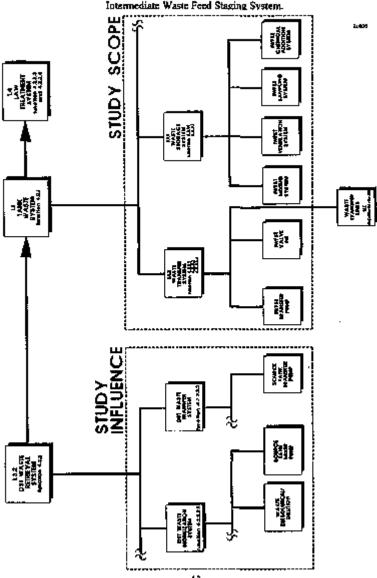


Figure 2-2. Architecture Tree with the Phase I Privatization Intermediate Waste Feed Staging System.

2.2.2 Waste Transfer System

The Waste Transfer System (WTS) includes both the WTS under the DST Waste Retrieval System and the WTS under the Tank Waste System

2.2.2.1 Waste Transfer System Under Double-Shelf Tank Waste Retrieval. After the wastes have been mobilized, the transfer pumps within the source tanks will be required to move waste through pipelines to the staging tanks. For the purposes of this study, the basis for the pressure and velocity required to push the waste will be that selected by a decision on the Decision Document for Phase I Privatization Transfer System Needs (Galbrauth et al. 1996).

It may be desirable to locate the intake for some of the manifer pumps such that most (if not all) of the insoluble solids (i.e., sludges) within the source tanks are left behind. It would be desirable to leave the sludges behind in that the DOE is committed to provide a waste feed to the private contractors with no more than five volume percent (settleable) solids. This study will identify the cost and benefits of controlling the amount of insoluble solids entrained (solids entraneout) and subsequently transferred to the staging tanks.

The control of solids entrainment at the source tanks is outside the scope of this study but is investigated in enough detail to define interface requirements pertaining to the solids entrainment control

2.2.2.2 Waste Tank System Under the Tank Waste System. If there is a potential to have a significant amount of sottleable solids within the staging tanks, then it may be desirable to locate the intake for the transfer pumps such that most (if not all) of the insoluble, settleable solids within these tanks are left behind. This study will identify the cost and benefits of locating the transfer pump intake at the end of a flexible hose positioned at a point above the settled solids in the source tank

The pipehnes that will serve as the transfer route from the source tanks to the staging tanks were selected in the Decision Document for Phase I Privatization Transfer System Needs (Galbrauth et al. 1996). Appendix D, Waste Transfer System Engineering Report, analyzes options for connecting the pipelines with the IWFSTs.

2.2.3 Waste Storage System

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To verify that the waste feed batches within the staging tank comply with the feed envelope enterna, a number of samples have to be taken from the staging tanks – The issue on the *IWFST Sampling System* is what type of sampling system is best suited for the Phase I feed batch sampling needs

The *IWFST Mixing System* issues are whether or not mixing is required, and if so, what type of mixing system should be used and whete in the staging tank should it be located. Factors affecting the mixing issue include the benefits in mixing potentially stratified liquid layers (i.e.,

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blend waste from two or more source tanks or blend waste with additives used for chemical adjustments of the waste), dissolving soluble sodium salts that did not dissolve during retrieval and transfer from the source tanks, redissolving precipitated salts (e.g., gibbsite), reducing sampling and analysis requirements by creating a homogenous solution, and removing problematic liquids (e.g., flushing the heel during envelope changes) and settled solids (i.e., tank clean out).

Depending on the mixing system used, upgrades to the *IWFST Ventilation System* may also be required. Ventilation system issues will also be investigated for alternatives where it is required.

The issue with the *IWFST Chemical Addition System* is how to best integrate it in with the other WTS subsystems.

2.2.4 Integrated Intermediate Waste Feed Staging System Subsystems

Because the issues and options for these systems effect each other, it is not feasible to consider each system individually. Therefore, alternatives have been generated that represent the most plausible combinations of options from the Waste Transfer and Mixing Systems. To each of these alternatives, the most appropriate options for the Sampling and Ventilation Systems were added before the alternative was analyzed.

A separate study in Appendix D compares valve pit alternatives in the Waste Transfer System (Under the Tank Waste System). This study also analyzes options for the connecting of the pipes with the tanks.

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3.0 CONSTRAINTS, REQUIREMENTS, AND ASSUMPTIONS

3.1 INTERMEDIATE WASTE FEED STAGING SYSTEM

3.1.1 Intermediate Waste Feed Staging System Constraints

The Intermediate Waste Feed Staging System will conform to all of the following regulatory documents

Constraints are requirements that are imposed by an external organization. The design, operation, and maintenance of the IWFSS are affected by state and federal regulations, agreements, DOE Orders, and WHC requirements. In addition, there are guidelines and specifications that set forth engineering requirements deemed necessary for safe design and construction of the system. The requirements and guidelines presented in these orders, regulations, codes, and agreements must be followed when designing and installing a mixing system. The format below establishes a hierarchy into the listed documents to be used during the definitive design stage of the IWFST upgrades.

- DOE Order 5480 28, Natural Phenomena Hazards Mitigation
- DOE Order 5820 2A, Radionctive Waste Management
- DOE Order 6430 I.A., General Design Criteria
- WAC 173-303-640, Dangerous Waste Regulations, Tank Systems
- WHC-IP-1043, WHC Occupational ALARA Program (WHC 1995)
- WHC-SD-GN-DOS-30011, Radiological Design Guide (WHC 1994)
- WHC-SD-TP-SARP-001, Sample Pig Transport System Safety Analysis Report for Packaging (Onsite) (Carlstroin 1995)
- WHC-SD-WM-SARR-031, Safety Analysis for Push and Rotary Mode Core Sampling (Milliken 1995)
- WHC-CM-2-14, Hazardous Material Packaging and Shipping (WHC 1992a)
- WHC-CM-4-46, Safety Classification of Structures Systems, and Components (WHC 1992b)
- ASME B31 3, Process Piping

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3.1.2 Intermediate Waste Feed Staging System Requirements

Any long-length equipatient installed in the staging tanks (e.g., mixer pumps, transfer pumps, thermocouple trees) must be designed to fit in the burial containers developed under the Long-Length Contaminated Equipment Disposal Program. In addition, the equipment weight anust be below the limits of the trailers for the bandling and transport of the burial containers. The design information for the long-length equipment can be found in the following documents.

- WHC-S-0321, Specification for Trailers for the Handling and Transport of Tank Farms Long-Length Contaminated Equipment (McContrick 1996)
- WHC-S-0402, Specification for Contaminated Equipment Buriol Container (McConneck and Edwards 1996)

The RFP (DOE-RL 1996) and amendments identified the services that would be provided to the private contractors. The following are those services that would be provided by the IWFSS

- Stage and deliver sufficient quantities of waste feed to the contractors' tanks.
- The batches of waste feed staged to the private contractors must fit within the modified *RFP* feed envelopes
- Provide composition information before the transfer to the contractors' tanks.

The RFP (DOE-RL 1996) also states that

The feed tanks for private contractors 1 and 2 will be 241-AP-106 and 241-AP-108.

and the Decision Document, Low-Level Waste Feed Staging Strategy (WHC 1996c), has decided that

 Two intermediate waste feed staging tanks are required to implement the LLW Feed. Staging Plan

Also, the Decision Document for Phase I Privatization Transfer System Needs (Galbraith et al. 1996) decided that

 DST 241-AP-102 and 241-AP-104 will be the LLW intermediate waste feed staging tanks for Phase I

The RFP (DOE-RL 1996) lists the following as a performance requirement

 Minimize the usage of sodium compounds (e.g., sodium hydroxide, sodium nitrite, fluorides, and sulfates) that could increase the volume of immobilized LAW and immobilized HLW.

The basis for this requirement is DOE Order 5820 2A, Chapter III, 3 e.4. This is taken to mean not only minimizing the use of sodium bearing hquids, but minimizing conditions that will require future use of sodium bearing solutions. Other constraints on the IWFSS listed in the TWRS Functions and Requirements Document (F&R) (Carpenter 1996) are listed below.

- Estimated TWRS Project Schedule The IWFSS must support the TWRS project schedule Proof-of-Concept operations will be from June 2002 through June 2007, with DOE's option to extend processing through June 2011
- Chemical Concentrations Limits The IWESS systems interfacing with the waste sources must be capable of handling waste with the chemical concentrations specified in OSD-T-151-00007 (WHC 1996b)
- Tank Dome Static Loading The weight of any portion of the IWFSS installed on a tank shall be limited by the static dome loading design limits specified in OSD-T-151-00807 (WHC 1996b)
- Temperature Non-Aging Waste DST Waste The IWESS must be capable of handling waste with a maximum temperature of 82°C (180°F) as specified in WHC-SD-WM-OSR-016, LCO 3 2 2 (WHC 1996a)
- Tank Ventulation System Pressure The IWFSS shall not over- or under-pressurze the tanks based on the lamits specified in OSD-T-151-00007 (WHC 1996b)

3.1.3 Intermediate Waste Feed Staging System Assumptions

The *LLW Feed Staging Plan* (Certa et al. 1996) incorporates the following enabling assumptions regarding the IWPSS

- The starting date for feed staging transfers is October 1, 2000 (Certa et al. 1996, page 3-1).
- The DOE, as represented by the PHMC, will demonstrate that the delivered waste meets the compositional envelope criteria by sampling and analyzing the waste in the intermediate waste feed staging tanks
- The samples and the analysis of waste in the staging tanks will also satisfy regulatory requirements (if any) imposed on the PHMC before the transfer of the waste to the contractors' tanks

 Not all of the DST waste compositions fall within a modified *RFP* feed envelope. The tanks that contain waste within a designated envelope and are scheduled for staging are referred to as source tanks and are listed in Table 3-1. Some of these are subject to change as envelopes evolve and OWVP's are revised.

Envelope	A	в	С
Tank	241-AN-103* 241-AN-104 241-AN-105 241-AP-104* 241-AP-106 241-AW-101	241-AY-101*	241-AN-102 241-AN-1069 241-AN-107 241-AP-1079

Table 3-1. Source Tanks for Phase I Privatization Feed Envelopes.

It is assumed that this tank waste will be concentrated or blended with a more concentrated waste to meet the minimum sodium limit of 3.0M.

^bIt is assumed that these tank wastes will be diluted or blended with less concentrated wastes to meet the maximum sodium limit of 14*M*.

'The location of this waste may change.

3.2 WASTE TRANSFER SYSTEM

3.2.1 Waste Transfer System Requirements

The *LLW Feed Staging Plan* (Certa et al. 1996) lists the following as feed makeup and delivery requirements.

- Receive a batch of waste transferred from one or more source DSTs via the recommended transfer system upgrade Alternative K (see Galbraith et al. 1996, LLW Option 4, HLW Option 3).
- Transfer the supernatant and solids (if the solids content and composition is acceptable) to the contractors' tanks. The transfer sctup time should be consistent with the feed delivery study's recommended case (Certa et al. 1996) and nominally take one day.
- Transfer the supernatant to the contractors' tanks leaving all or some of the settled solids behind (if the solids content and composition is unacceptable). The time needed to settle out solids should be no longer than 30 days. The transfer setup time

should be consistent with the feed delivery study's recommended case (Certa et al. 1996) and nominally take one day.

- Pump transfer rate should be 0.76 ML/day (140 gal/min).
- Follow each feed delivery transfer with a line flush of 1.5 line volumes.
- The liquid heel remaining in the staging tank after the feed batch has been transferred to the contractors' tanks should be no more than 0.10 ML (10 in.).
- Transfer the staging tank's entire contents (excluding the heel) to another DST if the waste is out-of-specification and must be removed or set aside for later disposition.
- Remove problematic (due to quantity, composition, or physical properties) solids that were intentionally or inadvertently retrieved and transferred from the source DSTs or that precipitated during or after the transfer. These solids would be transferred to another DST for future processing.

3.2.2 Waste Transfer System Assumptions

There are two types of solids of concern to the Wasts Transfer System: soluble solids--salts that were not dissolved during retrieval and transfer or that precipitated while in the staging tank; and insoluble solids--metal and metal oxide sludges and other compounds that will not dissolve in water or dilute caustic solutions.

The waste phase the solids are associated with divides the solids into two classifications: suspended and settled. The suspended solids consist of undissolved soluble solids or insoluble solids too small to settle out of the supernatant. Suspended soluble solids can be dealt with by dissolving them either during retrieval and transfer or during mixing in the staging tanks. If the soluble solids are not dissolved, they will likely fall to the bottom of the tank where their transfer will be controlled with the rest of the settled solids. Suspended insoluble solids are not realistically separable from the retrieved supermatants and slurries. Therefore, controlling the transfer of these solids from the source tanks to the staging tanks, or from the staging tanks to the contractors' tanks, is not feasible.

Settled, or settleable, solids are those solids that settle to the bottom of the tank. The settled solids in the staging tanks are expected to be primarily insoluble solids from source tank sludge layers entralned during the retrieval and transfer process. If adequate mixing and dissolution are not performed, the settled solids in the staging tank may very well include a sizeable amount of soluble solids.

The following are enabling assumptions used for the Waste Transfer System in this study.

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- The DST Waste Transfer System under the DST Waste Retrieval System will dilute the retrieved waste (if required) and dissolve soluble solids in the retrieved waste before the waste is transferred into the staging tanks
- Retrieval will transfer some undissolved soluble solids to the staging tanks if not required to dissolve all the soluble solids. Further dissolution may require the addition of dilute caustic solution and heat. It may also require the addition of concentrated caustic solution to adjust the hydroxide concentration of the transferred waste to avoid precipitation of solids.
- In order to fail below the maximum five volume percent (settleable) solids as required by the *RFP* (DOE RL 1996), the Waste Transfer System needs to actively control the entrainment of solids in the transferred waste
- Solids entrainment can be restricted at either the source tanks, as waste is transferred to the staging tanks, or at the staging tanks, as the feed batches are transferred to the contractors' tanks
- One new generation flex-and-float-intake docant/transfer pump, orther in each source tank or in each staging tank, is assumed to be sufficient to control the entrainment of solids to below the maximum five volume percent (settleable) solids required by the *RFP* (DOE RL 1996)
- A flex-and-float-intake decant/transfer pump will be used to decant supernatant chiring waste transfers where the control of solids entrainment is required
- For transfers where the solids entrainment is not controlled, a New Generation Transfer Pump (NGTP) or equivalent with a fixed-intake will be used
- Five source tanks (24 i-AN-103, 24 i-AN-105, 241-AP-104, 241-AP-106, and 241-AP-107) have no or very little waste excluded from retrieval (settled insoluble solids) and are scheduled for complete retrieval (Certa et al. 1996). These tanks will have NGTPs or equivalent installed.
- Six source tanks (241-AN-102, 241-AN-104, 241-AN-106, 241-AN-107, 241-AW-101, and 241-AY-101) have waste excluded from retrieval (settled insoluble solids) and are scheduled for selective retrieval (Certa et al. 1996). Therefore, decant/transfer pumps would be installed on these tanks when solids entrainment control at the source tank is required.
- If solids entrainment is not controlled at the source tank, settleable solids will enter the staging tanks and accumulate. The accumulated settled solids may limit the useable volume of the tank and require removal before the completion of Phase 1 Privatization. The accumulated solids will eventually have to be removed, if not in Phase 1, then in Phase 11

 Addition of a new pit on the staging tanks will not exceed the dome limit of the tanks. It is assumed that the weight of the pit will be less than the weight of the soil removed.

3.3 MIXING SYSTEM

3.3.1 Mining System Requirements

If a mixing system is used in the IWFSS, the following are requirements for it.

- Heat Generation Limit. The mixing system will be limited to a total thermal input load based on the tank operating limits of 20.5 XW (70,000 BTU/h) radiolytic heat generation and a maximum solution temperature of 49 °C (120 °P). A ventilation system for adding a 300-hp mixer pump is addressed in Appendix C.
- The time allocated for mixing the batch should be consistent with the *LLW Feed* Staging Plan (Certa et al. 1996) and require no more than 14 days with a median of 7 days or an equivalent distribution.

If mixer pumps are installed in the staging tanks, instrumentation to monitor and/or control the following parameters shall be designed and installed unless existing tank instruments can be utilized:

- Monitor tank level, temperature (waste and vapor space), pressure (vapor space), and gas concentrations.
- Determine the extent of mixing effectiveness.
- Monitor mixer pump motor amperage, rpm, and temperature.
- Monitor temperatures of mixer pump drive and bearing components.
- Monitor mixer pump bearing/seal lubrication water flow rate.
- Measure vibration of the mixer pump assembly.

3.3.2 Mixing System Assumptions

The following are enabling assumptions used in this study for the Mixing System.

- One 300-hp mixer pump in each staging tank will adequately mix the feed batch to dissolve soluble sodium saits that either did not dissolve during retrieval and transfer or that precipitated after transfer (e.g., gibbsite [NaAlO₂])
- A single 300-hp mixer pump can actively mix the waste in the staging tank for 75 hours per week before the waste temperature reaches \$2 °C (180 °F), the maximum allowable waste temperature
- Four hours of active mixing per day with a single 300-bp mixer pump in a staging tank can be done before the ventilation system is overloaded
- Insoluble solids entrained in the retrieved superioritants will accumulate at the bottom
 of the staging tanks if no solids entrainment control is place at the source tank
- If solids entrainment is not restricted at the source tank, a mixing system capable of suspending solids (i e, a mixer pump) will be installed in the staging tanks to assist in removal of accumulated solids
- Pulsed-air systems are generally used to mix liquids, not cotrain solids. Because of lack of data, a single pulsed-air system in each staging tank is not assumed to be capable of suspending solids adequately for solids removal.
- One 300-hp mixer pump in each staging tank is adequate for maintaining solids in suspension for a waste with a low solids fraction (e.g., dilute supermatant solution).
- Soluble solids that were not dissolved during retrieval and transfer to the staging tank or that precipitated during or after transfer to the staging tank may settle and accumulate at the bottom of the staging tanks. Without the inclusion of the chemicals in these precipitated solids the feed batch may not meet the modified *RFP* feed envelope.
- Analysis of the impact of the mixer pump jet forces on existing or added internal tank equipment is beyond the scope of this study.
- If mixer pumps or pulsed-air mixers are installed in the center 106 7-cm (42-m)
 nears on the staging tanks, the current transfer pumps and thermocouple trees will be
 removed and replaced

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3.4 CHEMICAL ADDITION SYSTEM

3.4.1 Chemical Addition System Requirements

The LLW Feed Staging Plan (Certa et al. 1996) lists the following as a feed makeup and delivery requirement.

 Provide for a flush or other means to remove or dilute potentially problematic supernatant heels before switching feed envelopes.

3.4.2 Chemical Addition System Assumptions

Assumptions made for the Staging Tank Chemical Addition System are:

 The mobile chemical addition system scoped for Project W-211 will be sufficient for the needs of the IWEST Chemical Addition System.

3.5 SAMPLING SYSTEM

3.5.1 Sampling System Requirements

The LLW Feed Staging Plan (Certa et al. 1996) lists the following Sampling System requirements.

- Take the proper number, location, and type of samples to:
- Insure that the waste composition meets the modified RFP feed envelope.
- Satisfy regulatory requirements, if any, for delivery of and storage of waste to the private contractors
- Satisfy the OSD and waste compatibility DQO for transfer and storage of waste in the staging tank
- Establish the official composition of the waste for assessing the private contractor's performance
- Establish the quantity of sodium delivered to the private contractors.

 The time needed to obtain samples and deliver them to the laboratory should be consistent with the feed delivery study in the LLW Feed Staging Plan (Certa et al. 1996, Appendix E) and nominally require 2 days.

Other requirements on the Sampling System are as follows.

- The system must be able to obtain the required samples through tank-top risers with nominal diameters of between 10 and 30 cm (4 in. and 12 in.).
- Retrieved samples and associated hardware must fit in the existing Hanford her cell facilities.
- The shielding design criteria in the Radiological Design Guide, Section 7.0, (WHC 1994) will be used to determine the shielding requirements for the sampling system. Shielding shall be designed to limit the total whole body dose to less than 5 mSv per year.

3.5.1.1 Modified Request for Proposal Feed Envelopes. The LLW Feed Staging Plan (Certa et al. 1996) recommended several modifications to the feed envelopes detailed in the RFP (DOE RL 1996). The modified RFP Feed Envelopes include the following requirements.

- The modified RFP waste feed envelopes are mutually exclusive (i.e., each waste can fall into only one feed envelope).
- The feed delivered to the contractors' tanks shall have no more than five volume percent of (settleable) solids.
- Volume percent settled (or settleable) solids will be measured by Method 2540F, Settleable Solids (Greenberg et al. 1992).
- Tank Farm Operations specifications given in the Operating Specifications for the 241-AN, AP, AW, AY, AZ, and SY Tank Farms (OSD-T-151-00007) will be met.
- The sodium molarity is defined to be between 3 and 14 molar.
- The concentration requirements for all other constituents are given as ratios to the sodium concentration. Table 3-2 lists the maximum constituent concentrations for each feed envelope. Table 3-3 lists the Envelope B minimum criteria and Table 3-4 has the Envelope C minimum criteria.

Chemical	Maximum I	Ratio, analyte (mole) to :	sodium (mole) *
analyte	Envelope A	Envelope B	Envelope C
Aluminum	0.19	0.19	0.19
Barium	0.0001	0.0001	0.0001
Çalcium	0.04	0.04	0.04
Cadmium	0.004	0.004	0.004
Chloride	0.037	0.085	0.037
Chromium	0.0069	0.02	0.0069
Fluoride	0.091	0.2	0.091
Iron	0.01	0.01	0.01
Mercury	0.00001	0.00001	0.00001
Potassium	0.18	0.18	0.18
Lanthanum	0.00008	0.00008	D. 00008
Sodium	I		1
Nickel	0.003	0.003	0.003
Nitrite	0.38	0.38	0.38
Nitrate	0.8	0.8	Q.8
Hydroxide	0.7	0.7	0.7
Lead	0.00068	0.00068	0.00068
Phosphate	0.038	0.13	0.038
Sulfate	0.0097	0.07	0.82
Inorganic carbon	0.3	0.3	0.3
Organic carbon	0.06	0.06	0.5
Uranium	0.0012	0.0012	0.0012
Radionuclide	Maximum ratio	, radion <u>uclide (b</u> ecquere	() to sodium (mole)
Transuranics	6.00E+05	6.00E+05	3.09E+06
^{10†} Cesium	4.30E+09	6.90E+10	4_30E+09
**Strontium	5.70E+07	5.70E+07	8.00E+05

Table 3-2. Modified Request for Proposals Envelope Maximum Concentrations. (2 Sheets)

Chemical	Maximum i	Maximum Ratio, analyte (mole) to sodium (mole)*									
analyte	Envelope A	Envelope B	Envelope C								
**Technetium	7.10E+06	7.10E+06	7.10E+06								

Table 3-2. N	dodified Req	west for	Proposals	Envelope	e Maximum (Concentrations.	(2 Sheets)
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Shaded numbers highlight differences between the feed envelopes.

Table 3-3. Modified Request for Proposal Feed Eavelope B Minimum Criteria

At least one of (these limits must be sat	isfied.
Analyte	Minimum Analyte:Na Ratio	Units
Chloride	0.037	mel/mot
Chromium	0.0069	mol/mol
Fluoride	0.091	mol/mol
Phosphate	0.038	mol/mol
Sulfate	0.0097	mol/mol
¹³⁷ Cesium	4.3E+09	βq/mol

Table 3-4. Modified Request for Proposal Feed Envelope C Minimum Criteria

Must be satisfied.										
Analyte	Minimum TOC:Na Ratio	Units								
TOC	0.06	mol C/mol Na								

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3.5.2 Sampling System Assumptions

The following are assumptions made for the Sampling System.

- Before staging a feed batch, the source tanks will be sampled and characterized. The composition of the waste as well as the existence of significantly different squeous layers in the tank will be determined. The waste in the source tank will then be assigned to one or more feed batches of a specific feed envelope.
- A statistical validation of the feed batch's chemical and physical characteristics will be needed to support the claim that the DOE and the PHMC contractor have fulfilled their obligation to provide LLW feed within the prescribed feed envelope. This statistical validation will require that each feed batch be sampled while in the staging tank and that the samples be analyzed.

3.5.2.1 Projected Feed Batch Compositions. The feed batch supernatant compositional masses (as they will exist in the intermediate waste feed staging tanks) are based on the *Projected Double-Shell Tank Supernatant Compositions for Phase I Privatization* (Shelton 1996) and were calculated for, although not published in, the *LLW Feed Staging Plan* (Certa et al. 1996). (See Appendix F) In calculating the total composition of the feed batches, an estimate of the composition of insoluble solids entrained in the supernatant is added to the supernatant compositional masses. In this calculation, it is assumed that:

 The solids entrained during retrieval and transfer have the same composition as the bulk solids in the source tank.

Because not all source tanks have solids composition data, it was assumed that:

 Only the source tanks with solids composition data have solids that add to the composition of the level batch.

Appendix F provides a more detailed discussion of the equations and assumptions used in calculating the projected feed batch compositions.

The composition for components is listed as a ratio of the component concentration to the sodium concentration (sodium ratio). The value listed for sodium is the sodium concentration in moles per liter.

Tables 3-5 and 3-6 show the projected total feed sodium ratios for Private Contractors 1 and 2, respectively, for the zero percent entrained (settleable) solids case. Tables 3-7 and 3-8 show the projected total feed sodium ratios for Private Contractors 1 and 2, respectively, for the two percent entrained (settleable) solids case. The total feed batch sodium ratios for the one, three, four, and five percent entrained (settleable) solids cases can be found in Appendix F.

Table 3-5. Projected Intermediate Waste Feed Staging Tank (AP-102) Feed Batch Sodium
Ratios for Private Contractor 1: 0 Percent Entrained, Insoluble Solids.

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Table 3-6	Projected Intermediate Waste	Feed Staging Tank (Al	P-104) Feed Batch Sodium
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Table 3-7. Projected Intermediate Waste Feed Staging Tank (AP=102) Feed Batch Sodium
Ratios for Private Contractor 1. 2 Percept Entrained, Insoluble Solids.

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182 _{CP}	1,245-44	4		1 800+00	1105-04	1 305+10	1346-04	1 345-00	1.00	1.335-07	1345-07	140E+18
TRU	2105-04	4 31 (7 (16-24	4 375+04	7 10 5+00	4 385-00	262-01	1 ME+08	1-	21.6	1475+04	• Mikol
2		4118-01	1005-00	3+6-52	3454-12	104-01	1.004.00	104-00	148-01	h Lati-M	1415-00	
PH-		•	•				Į					
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Dist.											1145+14	

Table 3-8. Projected Intermediate Waste Feed Staging Tank (AP-104) Feed Batch Sodium Rainos for Private Contractor 2: 2 Percent Entrained, Insoluble Solids.

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Hq.+3		8 TO - 11	3.00-12	6.ZM-14		44 3 -07		170-01		1 848-94		1.00
K*	106-02	405-00	1.55	1 MÉ-14	Last.or	1465-62	4.865-04	100.00	446-64	44.4	196-0	4.365-04
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a++	1109-17	1000-00	178-10	sant-ori	Lest-m	7 106-05	101-04	1995-14	1.00	1. HER-17	F 100-07	148-67
V V	1.345-54	245 0	128-44	6.086-06	145-4	7985-04	116-04	118-44	3435-64	1245-07	1205-00	136-10
an, 2000	101-0	1000-02	100-00	2.725-02.1	1948-021	1.78-01		1.000		411-02	120-01	1204-001
	1016-M	100-00	-	1475-00	1.000-00		106-0	105-0	+ 22-2		105-01	
F 1	4 001-04	s mi-a	100-00	6778-08	L 196 - 10				+ 17 5- -	186-8	1.75-8	LITE-0
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			_	_		_	_	_		_		_

3.5.2.2 Waste Variability and Sampling Locations. The Intention of sampling is to obtain a set of samples that are representative of the entire feed batch. Therefore, samples should be taken in such a way as to account for the compositional variability between supernatant phases.

Lateral Variability. The lateral variability is the variability in the composition of samples taken at the same waste beight but different lateral locations in the tank (i.e., at different risers). For supernatants it is assumed that:

- Different phases in the waste occur because of different densities (assumably arising, from different compositions)
- Each phase has a single source and is homogeneous.
- · Each phase is level throughout the tank.

From this and from past experience, it is concluded that:

The lateral variability for supernatants is very low (below analytical error).

Therefore, the following requirement on sampling is derived.

All the batch samples will be taken from a single riser on each staging tank.

Vertical Variability. Vertical variability is the variability in the composition of samples taken at the same lateral location (i.e., riser) but at different waste depths. If liquids with different densities (and assumably different compositions) are added together in a feed batch, stratified supernatant layers may form unless there is adequate mixing. Potential sources of stratified layers are as follows:

- Adding a new batch to the heel from a previous batch.
- Combining wastes from different source tanks
- Sequentially removing different phases of waste from a single source tank.
- Adding chemicals to adjust a feed batch composition.

Because it is quite probable that stratified supernatants will appear without adequate mixing:

Ventical variability is considered to be the most probable source of sample variability.

Therefore, the following requirement is derived.

Samples will be taken at several different heights in the waste.

3.5.2.3 Estimated Sampling and Analysis Variability. In calculating the number of samples that are needed to verify that a feed batch meets the feed envelope criteria, an estimate of the analytical error and sampling variability is needed. The calculations in this study use relative standard deviation (RSD) values that combine the analytical error and sampling variabilities. These RSDs were determined from the mean concentration, the variance of the mean, and the number of sample locations reported in previous sampling and analysis reports for supernatant characterization (Simpson 1994a, Welsh 1994a, Simpson 1994b, Welsh 1994b). These values are applicable to the supernatant. When solids are added to the feed batch composition, it is assumed that:

 The RSD values for the supernatants are valid for the total feed batch composition that includes the composition of entrained solids (sludges).

The "not-mixed" scenario assumes that the staging tanks are not upgraded with an active mixing system. The "well-mixed" scenario assumes the staging tanks are upgraded with active mixing systems capable of mixing stratified liquid layers into a homogenous mixture.

3.5.2.4 Confidence Level. It is assumed that:

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- Ninety five percent confidence intervals are needed for both types of error (i.e., false positive and false negative) to validate that a feed batch meets the feed envelope criteria.
- The component concentrations are normally distributed around the mean.

3.5.2.5 Sampling Number. The number of samples required to validate a specific feed batch (sampling number) for each component was calculated. Table 3-9 sammarizes the number of samples required for each feed batch validation for Private Contractors 1 and 2 for the zero percent entrained insoluble solids case. Table 3-10 summarizes the number of samples required for each feed batch validation for Private Contractors 1 and 2 for the zero percent entrained insoluble solids case.

	A T CLOCHI I	CIIII PINKO, INS	oneon oonne		
Batch #	Well-Mixed Scenario		Not-Mixed Scenario		
	Contraction I	Contractor 2	Contractor 1	Contractor 2	
1	3	3	7	7	
2	8	5	47	34	
;	3	3	7	7	
4	3	3	4	4	
\$	3	3	• 5	- 1	
6	3	3	9	9	
7	19	19	\$ 9	89	
8	19	19	\$9	89	
9	3	3	10	10	
10	3	,	4	4	
11	3	3	5	4	
12	4	3	15	4	
Total	74	70	291	266	
Scenerio Total		144		57	

Table 3-9. Summary of Phase I Privatization Intermediate Waste Feed Staging Tank Required Samples with 0 Percent Entrpined, Insoluble Solids.

	Well-Maxe	d Scenario	Not-Microal Scenario		
Batch 4	Contractor I	Contractor 2	Contractor 1	Contractor 2	
1,	;	3	7	7	
2*	+	\$	47	ĸ	
3•	÷	3	7	7	
4.	э	3	•	4	
5.	\$	3	\$	\$	
6	Familed	Failed	Failed	P #led	
7	21	શ	102	102	
8	21	21	102	102	
9	3	3	10	10	
10*	3	3	4	4	
ur	3	3	\$	4	
12*	Failed	3	Failed	4	
Total "	11	74	299	246	
Scenano Total *	13	13	585		

Table 3-10. Summary of Phase I Privatization Intermediate Waste Feed Staging Tank Required Samples with 2 Percent Entrained, Insoluble Solids.

* No points data available for these batches

* No solids data available for Contractor 2's Batch 12

⁴ Assemed the each field batch currently in the feed staging plan that would fink as replaced by a batch that meets the envelope: Assume 3 samples for each new feed batch

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4.0 DECISION CRITERIA

This section identifies the performance measures that are used to differentiate between alternatives. It is important to note that the performance measures represent a mixture of quantitative and qualitative factors. Some of the performance measures, such as cost, represent directly measurable variables. Other performance measures, such as operability, are much more dependent on the judgement of experienced engineers. Although this study focuses on the more tangible and immediately visible performance measures such as cost and schedule, it should be noted that some of the less tangible performance measures, such as operability and safety, can carry heavy hidden cost and performance penalties (e.g., unplanned shutdowns due to equipment failures and the need to changeout in-tank equipment on a greater frequency).

4.1 COST

To the extent practical, the system, equipment, or component will be evaluated with respect to capital and operating life-cycle costs.

4.2 TECHNICAL MATURITY

The technical maturity of a process, system, or piece of equipment can be assessed in terms of the following maturity hierarchy (given in descending order of preference):

Available:

- Technologies that are applied on a production scale in the nuclear industry.
- Technologies that are applied on a production scale in a conventional commercial industry.

Field Testing:

- Technologies that have been demonstrated on a "hot" or nuclear pilot scale using actual feed materials.
- Technologies that have been demonstrated on a "cold" or non-nuclear pilot scale using simulated feed materials.

Prototype:

 Technologies that have been demonstrated on a "hot" or nuclear beach scale using actual feed materials.

 Technologies that have been demonstrated on a "cold" or non-nuclear bench scale using simulated feed materials

Under development

- Technologies that are supported by studies which are backed by bench scale experiments
- Technologies that are supported by conceptual studies that are not backed by bench scale experiments

Unavailable

Technologies that are not available for use

In addition to the hierarchy given above, other factors that influence technical maturity or technology assurance include, (1) maximizing flexibility (adaptability for new technologies or mission change), (2) design flexibility or adaptability for incorporating improved technology, and (3) avoiding regulatory uncertainty

4.3 MAINTAINABILITY

The maintainability of a system can be assessed by evaluating the complexity, reliability, and repairability of the associated equipment and components. Complexity is influenced by factors such as the level of training required to perform maintenance on the equipment, the need for special or unique tools or procedures, design qualities such as features that ease repair, standardized parts and provisions for troubleshooting. Reliability can be directly measured by failure rates/mean time to failure data, but is also associated with frequency of test, calibration, and preventive maintenance procedures. Another key measure of reliability is the impact of failures on the process, including recovery or downtime following a failure. Repairability is influenced by work space factors (interferences, confined work spaces, etc.), location of the equipment, means of repair or replacement (remote or contact maintenance), number and type of personnel required to support repairs, pre-maintenance proparation requirements and postmaintenance impacts such as quantities and types of waste produced and functional test requirements. With regard to these aspects of maintainability, this analysis will highlight those characteristics that are significantly different between the alternatives

4.4 OPERABILITY

Operability of a system is mostly a qualitative measure of the inherent complexity of a system that influences other aspects of operability such as the following

- Startup and Shutdown of the System. This is an important operability issue since most upset conditions occur during startup and shutdown when the system is in a state of flux and unsteady state conditions are prevalent. This is heavily influenced by the number of sub-systems or unit operations involved.
- Process Control. Operability with regard to process control is influenced by the number and type of process control points (including process samples).
- Troubleshooting and Response to Off-Normal Conditions. This factor is influenced by the diversity of systems and equipment. Systems that use simple, mature technologies and equipment are favored over novel and unique technologies and equipment for which there is little operating experience.
- Operator Interfaces. This aspect of operability is influenced by such factors as the level of training required to operate the system and the degree, type, and frequency of operator interaction with the system.

With regard to those aspects of operability, this analysis will highlight those characteristics that are significantly different between the alternatives.

4.5 SCHEDULE IMPACT/RISK

Schedule impact/risk will be assessed relative to implementation of a given alternative. Schedules to be considered include start-up, production, Tri-Party Agreement, and other internally (WHC) or externally (DOE, regulatory, stakeholder) driven schedules.

4.6 ENVIRONMENTAL IMPACT

The environmental impacts of a system can be assessed by evaluating the following factors:

- Gaseous effluent generation
- Secondary dangerous waste generation

Gascous offluent generation is defined as the rate of emission of regulated pollutants, both radioactive and nonradioactive. Ideally, emission rates should be kept as low as reasonably achievable (ALARA). The degree of treatment required to meet airborne effluent discharge limits is also a factor that should be examined in comparing systems.

Secondary dangerous waste generation is defined as the quantity of wastes (including mixed wastes) generated as a result of the primary processing operation. Secondary dangerous waste generation should be minimized as much as possible. The extent of in-plant secondary

waste treatment facilities and dangerous waste packaging and storage and accumulation areas are factors that should be considered when comparing systems based on secondary waste generation.

4.7 SAFETY

To the extent practical and meaningful, alternatives should be compared on the bases of associated hazards and implications for onsite/offsite safety, worker safety, and mission and property protection. Topical areas for consideration include the following:

- Hazards
 - Introduction/creation of hazards
 - Ease of hazard prevention
 - Ease of hazard mitigation
- Offsite/onsite safety
 - Hazard categorization
 - Safety class
 - Performance category, or seismic criteria
 - Radiological risk acceptance criteria compliance
 - Toxicological risk acceptance criteria compliance
- Process and industrial safety.
 - Health physics requirements
 - Compliance with DOE 6430.1A and related industry standards.
- Mission and Property Protection
 - Potential for accident propagation and impacts to other facilities.
 - Potential impacts due to accidents initiated at other facilities
 - Implications for recovery from accidents expected to occur during the lifetime of the mission.

4.8 REGULATORY COMPLIANCE

The regulatory compliance decision criterion includes consideration of regulatory compliance, permitting, and complexity issues. Permitting requirements should be evaluated based on the following factors: (1) number of permits required or modified, (2) complexity of required permitting documentation, (3) potentially required permits or approvals that are unique

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to the system being examined, (4) regulatory obstacles, and (5) impacts of permitting activities on the project schedule.

4.9 PUBLIC ACCEPTANCE

This section considers the acceptability of an alternative relative to expressed stakeholder values and concerns. These performance measures have evolved from a previous TWRS Leadership Council and were used in previous analyses (Boomer et al. 1994) and a TWRS Decision Board that was established in 1994 to recommend a TWRS facility configuration. The performance measures were selected to bound and consolidate the various stakeholder values (see Table 4-1).

Table 4-1	Stakeholder	Values
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Stakebolder value	Study performance measure
Presect the Columbia River	Assessed by invitotimental acceptability performance measure
Deal realistically and forcefully with groundwater containing too	Not applicable to this study
Do no harm during cleanup or with new development	Assessed by sett and location of facilities
Transport wents safely and be prepared for problems	Non assersed
Use the central plateau wesely for waste management	Noi applicable
Clean up areas of high foture use value	Not assessed
Capture economic development opportunities locally	Plan wasesed
involve the public on future decisions about Hanford	This study will be available to the public
Protect the environment	Assessed in safety and environmental performance rostsures
Protect public/worker health and safety	Assessed in suffery, operability and manpanability performance measure
Establish juqqqgement practices that cosure accountability, efficiency and allocation of funds to high priority (team)	Not assessed
Get on web the cleanup to achieve substantive progress in a tone)y manner	Assessed in terms of capability of discritatives to meet Tri Party Agreement schedule
the a systems approach that keeps and points in mind as intermediate decisions are made	Systems engineering approach incorporated as part of study methodology
Protect Rights of Network American Indiana	Natasiisisad
Cleanup to the level necessary to enable the future the option to occur	Nol assessed
Enduré Campéliance	Assested in terms of Environmental Acceptability performance measure
Enhance rechnology development	Not applicable, uses existing process
Reduce Cost	Directly assessed by cost data for the alternatives
Improva veste innnagement	Not assessed
Use Mature Technologies	Assessed gualitatively as Development Status performance measure
Enhance public acceptance	Not a sessed
Use open and fair processes	Systems engineering methodology is used as basis for blody
Increase efficiency	Assessed by cost data for each alternative

5.0 INTERMEDIATE WASTE FEED STAGING SYSTEM OPTIONS AND ALTERNATIVES GENERATION AND SCREENING

In the following sections, the different options for each system are discussed and screezed. Then a set of options, one from each system, is assembled to produce an alternative. All the alternatives not screened meet all the constraints and requirements listed in Section 3.0

5.1 INTERMEDIATE WASTE FEED STAGING OPTIONS AND SCREENING

Options were generated for the Waste Transfer System, the IWFST Mixing System, and the IWFST Sampting System by informal brainstorming and documented in meeting minutes (Galbraith 1996)

5.1.1 Waste Dissolution/Delution System Requirement Options

The LLW Feed Staging Plan (Certa et al. 1996) indicates that most of the retrieved waste will require some dissolution of soluble solids and dilution of supermatants at the source tank to make the waste pumpable using standard tank farm equipment. This system is outside the scope of this study but is investigated in enough detail to define interface requirements.

Dissolve all Soluble Solids. This option would require that the Waste Dissolution/Dilution System dissolve all the voluble solids in the waste being transferred into the staging tank before the waste enters the staging tanks. This requirement would also require that the transferred waste's hydroxide concentration be adjusted to avoid precipitation of aluminum salts in the staging tank.

Dusaive Minimum for Waste Transfer. This is the "no requirement" option Although option places no dissolution requirement on the *Waste Dissolution/Dilution System*, it must still dissolve the minimum soluble solids necessary for the waste transfer. This is required by the Waste Pumpability Rule.

5.1.2 Waste Transfer System Options

The purpose of the Waste Transfer System (WTS) is to move waste from the source tanks to the staging tanks and then to the contractors' tanks. One of the constraints on the WTS is that the feed batches sent to the private contractors must contain no more than five volume percent settled solids. Because of this, the issue for the Waste Transfer System is how and where to control the solids content of the feed batches. This issue will determine what type of retrieval/transfer equipment is required in the source tanks and in the staging tanks. Other Waste Transfer System issues concerning the construction of transfer lines, pits, and pads do not affect issues in the other systems and are discussed in Appendix D.

The pump systems under consideration are nearly identical except for their intake. The fixed-intake transfer pump is installed with its intake fixed at a specific beight and will remove all layers above its intake point. Since this system is used more often at the Hanford Site, it is the default system. The decant/transfer pump is similar but has an intake at the end of a flexible hose. This makes it useful for selectively decanting supernatants from an upper or mid layer and for the removal of supernatant heels, if required

The stinds entrainment control can be placed either on the source tank, on the staging tank, on both, or on neither Because several of the Phase I source tanks have relatively no insoluble solids and are planned for complete retrieval, the fixed-intake transfer pumps will be installed regardless of placing the solids limiting at the source tank or not From this, four combinations of transfer pumps develop and are discussed below

No Solids Entrainmount Control. This option does not provide for a means to control the entrainment of settled solids in the feed batches. Therefore, this option was dropped from further consideration because it did not meet the criteria of providing feed batches with less than 5 volume percent solids.

Source Tank Solids Entruinment Control. This option places an interface requirement of controlling the entramed solids/sludges to a minimum on the DST Waste Retrieval System. It is assumed that decant/transfer pumps would be installed in tanks scheduled for selective retrieval. These tanks (i.e., AN-102, AN-104, AN-106, AN-107, AW-101, and AY-101) contain settled solids (sludge) layers that the *LLW Feed Staging Plan* (Certa et al. 1996) excludes from retrieval. Fixed-intake transfer pumps would then be installed in source tanks containing no or very little sludge and that are therefore scheduled for complete retrieval (i.e., AN-103, AN-105, AP-104, AP-106, and AP-107).

The risks associated with this option are that some insoluble solids may exist in the tanks scheduled for complete retrieval and that some sodium salts may precipitate during chlution and transfer to the staging tank

Staging Tank Solids Entrainment Control. In this option, no interface requirement is placed on DST Waste Retrieval System to control the entrainment of solids during retrieval and transfer. Assumably, fixed-intake pumps would be installed in all the source tanks. This option results in solids, in possibly excessive amounts (see Section 3.2.2.1), being transferred into the staging tanks. In the staging tank, the entrained solids would be allowed to settle into a supermatant and settled solids layers. A single docant/transfer pump installed in each of the staging tanks would be used to decant the supermatants from the settled solids layer.

Source Tank and Staging Tank and Solids Entrelowent Control. This option places an interface requirement of controlling the entrained insoluble solids to a minimum on the DST Waste Retrieval System. Transfer pumps would be installed in source tanks in the same fashion as stated above for the *Source Tank Solids entrumment control* option. A single decant/transfer pump would be installed in each staging tank. Adding the solids entrainment control at the source tanks adds approximately \$5,100,000 to the alternatives.

This option was dropped from further consideration because it is assumed that decant/transfer pumps either in source tanks or in the staging tanks is sufficient to control the solids entrainment within acceptable levels and the additional costs for providing control at both locations is not warranted

5.1.3 Intermediate Waste Food Staging Tank Mixing System Options

The primary gurpose of the IWFST Mixing System, if needed, is to blend stratified liquid layers into a homogenous mixture. Stratified layers in the slaging tank may arise from the layer-by-layer transfer of source tank supernatants, the additional wastes from two or more sources tanks into a single batch, or from the addition of chemicals (blend additives) to reformulate the batch.

5.1.3.1 No Mixing Option. In this option, no inversare unstalled in the staging tanks. This option is carried forward but only for alternatives in which insoluble solids (i.e., sludge) control at the source tank is performed.

5.1.3.2 Polsed-Air Options. These concepts introduce rapid air pulses at the bottom of the tank, to create a toroidal current (upward in the center and downward near the edges of the tanks) to vortically mix stratified liquid layers in the tank. The pulsed-air method may mix stratified liquid layers but thus has not been demonstrated with a Hanford waste. Also, it is not known how effective these concepts will be for mobilizing solids for solids transfer out of the staging tanks.

Pulsed-Air Mixer - Single Unit. The single unit pulsed-air option uses a single unit installed in the tank through the 106 7-cm (42-in) riser in the central pit. This single unit is anticipated to give effective vertical mixing of stratified liquid layers but is not expected to give the tank waste chough motionium to adequately mobilize solids for removal (Powell and Hymas 1996). Insufficient data exist to make this determination. Therefore this option will only be carried forward for alternatives that do not require solids removal from the staging tanks.

Palaed-Air Miner - Multiple Units. The multiple unit pulsed-air mixing concept is the same as the single unit concept plus the addition of three smaller air pulse systems installed in each staging tank. These smaller systems are installed along the 30-ft radius in the tank and are used to better mobilize the solids for solids removal. This option was dropped from further consideration because it has not been demonstrated that multiple units will improve the vertical mixing beyond what a single unit will do. Also, it has not been demonstrated at this time that this system could adequately mobilize the solids for solids removal.

5.1.3.3 Mixer Pump Options. The Mixer Pump options consist of high-capacity low-head 300-hp pumps with closely-spaced suction and discharge ports. They are designed to recirculate the fluids within an underground radioactive waste tank to achieve mobilization and mixing of waste sludge and supernate. Mixer pumps are key to retrieval systems such as the Project W-211, Initial Tank Retrieval Systems (Ricck 1995).

Mixer Pump Ou-Center. This option uses a single mixer pump of the style developed by projects W-211 and W-151 and is installed into the tank through the 106.7-cm (42-in.) discr in the central pump pit.

Mixer Pump Off-Center. This option uses a single mixer pump of the style developed by projects W-211 and W-151. The mixer pump is installed into the tank through existing 106.7-cm (42-in.) construction riser on a 6.3-m (20-ft 9-in.) radius. This riser is extended to grade and a pad is constructed for the system.

Double Miner Pumps Off-Center. This option uses two mixer pumps of the style developed by projects W-211 and W-151. The mixer pumps are installed into the tank through existing 106.7-cm (42-in.) construction risers on a 6.3-m (20-ft 9-in.) radius. These two risers are at 90 degrees from each other and are below grade. This option was dropped due to its high cost and the belief that two off-center pumps 90 degrees opposed will not perform appreciably better than a single mixer pump on-center. This has been demonstrated in scale-model, multiplemixer pump tests performed by PNNL for determining mixer pump efficiencies.

5.1,3.4 Other Options. Other options that were discussed include the following.

Madified Slarry Distributor System. This system would use a transfer pump to move the waste from the IWFST to the AP valve pit and back to the tank through a shury distributor with a movaable discharge nozzle. The alway distributor would spray the recirculated waste over the surface of the tank contents to provide mixing of the waste. Slurry distributors have been widely used at Hanford to distribute the heavier slurries in the waste, but not as a mixing system. This system would need to be tested and evaluated for dissolving and mixing efficiencies in scaled models before it would be feasible in the staging tanks. For this reason, the Modified Slurry Distributor System was screened from further evaluation.

Mechanical Agitaters. Mechanical agitation is not generally considered feasible for mixing 3,785-m³ (1- Mgal) tanks. Therefore, this option was removed from further consideration.

5.1.4 Intermediate Waste feed Staging Tank Sampling System Options

The purpose the IWFST Sampling System is to validate that the feed batches meet the modified *RFP* feed envelope limits. The sampling system concepts considered in this study were as follows.

Grab Sampling. This concept is the "bottle-on-a-string" method frequently used at the Hanford Site.

Core Sampling System - Stationary. This concept involves the permanent placement of a core sampling system, of the type currently used at Hanford, onto each staging tank.

Core Sampling System - Moveable. This concept is similar to the stationary core sampling option except it uses a single core sampling system that can be moved from one staging tank to the other on a rail system

Loolok'-Type Sampling System. This concept uses the conceptual design done for the Grout Disposal Program that locates a sampling facility within the AP Tank Farm and pulls samples from a recorculation loop located in each tank

5.2 INTERMEDIATE WASTE FEED STAGING SYSTEM ALTERNATIVES GENERATION AND SCREENING

Figure 5-1 shows each of the IWFSS subsystems from the TWRS Architecture Tree in Figure 2-1 with the options that were generated and carried forward. The issues and options for these systems affect each other, in particular, the IWFST Transfer Pump and the IWFST Mixing System. Therefore, alternatives were generated that represent the combinations of options for the transfer pump and the mixing system. Table 5-1 shows this alternatives generation.

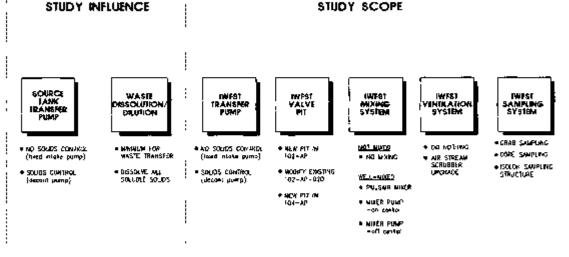
To each of these alternatives, the most appropriate options for the valve pit and the sampling and ventilation systems were added. Figure 5-2 shows how the options for these systems fit together into the alternatives.

If the Waste Dissolution/Dilution requirement is to dissolve the minimum soluble solids for the waste transfer, some soluble solids may be introduced into and settle to the bottom of the staging tank. If no method of mobilizing the soluble solids is available, soluble sodium saits may be unintentionally excluded from feed batches that could cause the batched quantity of sodium to fall below the required minimum amount. For this reason, the "Dissolve All Soluble Solids" requirement was placed in alternatives where there is no mixing system or the mixing system does not mobilize solids (i.e., the pulsed-air mixer)

^{&#}x27;Isolok is a registered trademark of Bea E. Haeger, Yorkville, IL

Figure 5-1. Intermediate Waste Feed Staging System Subsystem Options.

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Alternatives	1	24	3*	4	\$	6	7	8
Waste Transfer System								
No solids entralizment control ^b						:		
Solids entrainment control at IWFST	x	x	х	x				
Solids entrainmant control at Source Tank					x	x	х	х
Solide extrainment control at IWFST and Source Tank*						[
IWFST Mixing System								
No Miner	X				х	(i –
Pulsair Mixer - Single Unit	ľ	x				X		
Pulasir Mixer - Muldple Unie "						[ļ
Mixer Pump On-Center			х				х	
Misser Pump Off-Center	1	i		Х			1	х
2 Mixer Pomps Off-Cewier ^b			<u> </u>	[[
Modified Slarry Distributor ^b								
Mechanical Agitators ⁶	<u> </u>							

Table 5-1. Intermediate Waste Food Staging System Alternatives.

Shaded rows indicase system options that were screened from further analysis. Shaded columns indicate alternatives that were screened from further analysis

* Solids entrainment control implies a decast oump at that location and a fixed intake pump at the other tocstion unless otherwise specified.

*This option was screened because a did not meet the minimum criteria for this system.

⁴ This option was screened because it was more expensive then the other options and provided either no or mistmal additional benefits.

⁴ If solids entrajorment controls are not placed on the retrieval of supernalants into the IWFST, a entiser pump in the IWFST will be required to suspend the vertical solids for solids removal. Without solids removal, the solids accumulation would decrease the useable volume of the IWFSTs and the schedule would be missed.

* Both the "Solids coursingent control at (WFST" and the "Mixet Pump on-Center" options currently require the exclusive can of the only 106 7-cm (42-in.) riser available on the (WFSTs. Therefore, these options cannot be used together without some redesign of the decanomarsfer pamp.

Figure 5-2. Intermediate Waste Feed Staging System Alternatives.

ALTERNATIVES	STUDY INFLUENCE	STUDY SCOPE	
	BURCS TANK BURCS FLOOR FLOOR FLOOR FLOOR FLOOR		- MMP401 4 AMARTANG 5733000
ţ			one surve
2		10049 CONFRONT	****
з	-40 SELOS (DATRI - MARANI FR (Inge Magan gang) (Rand) (Rand) (R	t	
4	• so pajo cácha, • denda file (Lad accorpora) •• St Hangen	·	
5		• 42 SOLIES (COMPOLITION - + BO MOLIES - + B	ove surres -
6	+ 20,85 (0,486, 4 DEXILUTE HALTS (4 CON 1 HERE)	(New Mars parties -	0040 Jan 194
7	н хоциад срыжая, н униваци Ара Наста Паластра Наста Паластра	Success Subar	, buend and
8	• Sauth COA "YA. • Mitthew FOH (development) Book Mandfild 	a	

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5.2.1 Alternative I

Alternative 1 combines the following options.

DST Retrieval Interface Requirements.

- No source tank solids entrainment control (fixed-intake transfer pumps in all source tanks).
- Dissolve all the soluble solids.

IWFSS Options.

- A decant/transfer pump in each IWFST (Solids Entrainment Control).
- A new valve pit on AP-104.
- No mixer pump in each IWFST.
- No ventilation upgrades.
- A grab sampling system.

If the solids entrainment control is not performed at the source tank, insoluble solids (i.e., aludges) will be entrained and transferred to the staging tank where they will settle to the tank bottom and accumulate. Without the removal of these solids, they will reduce the useable volume of the tank causing the schedule to be impacted. Therefore, this alternative was screened from further consideration.

5.2.2 Alternative 2

Alternative 2 combines the following options.

DST Retrieval Interface Requirements.

- No source tank solids entrainment control (fixed-intake transfer pumps in all source tanks).
- Dissoive all soluble solids.

.

IWFSS Options.

- A decant/transfer pump in each IWFST (Solids Entrainment Control).
- New pits on AP-102 and AP-104 (106.7-cm (42-in.) riser) for the decant/transfer pumps.
- A pulsed-air mixer on-center in each IWFST.
- No ventilation upgrades.
- A grab sampling system.

If the solids entrainment control is not performed at the source tank, insoluble solids (i.e., sludges) will be entrained and transferred to the staging tank where they will bettle to the tank bottom and accumulate. Without the removal of these solids, they will reduce the useable volume of the tank causing the schedule to be impacted. Therefore, this alternative was screened from further consideration.

5.2.3 Alternative 3

Alternative 3 combines the following options.

DST Retrieval Interface Requirements.

- No source tank solids entrainment control (fixed-intake transfer pumps in all source tanks).
- Dissolve the minimum amount of solids to most waste transfer requirements.

IWFSS Options.

- A decant/transfer pump in each 1WFST (Solids Entrainment Control)
- New pits on AP-102 and AP-104 (106.7-cm [42-in.] riser) for the decant/transfer pumps
- A mixer pump on-center in each IWFST.
- No ventilation upgrades.
- A grab sampling system.

The decant/transfer pump requires a 106.7-cm (42-in.) riser. The only 106.7-cm (42-in.) riser available on the tanks is at the center where the mixer pump would be located. A spare 106.7-cm (42-in.) riser on a 6.3-m (20-ft 9-in.) radius will be extended to grade. A pit will be added to contain the pump and jumpers and new waste transfer lines will be routed to the central pump pit.

5.2.4 Alternative 4

Alternative 4 combines the following options.

DST Retrieval Interface Requirements.

- No source tank solids entrainment control (fixed-intake transfer pumps in all source tanks).
- Dissolve the minimum amount of solids to meet waste transfer requirements.

SWFSS Options.

- A decant/transfer pump in each IWFST (Solids Entrainment Control).
- The decant/transfer pumps will be installed in the 241-AP-02A and 241-AP-04A central pump pits.
- A mixer pump off-center in each IWFST.
- No ventilation upgrades.
- A grab sampling system.

5.2.5 Alternative 5

Alternative 5 combines the following options.

DST Retrieval Interface Requirements.

- Control solids entrainment (decant/transfer pumps in six source tanks, fixed-intake transfer pumps in the five other source tanks).
- Dissolve all the soluble solids.

IWFSS Options.

- A fixed-intake transfer pump in each IWFST (No Solids entrainment control).
- The AP-102 transfer pump will either be installed in the 241-AP-02D pit or the central pump pit. The AP-104 pump will either be installed in the central pump pit or the new waste transfer valve pit.
- No mixer pump in each IWFST.
- No ventilation upgrades.
- A grab sampling system.

5.2.6 Alternative 6

Alternative 6 combines the following options.

DST Retrieval Interface Requirements.

- Control solids entrainment (decant/mansfer pumps in six source tanks, fixed-intake transfer pumps in the five other source tanks).
- Dissolve all the soluble solids.

IWFSS Options.

- A fixed-intake transfer pump in each IWFST (No Solids entrainment control).
- A new pit on AP-104.
- A pulsed-air mixer on-center in each IWFST.
- No ventilation upgrades.
- A grab sampling system.

5.2.7 Alternative 7

Alternative 7 combines the following options.

DST Retrieval Interface Requirements.

- Control solids entrainment (decant/transfer pumps in six source tanks, fixed-intake transfer pumps in the five other source tanks).
- Dissolve the minimum amount of solids to meet waste transfer requirements.

WFSS Options.

- A fixed-intake transfer pump in each 1WFST (No Solids entrainment control).
- A new valve pit in AP-104.
- A mixer pump on-center in each IWFST.
- No ventilation upgrades.
- A grab sampling system.

5.2.8 Alternative 8

Alternative 8 combines the following options.

DST Retrieval Interface Requirements.

- Control solids entrainment (decant/transfer pumps in six source tanks, fixed-intake transfer pumps in the five other source tanks).
- Dissolve the minimum amount of solids to meet waste transfer requirements.

IWFSS Options.

- A fixed-intake transfer pump in each IWFST (No Solids entrainment control).
- The transfer pumps will be installed in the 241-AP-02D pit and 241-AP-04A central pump pit.
- A mixer pump off-center in each IWFST.
- No ventilation upgrades.
- A grab sampling system.

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6.0 INTERMEDIATE WASTE FEED STAGING SYSTEM DESIGN CONCEPTS

6.1 WASTE TRANSFER SYSTEM DESIGN CONCEPTS

The decision to upgrade the SN-650 transfer line and add a new process pit in the AP Tank Farm has been made (Galbraith et al. 1996). An Engineering Report is presented in Appendix D that provides three options for installing a transfer pit in the AP Tank Farm. Option 1 would add a new pit on the north side of the 241-AP-102 Tank at a total construction cost of \$2,800,000. This is equivalent to Alternative K as presented in *LLW Feed Stagung Plan* (Certa et al. 1996). Option 2 looked at using the existing 241-AP 02D Pump Pri at a total construction cost of \$1,900,000. Option 3 would add a new pit on the 241-AP-104 Tank similar to the 241-AP-02D Pump Pri at a total construction cost of \$2,750,000.

Option 1 meets all of the requirements for the transfer system. Option 2 was not preferred because the space required for the jumper arrangement is not available in the 241-AP-02D Pump. Pit. In addition, the topography of the transfer system in Option 2 does not meet the requirements of Alternative K. Option 3 meets all of the requirements for the transfer system. However, in order for Option 3 to maintain the topography requirements of Alternative K, the new pit needs to be separate from the decant/transfer pump. If the pump is located in the same pit, a wall separating the pump discharge jumper arrangement from the HLW feed jumper arrangement would be needed (See Appendex D).

Option 1 and Option 3 are almost identical in each of the decision criteria used. All of the requirements of the transfer system, including the topography are met and the costs are similar. However, Option 3 is the preferred option because the new pit on the staging tank would allow access to a 30 5-cm (12-in) riser. Thus pit could be used in the future for m-tank equipment where as the pit in Option 1 could only be used for the scope of Phase I Privatization.

Additional cost savings could be made with Option 3 depending on the decisions made on solids entrajonment control and the mixing system. Size and specific location of the new pump pit could be optimized with the upgrades required for these other systems. However, these possible cost savings would be addressed during the definitive design stage and do not affect the decisions to be made here.

No matter which alternative is chosen, the failed mixing pump in the AP-102 central pump pit and the slurry distributor in the AP-104 central pump pit would need to be removed. In addition, the existing transfer pumps and thermocouple trees would need to be removed. The cost for temoval and disposal of this equipment is approximately \$5,500,000. (For the no mixer alternatives, it is assumed that the existing thermocouple trees will not be removed. For this case, the cost for removal and disposal of the remaining equipment would be approximately \$3,900,000). This includes \$2,900,000 for greenhouse and support costs and mimobilization cost. Also, a new thermocouple tree, vapor pressure indicator, and level indicator will be required in each staging tank. The total costs to purchase and install this equipment in both of

the staging tanks are approximately \$260,000. These costs need to be added to the costs provided below

6.1.1 Intermediate Waste Feed Staging Tank Solids Entrainment Control

if the IWFSTs are required to control solids entrainment, a decant/transfer pump will be required. The superinte decant/transfer pump designed for the 241-AZ Farm requires a 106 7-cm (42-in) riser. This would leave two concepts on the IWFSTs depending on which mixing system concept is chosen.

The first concept would be to use the 106 7-cm (42-m) nser in the central pump pit. This would conneide with Option 1 in the Mixing System AOA (See Appendix A). The mixer pumps would be placed off-center and the new decant/transfer pump would be in the central pump pit. In addition, the jumper arrangement in each pump pit would require modifications at an estimated cost for both pits of \$730,000. This includes decon of the pits, new cover blocks, and removal and disposal of the existing jumpers. The cost of two new decant/transfer pumps would be approximately \$1,000,000 including run-in test and shop modifications. The total construction cost for this concept would be approximately \$4,400,000. This includes \$1,200,000 for design and management and \$700,000 for bumout. There would be no difference in cost for this concept with a docant/transfer pump is installed in a 30 5-cm (12-m) isser in the central pump pit. Currently a docant/transfer pump that will operate with a mixing system has not been designed that will fit in a 30 5-cm (12-m) inser

The second concept would be to add a rew pump pit above the off-center 106 7-cm (42-in) inser. This coincides with Option 2 in the Mi ong System AGA (see Appendix A) that uses the central pump pit 106 7-cm (42-in) nser for the priver pump. This would require a new pump pit and a new transfer line between the new pit and the central pump pit at an estimated cost of \$1,700,000 for both staging tanks. This includes rerouting of existing transfer lines and instrument air lines, and a new core drill in the 241-AP-04A. Central Pump Pit. In addition, the cost pictudes the jumper arrangements and leak detectors in the new pits. The jumper arrangement in each central pump pit would require modifications at an estimated cost for both pits of \$910,000. This includes decor of the pits, new cover blocks, and removal and disposal of the existing cover blocks and jumpers. The cost of two new decant/transfer pumps would be approximately \$1,000,000 including run-m test and shop modifications. The total construction cost for this concept would be approximately \$6,100,000. This includes \$1,200,000 for design and management and \$1,300,000 for burnout. The difference in cost for this concept if the decant pump (or a fixed-intake transfer pump) is installed in a 106 7-cm (12-in) mer would be approximately \$850,000.

6.1.2 Source Tank Solids Entrainment Control

If the source tank is used to control the solids, the staging tanks would not require a decant pump. The staging tanks would just need to be equipped with a standard fixed-intake transfer pump to feed the contractors' tanks. The New Generation Transfer Pump (NGTP) or equivalent is assumed to be used. The NGTP can fit in a 30.5-cm (12-in.) diameter riser in the central pump pit or in the 241-AP-02D Pump Pit and a new pump pit above riser no. 13 (30.5-cm [12-in.]) on the 241-AP-104 Tank. The location of the pump will depend on the concept chosen for the mixing system.

If Option 1 (Mixer Pump Off-Center) for the mixing system is chosen, the NGTP could be located in the central pump plt of the staging tanks (see Appendix A). The cost associated with installing the transfer pump would be the same as the cost for installing the decant pump in the central pump pit. The total construction cost of this concept would be approximately \$4,400,000. This includes procurement, design, removal and installation of jumpers, and burnout costs.

If Option 2 (Mixer Pump On-Center) for the mixing system is chosen, the NGTP could be located in the 241-AP-02D Pump Pit and in a new pump pit on the 241-AP-104 Tank (see Appendix A). The new pump pit and transfer line would have a total cost of approximately \$850,000. A new jumper arrangement in the central pump pit on the 241-AP-104 Tank would be around \$460,000. If the cost for design and burnout are included, the total construction cost for this concept would be approximately \$5,300,000. This includes procurement, design, and burnout costa.

6.2 MIXING SYSTEM DESIGN CONCEPTS

Table 6-1 summarizes the combined costs and concepts for the waste transfer and mixing systems. The combined cost includes the associated equipment removal and greenhouse/support costs. Details of the waste transfer system design concepts were addressed in the provious section. Details of the mixing system design concepts are in the following sections.

6.2.1 No Mixing System

In this concept no mixer pumps are installed in the staging tanks. The decant pump or fixed-intake pump could be located in the central pump pit of the staging tanks (see Appendix A). The cost associated with installing either of these pumps would be the same as the cost for installing the decant pump in the central pump pit (see Section 6.1.2). The total construction cost of this concept would be approximately \$4,400,000. This includes procurement, design, removal and installation of jumpers, and burnout costs. If the cost for equipment removal and replacement is included, the total construction cost would be approximately \$8,300,000.

6.2.2 Pulsed-Aar Mixing System

6.2.2.1 Description. The pulsed-air mixing system shown in Figure 6-1 is composed of a control skid and Air Delivery Assembly (ADA). The control skid will house the Programmable Logic Controller (PLC), Operator Interface Terminal, and the air compressof. A durable air hose will then run from the control skid to the central pump pit(s) on AP-102 and AP-104. The air hose will connect to the top of the ADA via a 5-cm (2-in) jumper (the jumper will have a check valve to prevent back flow). The ADA consists of a 14-3-m (47-ft) long 5-cm (2-in) schedule 80 stanless steel pipe, with a Double Accumulator Plate (DAP) welded to the end. A DAP is made up of two stanless steel plates (size of plate is dependent of riser chameter). The plates are oriented so that one is directly above the other with about a 2-54-cm (1-in) space separating them.

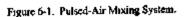
Table 6-1. Combined Construction Cost of Waste Transfer and Mixing System Concepts.

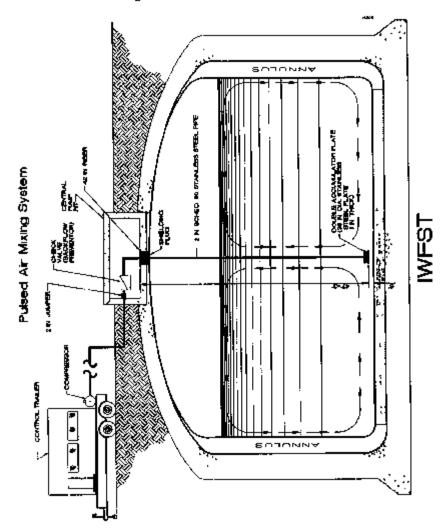
			Conve							
(comp)	Cost	Alta					filmivo			
Concept	(s milhoe)	1	2*	3	4	5	6	7	\$	
SN-650 Transfer System										
Option 1 or Option 3	24	1	1	1	1	1	1	1	1	
Option 2	19	Servened Concept								
No Milding System										
No Mixer with Decare Pump (106.7 cm (42 in.))	\$3	•								
No Mixer with Fried-Intake Pump (30.5 cm [12 in.])	23					1				
Patale Mixing System and D	keens V Traqui	fer F vm	Р							
Pulsile Mixing with Decant Pemp (106.7 cm [42 in.])	12.4°		1							
Pulsair Mixing with Mixed- latable Pamp (30.5 cm [17 lh-])	11.61						1			
Mising System and Decast/T	ransfer Para	6								
On-Center Mixing with Decant Pump (106.1 cm [43 in.])	lté			1						
Off-Cantor Mixing with Decam Pump (106.7 cm [42 in.])	16.6				1					
On-Center Mitching with Pixed-Intable Pump (20.5 cm [12 in.])	124							•		
Off-Center Mixing with Fixed-intake Pump (30.5 em [12 in.])	16.6								1	
Total Construction Cos	t (\$ mi a lon)	11.4	19.2	21.4	19.4	11.1	14.4 (11.0) ⁴	20.6 (30.2)	19.4	

Servered Alternatives.

The cost includes an additional \$1.7 million for now pits on Tanks 241-AP-102 and - 104.

The cost includes on additional \$0.9 million for a new pit on Tank 241-AP-104. The total cost is reduced approximately \$0.4 million to account for shared per costs between the flored-intake pump pit on Tank 241-AP-104 and the new process on in the Transfer System Option 3.





The concept behind a pulsed-air mixer is very simple. Air, supplied by the compressor, is pulsed through the ADA. When the air reaches the DAP, it is forced in a radial direction. The air regroups directly above the DAP to form a large oval bubble. The bubble rapidly travels upwards, due to biolyant forces, to the top of the waste, pulling the heavy supernatant up with it. At the top of the supernatant, the bubble bursts violently, and energy is released from the bubble in a radial direction. The energy released from the bubble pushes the waste to the wall of the tank. At the wall, the supernatant is pulled to the bottom of the tank by gravity. This cycle is repeated to establish a toroidal mixing pattern in the liquid wasts (Figure 6-1).

Installation of the pulsed-air mixing system will be as follows. A shielding plog will be fabricated on the top end of the ADA, which will then be lowered into the nser, as one ngid unit, by a crane. The air line will then be attached. All shielding and containment structures for construction will be used as required (these are reflected in the cost estimate).

For the staging tanks, there are two options for implementing the pulsed-air mixer system. Option 1 consists of a single DAP (91.4-cm [36-in] diameter) installed through a 106.7-cm (42-in) riser in the central pump pit. To obtain the mixing pattern described above with one DAP, 5 to 12 pulses a minute (each pulse is 1 ft² at 80 psi) would be needed. It is estimated that the mixing time of the tank would be about 2 to 3 hours. Additional evaluations are required to determine the pulse frequency and interactions with the tank structure.

Option 2 is to install three 25 4-cm (10-in) DAPs through a 30 5-cm (12-in) spare nser located on the outer radius of the tank. The operation of the 25 4-cm (10-in) DAPs would be integrated with the operation of the centrally located 91 4-cm (36-in) DAP. Added DAPs will increase the cost by approximately 10 percent per DAP. This method is predicted to mobilize more solids off the bottom of the tank than the previous method. This option as well needs to be demonstrated to verify the performance of the system in a 3,785-m³ (1 Mgai) tank

6.2.2.2 Maintainability. The pulsed air mixer is easy to maintain since it has no mechanical parts in the waste tanks. The system consists of a long pipe welded to a DAP. Once the pipe and DAP are installed, there is no need for maintenance in the tanks. The only mechanical parts of the system are in the compressor located on the control skid (the control skid will be located near the 241-AP Instrument control building outside the fence).

Ventilation effects due to a pulsed-air mixer were evaluated. As an upgrade to the IWFSS, de-entrantment devices were investigated. The evaluation concluded that fluidies devices, which are currently used in the nuclear industry for de-entrainment and are inexpensive and compact, would fulfill the requirements of controlling aerosol particles generated by the pulsed-air nuxing system. Fluidies devices have no mechanical parts, and therefore are very low maintenance. The venulation evaluation (Appendix E) concluded that upgrade of the ventilation system was not warranted based on a life-cycle cost companison of scrubber installation versus HEPA filter maintenance costs. Therefore, no ventilation system upgrade is being recommended.

6.2.2.3 Technical Maturity. The purpose of the pulsed-air mixer is to mix stratified supernatant, then the utility of a pulsed-air mixer has been demonstrated commercially. Pulsed-

air mixers are used extensively in the petrochemical industry, along with many other industries to mix various types of viscous fluids.

If solids need to be removed from a large flat bottom tank, then a pulsed-air mixer is not technically matured. Pacific Northwest National Laboratories (PNNL) has conducted research on a pulsed-air mixing system for solid suspension. PNNL concluded that it was not feasible to use pulsed-air mixing for removing sludge off the bottom of a flat bottomed tank, but believes that pulsed-air mixers can mix stratified supernatants like those in the IWFSTs (Powell and Hymas 1996). PNNL plans to do more testing in FY 1997 on this subject as funding is provided by DOE's EM-50 Office of Science and Technology Development.

6.2.2.4 Operability. The pulsed-air mixer will be controlled from a control room mounted on a skid. A PLC-based controller with an Operator Interface Terminal will control the system. Once the PLC is set up, no personnel are required to operate the system, only routine surveillance would be required.

6.2.2.5 Safety. The pulsed-air mixing system is an intrinsically safe design and can be operated in a flammable gas environment. The control system as designed provides for a near zero probability for over pressurization of the tank. To increase the safety of the mixer even more, it will be tied into a pressure sensor on the tank to insure that no pressurization of the tank occurs. Also, the power supply to the mixing system will be connected to that of the ventilation system, so that when the ventilation system sbuts down, the pulsed-air mixing technology does not add heat to the tank.

6.2.2.6 Cost. The rough order of a magnitude cost estimate is provided in Appendix A. The cost estimates are for both of the staging tanks.

Option 1, single ADA installed in the central pump pits estimated to cost \$5,500,000. This cost does not include Other Project costs such as CDR prep, PSAR, and startup readiness review costs, this is approximated to be \$4,600,000. It also does not include approximately \$5,200,000 for removal of existing in-tank equipment in support of installing new equipment. In-tank equipment to be removed includes the failed mixer pump in AP-102, the slurry distributor in AP-104, the transfer pump from both tanks, and the thermocouple trees from both tanks.

Procurement took into account the cost of the pulsed-air control system (control trailer, PLC controller, software and compressor) and two decant/transfer pamps (one for each staging tank). It was assumed that only one control system and compressor were needed to operate the mixing systems of both of the staging tanks.

6.2.3 Mixer Pump On-Center

This concept coincides with Option 2 in the Mixing System AGA (Appendix A). The mixer pumps would be located in the 106.7-cm (42-in.) riser of the central pump pit. The total

construction cost for this concept is approximately \$6,700,000. This includes procurement of the pumps and control systems, design, fabrication, and burnout costs. The costs of the mixer pumps and control system are approximately \$2,300,000. Upgrades to the row water supply and addition of a nitrogen bottle station account for \$400,000 of the total costs. In addition, the costs for design and burnout account for a total of \$2,900,000.

6.2.4 Mixer Pump Off-Center

This concept coincides with Option 1 in the Mixing System AGA (Appendix A). The mixer pumps would be located 6.3 m (20 ft, 9 in.) off-center on a new concrete pad. The total construction cost for this concept is approximately \$6,400,000. This includes procurement of the pumps and control systems, design, fabrication, and burnout costs. The costs of the mixer pumps and control systems are approximately \$2,300,000. Upgrades to the raw water supply and addition of a nitrogen bottle station account for \$400,000 of the total costs. In addition, the costs for design and burnout account for a total of \$2,900,000.

6.3 INTERMEDIATE WASTE FEED STAGING TANK SAMPLING SYSTEM DESIGN CONCEPTS

6.3.1 Grab Sampling Method

The grab sampling system consists of a bottle, stopper, weight and wire rope. The bottle is lowered into the waste media where the sample is taken. This sampling method is the easiest to do, however, the success of the method is highly dependent on the skill and experience of the personnel taking the samples. In addition, the grab sampling method is the most susceptible to being delayed by weather conditions. This concept coincides with Option 1 of the Sampling System AGA (Appendix B). For the "well-mixed" waste scenario, this concept would have a total estimated cost of \$3,860,000. However, for the "not-mixed" waste scenario, this concept would have a total estimated cost of \$9,840,000.

6.3.2 Core Sampling System

The core sampling system consists of a specially designed and equipped core sampling truck. However, the sampling equipment could be mounted on a skid. The sampler is loaded into the drill string and the drill string is pushed through the waste using a drill rig. This sampling method is common on the Hanford Site and has been shown to be very reliable. This concept coincides with Option 2 of the Sampling System AGA (Appendix B). For the "well-mixed" waste scenario, this concept would have a total estimated cost of \$12,670,000. This includes the capital cost for a new core sampling truck or skid of \$5,750,000. However, for the "not-mixed" waste scenario, this concept would have a total estimated cost of \$18,540,000 including the cost for a new core sampling truck or skid.

6.3.3 Isolok-Type Sampling System

This concept uses the conceptual design done for the Grout Disposal Program that locates a sampling facility within the AP Tank Parm. The facility uses an Isolok⁴-type sampler system that can obtain representative samples of the feed batches in the staging tanks. This concept coincides with Option 3 of the Sampling System AGA (Appendix B). For the "well-mixed" waste scenario, this concept would have a total estimated cost of \$12,970,000. This includes \$11,250,000 in capital cost for the sampling facility. However, for the "well-mixed" waste scenario, this concept would have a total estimated cost of \$16,900,000 including the cost for the sampling facility.

6.4 INTERMEDIATE WASTE FEED STAGING TANK CHEMICAL ADDITION SYSTEM

For the addition of chemicals to the staging tanks, an estimate for a chemical addition system has been obtained. This estimate is based on a caustic supply system but will also have the capability to handle other chemicals that may be required. This estimate was costed from the chemical addition system scoped for the W-211 Project. The facility consists of a mobile hot water boiler system, a truck unloading station for NaOH, an in-line static mixer, and a flush tank. The boiler system would provide hot water that would be mixed with the supplied NaOH. The system would also provide flushing of the transfer lines after a transfer. No layout of the system has been done, however, site improvements would include transfer lines for NaOH and diluted waste, electrical and instrumentation distribution systems, and utility upgrades. The total construction cost for the caustic supply system is approximately \$1,600,000 based on the design from Project W-211.

7.0 INTERMEDIATE WASTE FEED STAGING SYSTEM ALTERNATIVE EVALUATION AND ANALYSIS

This section evaluates each of the alternatives carried forward in Section 5 according to the performance measures described in Section 4.

7.1 COST

Table 7-1 summarizes the costs associated with each of the alternatives selected for detailed evaluation. All costs are in fiscal year 1996 dollars.

The life-cycle costs for this evaluation focused on sampling costs and capital costs for required upgrades to existing tank farm systems. The capital cost estimates include the cost associated with the removal of existing in-tank hardwate that has either failed or will no longer be used in the foreseeable future. It also includes the cost of extending existing 106.7-cm (42-in.) risers to grade on source tanks requiring decant/transfer pumps. Costs not included are the removal of failed equipment (i.e., mixer and transfer pumps) during the Phase I operational period of five years.

Alternative 3. The life-cycle cost of Alternative 3 is estimated at \$27 million. This is a slightly higher cost than most of the alternatives and is a result of constructing new transfer pump pits on 106.7-cm (42-in.) risers for the decant/transfer pump and new transfer lines from the pits to the respective central pump pit. This alternative would not use the existing 02D pit on Tank AP-102.

Alternative 4. This alternative has a life-cycle cost of \$25 million and is the lowest cost of all the alternatives evaluated. This is less than Alternative 3 due to the fact that the mixer pump is installed on an off-center pad rather than in the central pump pit. This alternative also doesn't require new waste transfer lines. The decant/transfer pump is installed through the existing 106.7-cm (42-in.) riser in the central pump pit and uses the existing waste transfer system to transfer waste to the DSTs.

Alternative 5. This alternative has a life-cycle cost of about \$28 million. The only capital associated with this alternative is that required to remove existing equipment (an existing failed mixer in AP-102 for example). Therefore, this alternative has the lowest capital cost, about \$18 million, of all the alternatives evaluated. The reduction in capital, however, is completely offset by the highest operating cost (\$10 million). The higher operating costs are due to the additional sampling that would be required to demonstrate compliance with contract specifications.

<u> </u>	Ahomerics								
Con component 3		4 5 6			т	8			
DST WASTE RETRIES	AL SYSTEM RE	QUIREMENTS							
Solids cotrainment control Requirement	Na Salets Control	No Solids Coepool	Control Solute	Cantrol Soluts	: Comeal Soleds	Cahirol Sol ida			
Dissolution/Diffusion Requirement	Meximum For Wasie Transfer	Minumum For Waste Transfer	Dassolve Befare Waste Transfer	Decsalve Before Waste Transfer	Mananum For Waste Trunsfer	Matemum Por Waste Transfer			
Pump Pr Capital (TECC)	50	50	\$5,100,000	\$3,100,000	55, 100,000	\$3,100.000			
IWPST WASTE TRAN	SPER AND MIXT	NG SYSTEMS							
Transfer Punup Option	Decard Pemp (42-m mer)	Decare Pump (42-os Roser)	Fixed-Intake Pump	Fixed-Intake Pump	Fixed-Intake Pump	Fixed-Intake Pump			
Maxing System Option	Mixer Pump On-Center	Mous Pump Off-Canter	Nia Minter	Pulsed Are Mover	Mover Pump On-Center	Mixer Pemp Off-Center			
Transfer Pump/Mixer Capital (TECC)	\$18,600,000	\$16,600.000	58,300,000	\$11,600,000	\$17,800,000	\$16,600,000			
Valve Pit Capital (TECC)	\$2,800,000	\$2,800,000	\$2,800,000	\$2,600,000	\$2,800,000	52,800,000			
Total Transfer & Mixing System Capital	\$21,400,000	\$19,400,000	\$11,\$00,000	514,400,000	\$20,600,000	\$19,400,000			
SWEST CHEMICAL A	DOFTION SYSTE	M							
Capital (TECC)	\$1,600,000	\$1,600,000	\$1,600,000	\$1,600,000	\$1,600,000	\$1,600,000			
PATST VENTILATION	SYSTEM								
Орнол	Not Required	Not Required	Nos Required	Nor Required	Noi Required	Not Required			
IWPST SAMPLING SY	STEM								
Option	Gnib	Ģrab	Çab	Gnib	Grab	Gnb			
Cépital	\$0	\$0	\$0	\$0	8	\$0			
		\$1,320,000 \$530,000 \$520,000 \$60,000	\$1,320,000 \$1,380,000 \$1,850,000 \$180,000	\$1,320,000 \$330,000 \$320,000 \$60,000	\$1,320,000 \$530,000 \$520,000 \$50,000	Operaung - Sampling Prop - Sampling - Exposure Deturment			
						Transportation			

Table 7-1. Intermediate Waste Feed Staging System Alternative Cost Summary. (2 Sheets)

Cost composent	Alternatives*							
	;	4	5	ú	7	•		
Analysis ^a • Urquid Analysis • Solida Analysis • Core Handl ing	\$670,000 \$760,000 }¥A	\$670,000 \$760,000 N/A	\$2,400,000 \$1,710,000 NVA	\$670,000 \$750,000 N/A	\$670,000 \$760,000 387A	\$670,000 \$760,000 N/A		
Sampling System Total	13,860,000	\$3,860.000	\$9,840,000	\$3,\$50,000	\$3,\$60,000	\$3,\$60,000		
ALTERNATIVE TOTA	1.5							
Capital (TECC) ⁶	\$23,000,000	\$21,000,600	\$17,600,000	521,100.000	\$27,300,000	\$26,100,000		
Operaing	\$3,\$60,000	\$3,860,000	\$9,840,000	000,0 02 ,62	\$3,\$60,000	\$3,\$60,000		
Total ^{t i}	\$26,860.000	\$24,860,000	\$27,650,000	\$24,960,000	\$31,160,000	\$29,960.000		

Table 7-1. Intermediate Waste Feed Staging System Alternative Cost Summary. (2 Sheets)

* Attemptives 1 and 2 were screened from consideration

Sample cost is based on feed batches with 2 percent extremed involuble solids.

* This cost includes an additional \$3,100,000 incurred by the DST Waste Retrieval System due to the "Criminal Solids Entimement of Source Timb" requiriment. The assumes likely, for each solited task requiring solids estimation methods and the assumest likely and the solited to grade, a particular particu

⁴ The total cost does not include costs for replacement of failed experiment (i.e., maker and wansier pumps). The current design life for the new equipment (i.e., maker and transfer pumps) is 10 years.

Alternative 6. This alternative has a life-cycle cost of \$23 million. This alternative uses a pulsed-air mixer which is considerably less expensive than the mixer pump system. The configuration selected for this alternative uses the existing 106.7-cm (42-in.) riser in the central pump pit for the mixer. The fixed-intake transfer pump is installed through a 30.5-cm (12-in.) riser.

Atternative 7. This alternative has a life-cycle cost of about \$29 million which is the highest cost of all the alternatives evaluated. This alternative is similar to Alternative 3 with the exception that it uses a fixed-intake transfer pump, which can be installed in a 30.5-cm (12-In.) riser.

Alternative 8. The hardware for this alternative is the same as for Alternative 4 except that fixed-intake transfer pumps are installed in the AP-102-02D pit and AP-104-04A central pump pit instead of the decant/transfer pumps. The life-cycle cost for this alternative is \$30 million.

7.2 TECHNICAL MATURITY

Alternative 3, 4, 7, and 8. The technical maturity of the transfer pump and mixer pump systems associated with these alternatives is high. They all have been applied at the Hanford Site. Mixing systems configured in this manner have been used in two previous situations, 24)-AP-102 Grout Feed Tank and 24)-SY-101 Tank Mitigation. The Growt mixer failed after several weeks of operation and the fact that the pump motor was submerged made it very

difficult to repair. The design and deployment of the 241-SY-101 mixer was based on the lessons learned front the Grout Program and the results were judged to be successful.

The projected effectiveness of mixing millions of liters (gallons) of liquid waste using submerged jets, however, is difficult to calculate. Hence, the camera installed as part of the proposed tank modifications is intended to give operators a qualitative feel for mixing effectiveness.

Alternative 5. This alternative does not provide a mixing system or any equipment that uses a novel concept. Therefore, the technical maturity of the equipment is judged as "available."

The uncertainty associated with the entrainment and precipitation of solids is judged to be high so this alternative has the least certainty about readily demonstrating compliance with contract specifications. Therefore the technical information required to make this alternative viable is judged to be "under development."

Alternative 6. The technical maturity of a pulsed-air mixing system has been proven and used in the petrochemical industry, along with many other industries, to mix various types of fluids. Therefore, with regard to the mixing of liquids, this alternative is judged to be "available."

The suspension of solids, however, is another matter. The deployment of pulsed-air mixers in large diameter, flat bottom tanks has not been demonstrated (Powell and Hymas 1996). A limited number of additional air delivery devices could be installed within the staging tanks to enhance the suspension of solids but the effectiveness of that configuration is still uncertain. Therefore, with regard to the suspension of solids, this technology is still "under development."

7.3 MAINTAINABILITY

The design requirement on new mixer and transfer pumps is for a ten-year operational life cycle or 5,000 operational hours.

Alternatives 3, 4, 5, 7, and 8. Alternatives 3, 4, 5, 7, and 8 are judged to equal in this criterion. The systems that are provided are all common to the Hanford Site and minimal additional training will be required of personnel. In addition the systems have been shown to be reliable in other applications.

Afternatives 6. With regard to maintainability, Afternative 6 is different from the other alternatives that have mixing systems. With a pulsed-air mixing system, there are no moving parts in the tanks. The air compressor required to create the air pulse is located away from the tank. Further, this alternative uses a control system that is located on a skid outside the 241-AP instrument building.

7.4 SAFETY

Alternatives 3, 4, 5, 7, and 8. Alternatives 3, 4, 6, 7, and 8 are judged to equal in tins criterion

Alternative 5. Alternative 5 does not employ an active roxing system. This increases the probability that the supernatant will form stratified layers and will require a more intense sampling effort to demonstrate that the waste complies with contract and (possibly) regulatory specifications. This increase in sampling operations increases the radiation dose received by the operators.

7.5 OPERABILITY

Alternatives 3 and 4. Alternatives 3 and 4 both provide the IWFSS with *High Operability* The decant/iransfer pumps in these alternatives allow the IWFSS to decant supermatants to the private contractors even after excessive solids have been transferred into the staging tank. And, with the mixer pump to entrain the settled solids, the settled solids can be transferred back to the tank farms

Also, both of these alternatives, as well as Alternatives 7 and 8, have a mixer pump that can entrain precipitated solids to aid in their re-solubilization. Alternative 3 has this mixer pump oncenter and provide the IWFSS the most robust system to respond to off-normal conditions. Alternative 4 is operably the same as Alternative 3 except the off-center mixer pump will be less effective in mobilizing the solids for dissolution of transfer.

Alternatives 5 and 6. Alternatives 5 and 6 are ranked lowest in being able to respond to offnormal conditions and so provide the IWFSS with Low Operability. They do not provide for solids entrainment control in the staging tanks and therefore rely on the DST Waste Transfer System to control the quantity of insoluble solids transferred to the staging tank. And because these alternatives do not provide a mixing system in the staging tanks, they also rely on the DST Waste Transfer System to dissolve all the solidble solids before they enter the staging tanks and to adjust the waste composition so that precipitation will not occur

Alternatives 7 and 8. Alternatives 7 and 8 are ranked between Alternatives 3 and 4 and 5 and 6 in being able to respond to off-normal conditions and so provide the IWFSS with Medium Operability Alternatives 7 and 8 do not provide solids entraument control in the staging tanks and therefore, like Alternatives 5 and 6, rely on the DST Waste Transfer System to control the quantity of insoluble solids transferred to the staging tank

However, both of these alternatives, like Alternatives 3 and 4, have a mixer pump that can entrain settled solids to aid in transferring settled solids back to the tank farms. These mixer pumps can also entrain precipitated solids to aid in their re-solubilization. Alternative 7 has this mixer pump on-center, providing the IWFSS with a more robust system than the off-center mixers in Alternative 8.

7.6 SCHEDULE IMPACT/RISK

All of the alternatives evaluated can be made to support the Phase I Privatization schedule and the Tri-Party Agreement milestones. Some alternatives, however, have a greater risk than others of not meeting contractual requirements on the schedule. The construction / startup activity, the operational schedule, and the operational risks for each evaluated alternative are discussed below.

Alternative 3. The construction activity for this alternative is more complex than the others. Upgrades to the central pump pit for installation of the mixer system will require an extensive rework of the jumper configuration. Additionally, new transfer pump pits must be constructed over existing 106.7-cm (42-in.) risers. These risers must be extended to grade level. New waste transfer lines will be routed to the central pump pit.

With regard to the operational schedule, this alternative will allow for an expedited settle/decant cycle at the source tank because the staging tank is equipped to tolerate a reasonable quantity of solids. Therefore, the liquid waste from the source tank can be transferred shortly after the mixer pumps have stopped. This alternative, however, does not require that the retrieval system dissolve all the soluble solids or to adjust the retrieved waste's hydroxide concentration to prevent precipitation at the staging tank. To dissolve aluminum salts or to prevent them from precipitating, hydroxide additions at the staging tanks may be required either during or shortly after the tank has been filled. Otherwise, a significant amount of sodium may be left on the bottom of the staging tank.

With regard to operational risk, the centrally located mixer pump configuration is judged to provide the best situation for mobilizing solids if it becomes necessary. This alternative also uses a decant/transfer pump system at the staging tank that is judged to reduce the probability that a significant amount of solids will be transferred to the contractors' tanks.

Alternative 4. The construction activity for this alternative is simpler than for Alternative 3. The rework of the central pump pit is less extensive in that the installation of a decant/transfer pump is less obtrusive than the installation of a mixing pump. The construction activity is still complex in that it requires the extension of an existing 106.7-cm (42-in.) riser to grade and construction of a mounting pad for the mixer pump installation.

The operational implications for this alternative are similar to that given for Alternative 3. This system is judged to be adequate for the mixing of liquids. But with a mixer pump installed off-center in the tank, this configuration may not be as efficient at suspending solids in the staging tank. Past studies have shown that the energy of a submerged jet from these pumps dissipates rather quickly and is not likely to reach the other side of the tank.

Alternative 5. The construction activity for this alternative is much simpler than for the other alternatives presented in this analysis. This is no mixer system to install and the use of the fixed-intake transfer pump also simplifies the design. Therefore, this configuration results in a minimum amount of construction activity.

The operational impact of this alternative, however, could be severe. The increased possibility that the supernatant will form stratified layers will require a more intense sampling effort to demonstrate that the waste complies with contract and (possibly) regulatory specifications. Using evaporator operations and the former Grout Disposal Program as points of reference, the sampling and validation of a waste feed can hold up operations for months.

Alternative 6. The required modifications to the existing tank system are small compared with those for alternatives installing a mixer pump system on-center or off-center. Therefore, construction and startup milestones should be easily met with this alternative.

Operationally, this alternative presents some advantages and disadvantages. Since this alternative uses a pulsed-air mixing system with a fixed-intake transfer pump, the settle/decant cycle at the source tank must be performed with more care than that required for the other alternatives.

Alternative 7. Since it's similar to Alternative 3, this alternative will present similar complexities in construction and startup. The mixer system is located in the central pump pit that will require a reconfiguration of the waste transfer system jumpers. But unlike Alternative 3, the waste transfer system at the staging tank uses a fixed-intake transfer pump that uses the 02D on 241-AP-102 and a 30.5-cm (12-in.) riser in the new valve pit to be located on 241-AP-104. Therefore, construction and startup ochedules should be easier to meet with this alternative.

This alternative is also operationally similar to Alternative 3. Note, however, that the control of the insoluble solids at the source tank reduces the issue of insoluble solids but does not reduce the potential for soluble solids from being transferred into or precipitating in the staging tanks. To dissolve aluminum salts or to prevent them from precipitating, hydroxide additions at the staging tanks may be required either during or shortly after the tank has been filled. Otherwise, the fixed-intake for the transfer pump at the staging tank would transfer these soluble solids from the staging tanks to the contractors' tanks.

With regard to operational risk, the centered mixer pump provides a means of preventing or mitigating a problem associated with the accumulation of solids.

Alternative 8. The construction and startup activity for this alternative is similar to Alternative 4 with the exception that it uses a fixed-intake transfer pump at the staging tank. Therefore, the construction and startup schedule should be easily met with this alternative.

Operationally, this alternative is similar to Alternative 7. This alternative, however, installs a mixer pump off-center on the staging tank. This configuration is judged to be less effective in mobilizing the settled solids on the far side of the tank. If the mixer system cannot mobilize the settled solids, it will not be able to support the dissolution of soluble solids or the ramoval of the insoluble ones.

7.7 ENVIRONMENTAL IMPACT

All the alternatives are judged to equal in this oritorion.

7.8 REGULATORY COMPLIANCE

All the alternatives are judged to equal in this criterion.

7.9 PUBLIC ACCEPTANCE

All the alternatives are judged to be equal in this criterion.

8.0 OPEN ISSUES AND ACTIONS

Open issues that have been identified by this study are as follows

Support of Flammable Gas Release: Retrieval of several of the source tanks may be
impacted due to the Waste Tank Safety Watch List status. The issue is release to the
flammable gas release mechanism and how gas releases will be controlled during the
retrieval operation. This issue will have to be addressed on a tank by tank basis.

Action: The LLW Staging Plan (Certa et al. 1996) will need to address this issue in the next revision. The Unresolved Safety Question (USQ) process will be the mechanism to resolve this issue

Centrol of Settleable Solids: Controlling the settleable solids at the source tanks may be operationally difficult. The two types of solids to be dealt with are undissolved, soluble solids, and settleable, insoluble solids. In order to control the transfer of undissolved, soluble solids at the source tank, complete dissolution is required. Furthermore, the chemical composition of the supersalant may need adjustment to prevent re-precipitation of the soluble solids while in the staging tank. The transfer of settleable, insoluble solids can be controlled at the source tank by utilizing a new generation decant/transfer pump. If mixers are used in the source tanks, required settling time data are needed.

Action: Additional sampling and analysis of the proposed source tanks is needed to determine what controls must be imposed during the retrieval and traasfer operation to limit insoluble solids from reaching the staging tank and soluble solids from precipitating in the staging tank. This can be accomplished by implementing a rigorous sampling plan. The alternate to this would be to increase the volume percent of solids that can be transferred to the private contractors that would require negotiations between DOE and the private contractors.

Sampling Number: The sampling number calculated in this analysis determined the number of samples required to validate that the feed batch meets a specific feed envelope. It does not calculate the number of samples required to establish the official quantity of sodium delivered to the private contractors. For this, the accuracy for the mass of sodium transferred (e.g., ± five mass percent) and the confidence level for this measurement (e.g., 95 percent) needs to be singulated. Higher accuracy will reduce the uncertainty in the quantity of sodium transferred and may reduce the cost to DOE for the private contractors to immobilize it, if the private contractors are paid on the basis of the bighest possible sodium quantity in the feed batch (nominal mass plus the uncertainty).

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Action: Both the accuracy and the confidence level need to be evaluated against the increased cost of sampling and analysis and will require negotiations between the DOE and the private contractors.

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APPENDIX A

MIXING SYSTEM ALTERNATIVE GENERATION AND ANALYSIS

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APPENDIX A

MIXING SYSTEM ALTERNATIVE GENERATION AND ANALYSIS

ALT DECISION ANALYSIS SUMMARY

This alternative generation and analysis (AGA) report provides information for the Low-Level Waste Feed Staging Plan (Certa 1996). This AGA evaluates what infrastructure upgrades to the intermediate waste feed staging tanks (FWFST) are necessary to support a mixing system. Tanks 241-AP-102 and 241-AP-104 have been designated as the IWFSTs (Galbraith et al. 1996a).

Section A1.0 includes a description of the options evaluated and discusses the comparison of the options to the decision criteria. Section A2.0 details the problem statement, and Section A3.0 discusses the constraints and assumptions for the analysis. Section A4.0 provides the detailed analysis of the options, and Section A5.0 provides the document references. Cost estimates are included in Section A6.0.

A1.1 STATEMENT OF THE PROBLEM

What type of mixing system should be used in the FWFSTs to support the staging of low-activity waste (LAW) for Phase I privatization?

AL2 DECISION ISSUES

A1.2.1 Open Issues

One mixer pump is assumed to be adequate for maintaining solids in suspension for a waste with a low solids fraction. This is based on the fact that no sludges will be present in the feed staging waste. In addition, the waste feed envelopes specify that the insoluble solids fraction will not exceed 5 vol% of the waste transferred (DOE 1995).

One decant pump is assumed to be required in each IWFST. This is required if the solids fraction is inadvertently excreded during retrieval of the source double-shell tanks (DSTs) (Certa 1996). A 106.7-cm (42-in.) riser is required for the decant pump with the load sensing winch. The winch mechanism is required to eliminate the whipping action applied to the decant pump during the operation of a mixer pump. If the mixer pump is not used, the winch mechanism is not required and the decam pump could be installed in a 30.5-cm (12-in.) riser. This would reduce the upgrades noeded to the IWFSTs.

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A1.2.2 Scope

The objective of the Phase I privatization is to deliver LAW and HLW feed to the Phase I private contractors for vitrification. This report addresses the mixing requirements for the IWPSTs and the upgrades required to support various mixing system options.

A1.3 DESCRIPTION OF OPTIONS CONSIDERED

The tank contents will be mixed before transferring the waste to the IWFSTs. However, the mixing system must be capable of mobilizing any solids that may be intentionally or inadvertently settled in the IWFSTs. Based on successful retrieval operations at other U.S. Department of Energy (DOE) sites, mixer pamps were selected for Project W-211 (Rieck 1996) as the appropriate technology to remove settled solids and are, therefore, selected for the JWFSTs.

AL3.1 Background

Project W-151 chose mixer pumps as the planned method of waste retrieval, based on engineering technology studies, past experience with hydraulic sluicing at the Hanford Site, experience with mixer pumps at the Savannah River Plant, and by the recommendations from two engineering studies. Mechanical mixers, sluicing, ultrasonics, and air/vapor jets were also examined (Shaw 1992). Safety, versatility, schedule, and cost considerations were the principal factors that led to the choice of mixer pumps rather than hydraulic sluicing nozzles. Several studies (e.g., RHO 1984, Lawler 1986a and b, Stegen 1986) have concluded that mixer pumps would be the preferred method for many retrieval applications. Most of the studies done previously were concerned with retrieval of solids, not in maintaining solids in suspension as is the case with the IWFSTs. However, the advantages of mixer pumps over sluicing and mechanical devices identified in these reports are applicable to the IWFSTs. In these reports, the principal advantages of mixer pumps over sluicing and

- Mixer pumps can provide a uniformly mixed feed stream.
- Provide the option to perform in-tank washing and processing of solids.
- Do not require significant upgrades or addition of waste transfer lines.
- Require less equipment and operator action in the tank farm.
- Will result in lower operator exposure (as-low-as-reasonably-achievable (ALARA]).

In addition, the conceptual design features of the feed tanks for the Grout Treatment Facility included mixer pumps. Several waste mixing system options were examined for the Grout feed tank and a mixer pump was chosen (Lawler 1984). The main function of the grout tanks was to maintain solids in suspension and well-mixed prior to waste feed sampling and during feed transfer to the grout process. This matches the function of the mixing system required for the IWFSTs.

A1.3.2 Mixing System Options

One mixer pump will be required in each IWFST. The basis for this is that the insoluble solids fraction of the waste feed envelopes will not exceed five volume percent of the waste transferred (DOE 1995). The advanced design mixer pump (ADMP) is assumed to be used. The pumps will be installed through existing 106.7-cm (42-in.) riser penetrations. The effect of adding a 300-hp mixer pump on the IWFST ventilation system is addressed in Appendix C.

One decant pump will be required in each IWFST (see Section A1.2.1). The existing transfer pumps will be replaced with the new supernate decant pump. Decant pumps are required to leave some or all of the solids behind if the solids fraction is out-of-specification (Certa 1996). This would occur if too many solids were inadvertently retrieved and transferred from the source DSTs, or precipitated during or after the transfer. The pumps will be installed through existing 106.7-cm (42-in.) riset penetrations.

On both of the IWFSTs there are three 106.7-cm (42-in.) diameter risers. One 106.7-cm (42-in.) riser is located in the central pump pit. On tank 241-AP-102 a failed mixer pump is located in this riser and the transfer pump is located in the 241-AP-02D pump pit (30.5-cm (12-in.) riser). On tank 241-AP-104 a shurry distributor is located in the central pump pit 106.7-cm (42-in.) riser and the transfer pump is located in a 30.5-cm (12-in.) riser in the central pump pit. The other two 106.7-cm (42-in.) risers are located 90° apart on a 6.3 m (20 ft, 9 in.) radius. These two risers are listed as spares on both tanks.

There where two options considered for installing mixer pumps in the IWFSTs. Option 1 is to locate the mixer pump in tiser no. 5 (106.7 cm [42 in.]), off-centered on a new concrete pad. This option uses the design from Project W-211 that places the mixer pumps on slabs at grade (Rieck 1995). Mixer pump foundations will be reinforced concrete slabs 2.7 m (9 ft) by 2.7 m (9 ft) and 0.3 m (1 ft) thick placed 15 cm (6 in.) below grade. High pressure spray rings will be fabricated and installed on top of each of the mixer pump risers for future decontamination of the mixer pumps as they are withdrawn from the tank. The decant pump would be located in the central pump pit, riser no. 11 (106.7 cm [42 in.]). This would require modifications to the pit arrangement including removal of the falled mixer pumps on the IWFSTs is shown in Figures A1-1 and A1-2 for tanks 241-AP-102 and 241-AP-104, respectively. A typical cross-section of the slab and mixer pump assembly is shown in Figure A1-3.

Option 2 is to locate the mixer pump in the 106.7-cm (42-in.) diser of the central pump pit, riser no. 11. This option uses the design from Project W-211 that places the mixer pumps on the cover blocks of an existing pit. The mixer pumps would be supported on the central pump pit by a load distribution frame assembly. High pressure spray rings would be fabricated and installed

within the central pump pit for future decontamination of the mixer pumps as they are withdrawn from the tank. The decant pump would be located in riser no. 5 (106.7 cm [42 in.]). This would require a new pump pit and transfer line on the 1WFSTs. The pump pits would be approximately 2.7 m (9 ft) by 2.7 m (9 ft) by 1.8 m (6 ft) deep with 0.6 m (2 ft) thick cover blocks. The transfer lines would be double encased with a 7.6-cm (3-in.) diameter staintess steel primary encased in a 15.2-cm (6-in.) diameter carbon steel secondary and be approximately 6.4 m (21-ft) in length. In addition, this option would require modifications to the central pump pit arrangement including new 7.6-cm (3-in.) nozzle in the central pump pit of tank 241-AP-104, and removal of the failed mixer pump in tank 241-AP-102 and the slurry distributor in tank 241-AP-104. Also, new cover blocks would be tequired on the central pump pits to support the installation of the new mixer pumps. The location of the mixer pumps on the TWFSTs is shown in Figures A1-4 and A1-5 for tanks 241-AP-102 and 241-AP-104, respectively. A typical cross-section of the central pump pit and mixer pump assembly is shown in Figures A1-6.

A1.4 DECISION CRITERIA

Decision criteria consists of information used to distinguish preference among the options considered. The list of decision criteria specified in the draft decision plan are not all needed in evaluating the mixing options. The criteria to be used are described in Sections A1.4.1 through A1.4.5.

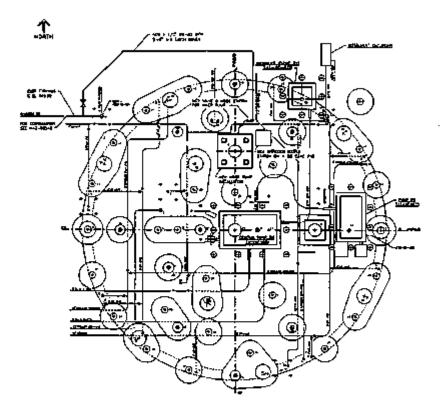
A1.4.1 Cost

The systems will be evaluated with respect to developmental costs, project capital costs, operating costs, and disposal costs.

A1.4.2 Schedule

The schedule impact/risk will be assessed relative to implementation of a given option. The DOE has developed a planning schedule with a start date of June 1, 2002, for the operations of Phase I facilities.



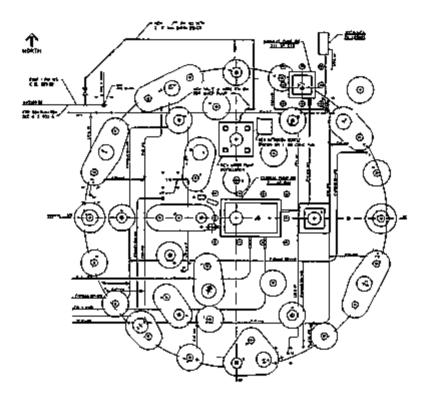


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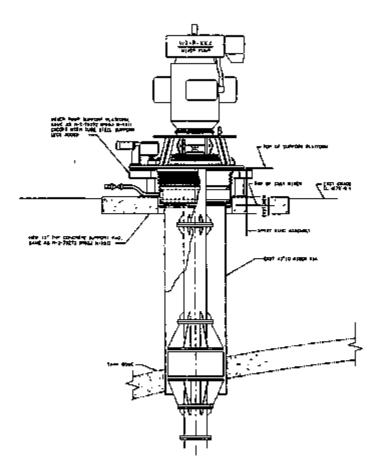
Figure A1-2 Mixer Pump on Slab 241-AP-104



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Figure A1-3. Mixer Pump on Slab: Assembly.



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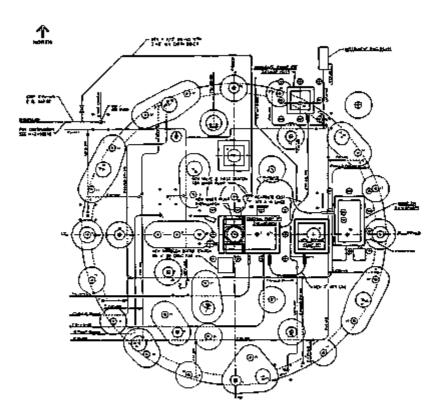


Figure A1-4. Mixer Pump above Central Pump Pit: 241-AP-102.

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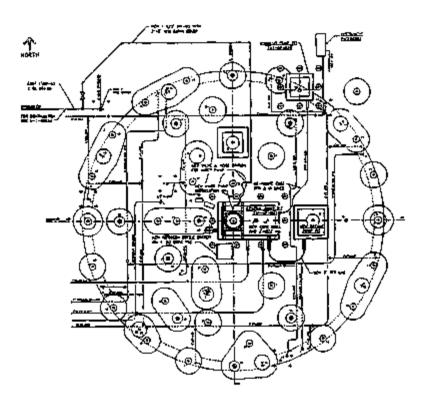
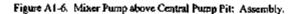
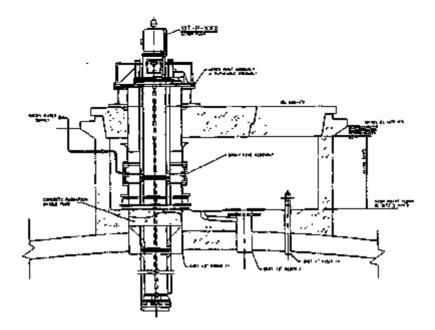


Figure A1-5. Mixer Pump above Central Pump Pit: 241-AP-104.

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A1.4.3 Maintainability

The maintainability of a system will be assessed by evaluating the complexity, reliability, and repairability of the associated equipment and components. Complexity will address any training requirements for operation personnel, the need for special tools or procedures, and design qualities such as features that ease repair. Reliability will address calibration and preventive maintenance procedures along with impact of failures. Repairability will address the location of the equipment, the means of repair, and the number and type of personnel required to support repairs.

A1.4.4 Technical Maturity

The technical maturity of the system will be assessed as to wether the system has been applied at the Hanford Site or commercial industry, and if the system has been tested experimentally by bench scale experiments.

A1.4.5 Performance Requirements

The mixing system must be able to perform the following (Certa 1996):

- Blend waste from two or more source DSTs.
- Provide a homogeneous feed to the private contractors.
- Dissolve soluble salts that did not diasolve during retrieval and transfer from the source DSTs
- Dissolve solids such as gibbsite that may have precipitated during retrieval and transfer
- Support chemical adjustment of the waste NaOH, NaNO₂, NaNO₃, and H₂O
- Support sampling protocol.

The transfer pump must be able to perform the following (Certa 1996):

 After delivery of a feed batch to the private contractors, the liquid heel remaining in the IWFSTs should be no more than 0.10 ML (25 cm [10 in.]) of waste.

A1.5 OPTION EVALUATION

A modified slurry distributor system was suggested. This would pump the waste to the 241-AP valve pit and back through a slurry distributor with a discharge nozzle. Slurry distributors have been widely used at the Hanford Site to distribute the heavier slurries into the tanks, but not as a mixing system. This system would need to be tested and evaluated in scale models to verify that the system could perform subsectorily in the IWFSTs. Therefore, the modified slurry distributor system was screened from further evaluation.

The pulsed air mixing system was also suggested. Studies have been done on this for retrieval, but not for just maintaining solid suspension. This technology appears to be simple and warrants further consideration. However, at this time the technology has not been proven or used with the waste in question. Therefore, the pulsed air mixing system was screened from further evaluation.

The analyses of the two mixer pump options have been summarized in a tabular form in Table A1-1. Since the two options involve the same equipment, the decision criteria of maintainability, technical maturity, and performance requirements will be the same. The main driver in selecting the preferred option will be based on cost and schedule.

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Decision Criteria	Option 1 "Mixer Pump on Slab"	Option 2 "Mixer Pump above Central Pump Pit"
Cost	\$16,600,000	\$ 19,200,000 (Note: \$1,100,000 of this is related to using the new decant/transfer pump, (W-151 design). If decant/transfer pump is not required and a fixed intake transfer pump could be used the cost could be eliminated.)
Schedule	Option 1 would have less impact on project milestones. The mixing pump mounting pad and the central pump pit new jumper arrangement are the major construction iteros. This option could be completed by the October 2000 need date.	Option 2 may create conflicts with project milestones due to more prolonged construction work. This option requires a major rework of the central pump pit in addition to a new pump pit and transfer line if the new decant/transfer pump is used.
Maigtainability	The systems associated with Option I are all common to the Hanford Site and no additional training is required of persoanel. In addition, the systems have been shown to be reliable in other applications and the equipment is readily assessable for repair.	Same as Option 1
Technical Maturity	The technical maturity of the systems associated with Option 1 is high. They have all been applied effectively at the Hanford Site.	Same as Option 3

Table A1-1. Matrix of Mixer Pump Options by Decision Criteria.

	Option					
Decision Criteria	Option I "Mixer Pump on Slab"	Option 2 "Mixet Pump above Central Pump Fit?"				
Performance Requirements	Mixing performance could be deminished with this option do to the off-center location .	This option is predicted to perform better than Option 1 since the mixer is located in the cener of the tank. Two tanks have been equipped with single mixer installed in the central pump pit and the performance was good; e.g. tanks 241-SY-101 and 241-AP-102.				

Table A1-1. Matrix of Mixer Pump Options by Decision Criteria.

A2.0 PROBLEM STATEMENT

The objective of this AGA report is to determine the best option for installing a mixing system in the IWFSTs. Tank 241-AP-102 was modified for the grout program and currently has an agitation system and a new transfer pump pit. The capabilities of these modifications to support the mixing requirements for the IWFSTs needs to be addressed along with the upgrades required for tank 241-AP-104.

This AGA will investigate options for the mixing of the IWFSTs and determine the modifications required to install these systems. Previous analysis of mixing systems will be used to screen options and a preferred option will be selected. The criteria for determining the best option will be based primarily on cost and technical maturity of the mixing system.

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A3.0 CONSTRAINTS AND ASSUMPTIONS

The IWFST mixing system would be considered part of the *Store Managed Tank Wastes Function 4.2.1.1* (WHC 1996). This includes the mobilization/suspension of tank waste solids, minor chemical adjustments, and in-tank blending and feed staging.

The performance requirements identified in Function 4.2.1.1 that pertain to the mixing system are as follows:

Estimated TWRS Project Schedule

The mixing system must support the TWRS project schedule. Proof-of-Concept operations will be from June 2002 through June 2007, with DOE's option to extend processing through June 2011.

Chemical Concentrations Limits

The mixing system systems interfacing with the waste sources must be capable of handling waste with the chemical concentrations specified in OSD-T-151-00007 (WHC 1996a).

Heat Generation Limit

The mixing system will be limited to a total thermal input load based on the tank ventilation system cooling capacity. This ventilation analysis for adding a 300-hp mixer pump is addressed in Appendix C.

Tank Dome Static Loading

The weight of any portion of the mixing system installed on a tank riser will be limited by the static dome loading design limits specified in OSD-T-151-00007 (WHC 1996a).

Tank Ventilation System - Pressure

The mixing system will not over- or under-pressurize the tanks based on the limits specified in OSD-T-151-00007 (WHC 1996a).

Temperature - Non-Aging Waste DST Waste

The mixing system must be capable of handling waste with a maximum temperature of 82 °C (180 °F) as specified in WHC-SD-WM-OSR-016, LCO 3 2 2 (WHC 1996b)

A3.1 CONSTRAINTS

Constraints are requirements imposed by an external organization. The design, operation and maintenance of the IWFST mixing system are affected by state and federal regulations, agreements, DOE Orders, and Westinghouse Hanford Company (WHC) requirements. In addition, there are guidelines and specifications that set forth engineering requirements deemed processary for safe design and construction of the mixing system. The requirements and guidelines presented in these orders, regulations, codes, and agreements must be followed when designing and installing a mixing system. The format below establishes a hierarchy into the histed documents to be used during the definitive design stage of the IWFST upgrades.

- DOE Ordet 5480 28, Natural Phenomena Hazards Mitigation
- DOE Order 5820 2A, Radioactive Waste Management
- DOE Order 6430 1A, General Design Criteria
- WAC 173-303-640, Dangerous Waste Regulations Tank Systems
- WHC-IP-1043, WHC Occupational ALARA Program.
- WHC-SD-GN-DGS-30011, Radiological Design Guide
- WHC-CM-4-46, Safety Classification of Structures, Systems and Components

The long-length equipment must be designed to fit in the bunal containers developed under the Long-Length Contaminated Equipment Disposal Program. In addition, the equipment weight must be below the limits of the trailers for the handling and transport of the bunal containers. The design information for the long-length equipment can be found in the following documents

- WHC-S-0321, Specification for Trailers for the Handling and Transport of Tank Farms Long-Length Contaminated Equipment
- WHC-S-0402, Specification for Contaminated Equipment Burial Container

Instrumentation to monitor and/or control the following parameters will be designed and installed unless existing tank instruments can be used

- Monitor tank level, temperature (waste and vapor space), pressure (vapor space), and gas concentrations.
- Determine the extent of mixing effectiveness.
- Monitor mixer pump motor amperage, rpm, and temperature.
- Monitor temperatures of mixer pump drive and bearing components.
- Monitor mixer pump bearing/seal lubrication water flow rate.
- Measure vibration of the mixer pump assembly.

A3.2 ASSUMPTIONS

The following assumptions have been made in the analysis of the IWFSTs mixing system options:

- Analysis of the impact of the mixer pump jet forces on existing or added internal tank equipment is beyond the scope of this report.
- One mixer pump in each IWFST will provide adequate mixing of the slurry/supernate waste to be staged.
- Decapt pumping will be required to transfer the supernate to the private contractor's feed tank if the quantity of solids is out-of-specification (Certa 1996).
- Addition of a new pit on the IWFSTs will not exceed the dome limit of the tanks. It
 is assumed that the weight of the pit will be less than the weight of the soil removed.

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A4.0 ANALYSIS OF OPTIONS

This section documents the methodology used to generate the options and documents any options that were screened. In addition, this section determines how well an option satisfies each selection criteria.

A4.1 GENERATION OF OPTIONS

The options for the mixing system were developed by informal brainstorming and documented in meeting minutes (Galbratth 1996b). The options generated for the mixing system consist of the following: Mixer pump system, pulsed air mixing system, and a modified shury distributor system.

The mixer pump system consists of high-capacity low-head pumps with closely-spaced suction and discharge ports. They are designed to recirculate the fluids within a radioactive waste tank to achieve mobilization and mixing of the waste. Mixer pumps are key to retrieval systems such as the Project W-211, "Initial Tank Retrieval Systems" (Rieck 1995). The mixer pump systems to be addressed will include concepts developed by Projects W-211 and W-151. This includes mounting the mixer pumps on top of the central pump pit and on a concrete slab.

A pulsed air mixing system is currently being evaluated by Pacific Northwest National Laboratory (PNNL) for use in sludge mobilization. This system mixes the waste by generating large oval-shaped bubbles of compressed air that are sequentially introduced under large accumulator plates at the bottom of the tank. The consecutively timed pulses quickly rise in a controlled sequence to the top of the tank, forcing liquids to circulate from top to bottom creating a vertical flow pattern.

The modified slurry distributor system would use a transfer pump as the driver for a recirculation system tied to a slurry distributor. The slurry distributor would spray the recirculated waste over the surface of the tank contents to provide mixing of the waste.

A4.2 SCREENING OF OPTIONS

The options generated can be initially screened against the critaria of technical maturity. The polsed air mixing system appears to be simple and warrants further consideration. However, at this time the technology has not been proven or used with the supernate waste in question, or in a one million gallon tank. Therefore, the pulsed air mixing system was screened from further evaluation. In addition, the modified sturry distributor system would need to be tested and evaluated in scaled models before it would be feasible in the IWFSTs. Therefore, the modified sturry distributor system was screened from further evaluation.

A4.3 ANALYSIS OF MIXER PUMP OPTIONS

The analyses of the two mixer pump options have been summarized in Table A1-1. Since the two options involve the same equipment, the decision ordered of maintainability, technical maturity, and performance requirements will be the same. The main driver in selecting the preferred option will be based on cost. This section provides a detailed description of the upgrades required for these two options and the cost associated with each upgrade. The costs are taken from the estimates provided in Section A6.0.

One mixer pump will be required in each IWF\$T. The initial cost of the ADMP including run-in test is approximately \$760,000.

One decant pump will be required in each IWFST. The existing transfer pumps will be replaced with the new supernate decant pump. The initial cost of the decant pump including runin test and shop modifications is approximately \$510,000. If the winch mechanism is not required, the cost would be approximately \$430,000.

A nitrogen bottle station will be required for each of the mixer pumps for the gas-seal purge. The nitrogen station will consist of four nitrogen bottles and an automatic switch-over manifold (with pressure regulator, pressure safety valve, pressure indicators, and check valve), that will automatically switch from the old bottle to the new on low pressure. A standard "K" size bottle (22.9 cm [9 in.] diameter by approximately 132.1 cm [52 in.] long) is expected to last approximately 30 days before being automatically switched over to a new bottle. The costs to install a nitrogen bottle station in both of the LWFSTs are approximately \$120,000.

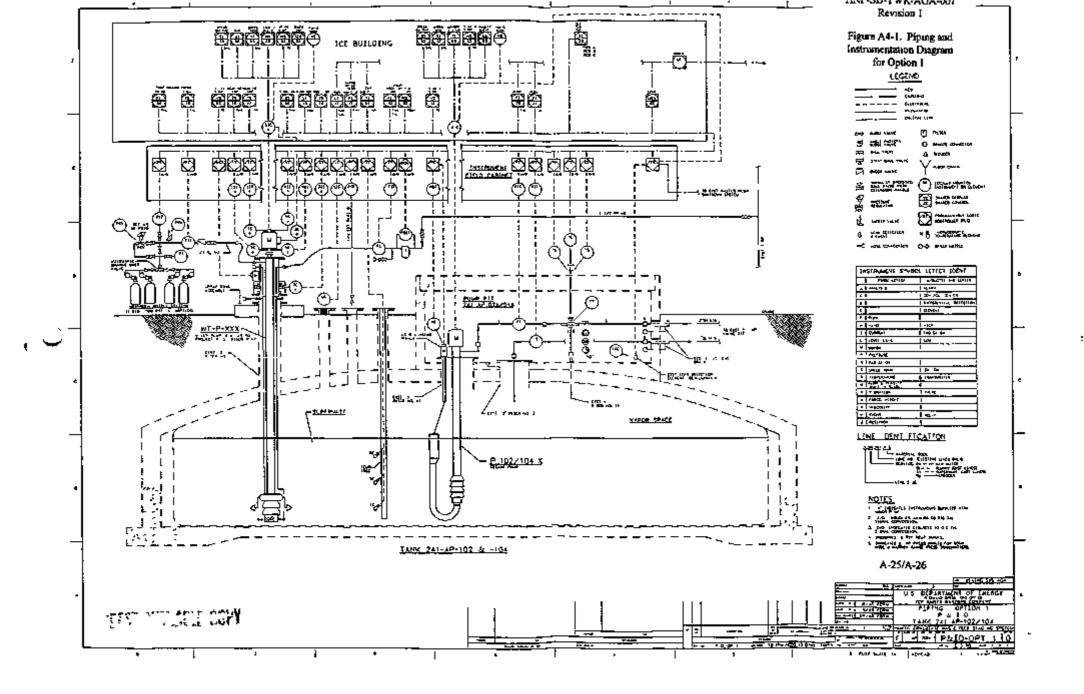
The failed mixing pump and the slurry distributor for tank 241-AP-102 in the central pump pit need to be removed. In addition, the existing transfer pumps and thermocouple trees need to be removed. The cost for removal and disposal of this equipment is approximately \$5,500,000. This includes \$2,900,000 for greenhouse and support cost plus immobilization cost.

A new thermocouple tree, vapor pressure indicator, and level indicator will be required in each IWFST. The total cost to purchase and install this equipment in both of the IWFSTs is approximately \$260,000.

A4.3.1 Option 1

Option 1 is to locate the mixer pump in riser no. 5 (106.7 cm [42 it.]), off-centered on a new concrete pad and locate the decant pump in the central pump pit riser no. 11 (106.7 cm [42 in.]). A piping and instrumentation diagram (P&ID) for Option 3 is shown in Figure A4-1.

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The work associated with Option 1 includes the following items for each of the IWFSTs:

- Purchase of one ADMP and one supernate decant/transfer pomp.
- Install approximately 23 m (75 ft) of new 3.8-cm (1.5-in.) raw water line including a new valve and hose station.
- Extend the 106.7-cm (42-in.) riser and install the mixer pump foundation. This will be a reinforced concrete slab 2.7 m (9 ft) by 2.7 m (9 ft) and 0.3 m (1 ft) thick placed 15 cm (6 in.) belowgrade.
- Pabricate and install a high pressure spray ring on top of the mixer pump riser for future decontamination of the mixer pump as it is withdrawn from the tank.
- Install a nitrogen bottle station for the gas-seal purge of the mixer pamp.
- Modify the central pump pit jumper arrangement as shown in Pigure A4-1.
- Remove the failed mixer pump in the central pump pit (tank 241-AP-102 only).
- Remove the slurry distributor in the central pump pit (tank 241-AP-104 only).

The total cost for the work included in Option 1 is approximately \$16,600,000. This includes \$3,000,000 for design and management, and an estimated burnout cost of \$1,700,000 based on previous construction in the AW Tank Farm. In addition, approximately \$5,700,000 of the total cost for Option 1 corresponds to upgrades for adding the mixer pumps. The total cost for Option 1 that corresponds to upgrades for adding the decant pumps is approximately \$5,200,000. There would be no difference in the cost for this option if the decant/transfer pumps were installed in a 30.5-cm (12-in), riser in the central pump pit.

A4.3.2 Option 2

Option 2 is to locate the mixer pump in the 106.7-cm (42-in.) riser of the central pump pit, riser no. 11 (106.7 cm [42 in.]) and locate the decant pump in a new pump pit above riser no. 5 (106.7 cm [42 in.]). A P&ID for Option 2 is shown in Figure A4-2.

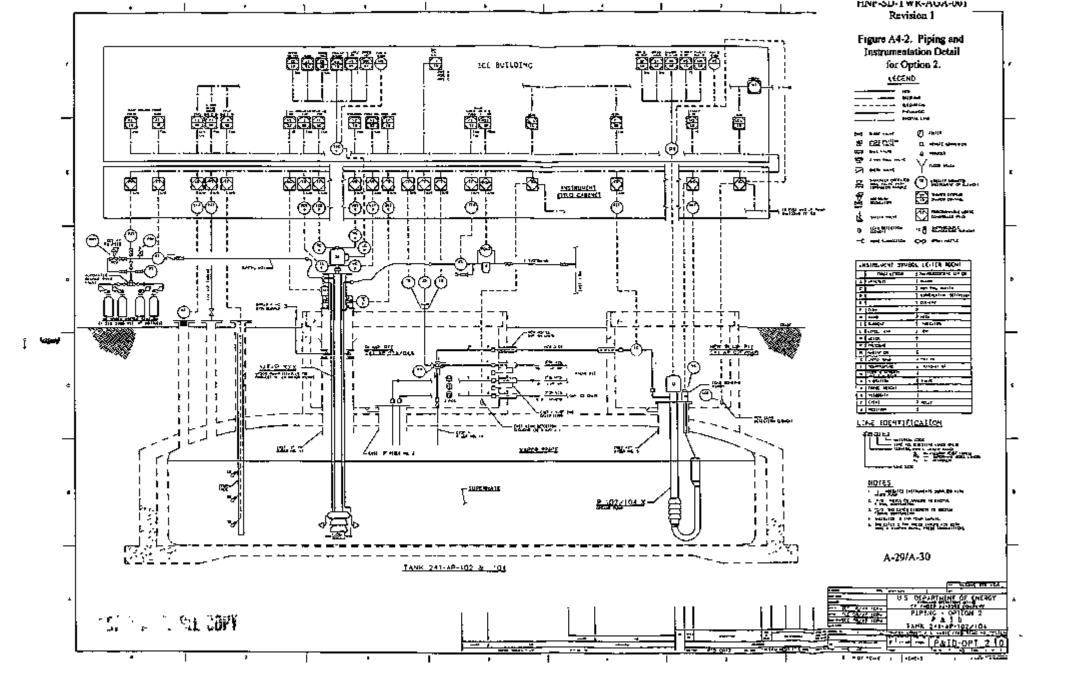
The work associated with Option 2 includes the following items for each of the IWFSTs:

- Purchase of one ADMP and one superniste decant/transfer pump.
- Install approximately 29 m (95 ft) of new (3.8-cm [1.5-in.]) raw water line including a new valve and hose station.
- Install the mixer pump on the cover blocks of the central pump pit. This will require the repiscement of the existing cover blocks. The central pump pit cover blocks are

0.6 m (2 ft) thick and cover an area that is 5.0 m (16.5 ft) by 3.2 m (10.5 ft).

- Fabricate and install a riser extension and high pressure spray ring within the central pump pit. See Figure A1-6 for a typical cross-section of this assembly.
- Install a nitrogen bottle station for the gas-seal purge of the mixer pump.
- Core drill and install a new 7.6 cm (3-in.) PUREX nozzle in the central pump pit (tank 241-AP-104 only).
- Modify the central pump pit jumper arrangement as shown in Figure A4-2.
- Install a new pump pit on the 106.7-cm (42-in.) riser no. 5. The pump pit would be approximately 2.7 m (9 ft) by 2.7 m (9 ft) by 1.8 m (6 ft) deep with 0.6 m (2 ft) thick cover blocks. The pit would include a statuless steel liner.
- Reroute the existing transfer line and instrument air lines that interfere with the installation of the new pump pit.
- Install a new transfer line between the central pump pit and the new pump pit. The transfer line would be double encased with a 7.6-cm (3-in.) diameter stainless steel primary encased in a 15.2-cm (6-in.) diameter carbon steel secondary and be approximately 6.4 m (2) fi) in length.
- Fabricate and install a jumper arrangement and leak detector in the new pump pit as shown in Figure A4-2.
- Remove the failed mixer pump in the central pump pit (tank 241-AP-102 only).
- Remove the slurry distributor in the central pump pit (tank 241-AP-104 only).

The total cost for the work included in Option 2 is approximately \$19,200,000. This includes \$2,600,000 for design and management and an estimated burnout cost of \$2,800,000 based on previous construction in the AW Tank Farm. In addition, approximately \$5,600,000 of the total cost for Option 2 corresponds to upgrades for adding the mixer pumps. The total cost for Option 2 that corresponds to upgrades for adding the decant/transfer pumps is approximately \$7,900,000 including the new jumper arrangements in the central pump pits. However, if fixed intake transfer pumps are installed in a 30.5-cm (12-in.) riser, the difference in cost for this option would be approximately \$1,100,000.



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A6.0 COST ESTEMATES

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U.S. DEPARIMENT OF EMERGY + DUE ONDER SIDD.5 PAGE 1-32 SUDPARAGEARM (H). REBUILTS GOMMOING DE ALL ATMENAL PLANT PROJECTL (CPP-S) AND LINE ITEM (LI) COST ESTIMATES, REFERENCET DOE 5100.5. FIGURE 1-51, MATED 10-31-84.

7. REMARCE

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- A.) DEF/ACH, EP4/INUP, APP PH4J/AGHI COITH ARE & AFACENIAGE OF BIREST CONSILUCIONS CUSIS LESS ADDIAL FEB3
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- D.) GINER PROJECT COSTS WERE INFUL BASED ON A PERCENTAGE OF CINECE CONSTRUCTION COSTS LESS BURJAL FEES. THE PERCENTAGES FOR TALSE FFIDITE WERE WELIFER WASED ON ESTIMATED COSIS FLOW PROJECT WITE.

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,	CEFIERBITE 3-08-46). Spi	РАГИВ ОН ТАГ 1004 ГІЗСАС ТЁРА ИМООВІ́ ()44930471000 ЖАГСИ № 15 6 АКТО ІМЧ РТ 1046 РЕАНТІЛЬ АЛТЕХ — (АВРОАТ ВСИЙЛАІ), 151006 МТ КГИ РІМАЧСЕ (ТРРССТАЧЕ 10-01-95), МАТЕХ ІВСІЦФЕ РА ИБЬОВ АНО БАЛРИЯ,	
۸-۵	SASED ON THE SEF-CA ESTIN		AGADÓS CACHAY LOCATES ON UNBERDAS SOFT
G	LICALATION 4/AD		
•	. NOUNDING U.S. DUPARIMENT OF ENERGY - 1 (GPP'S) AND LINE ITEM (LID CO	AGE ONDEN 5166.4 PACT I-32 CUNPARAGNAPH (M), PRAVINCI NOUNDI GSI ESIIMLIJS, ERFENTMER, DOG 5100.4, FIDWRE I-11, DATED 10-	NG OF ALL SANAAL PLNMT PEDJECIU 31-44.
7	 B.3 BIG/DGS, ENG/INSM, AND AD C.3 INESHOGAUPAN AND CCTV CO S.3 LIDDA ANA MAFEGTAC DEFIE B.3 LIDDA ANA MAFEGTAC DEFIE COMPRESSION AND COMPRESSION NEW COMPRESSION AND COMPRESSION F.3 AL DATESTER FO DESIGN CON 	NG ACHVINGD FON TAIS PROJECT. Ngj/ngni corti ang a pleachtage of dialet construction costi 19j/ngni costi aginacier for project numere w.211. For transfer rikep pung ange der Asstaltfra from Project n Cunscettor fo be friklele doore econta i cutsting power po In Agdye installen fok befailer vill ge to entring no Infactor. Installenton ber jundes vil ge to entring no Ila be ver fon listalle fok befailer vill ge to entring no Ila be ver fon listallen die solf entring fon Ila be ver fon listallen die solfete vill ge to entring no Ila be ver fon listallen die solf fon projection/name e	UMBER 4-219 Le Aiser Wild Acceptable flue 145 2719 IN Contact Anno 111

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içlər çünilüntilün	11,477,773	0	14,407,403	. ,oo	٩	11,497, 493	24	2,761,110	14,299,154	HNF
peojece rajal	18,497,993	••••••	11,497.993	0.0 +	,	11,497,993	24	2,781,11	64,279,11:	-SD-TWR-, Revision
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** (EST - |3168225)78 [310827]85 ** RP-102 & AP-104 FARE PULSE BIN BISTEN EVUT DELERBE - CORTHREENCT NUMLTAIS BAILS ASLET 7465 6 45 4 1416 00765786 07149156

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REFERENCES	COLUMNTE ANDIS INCET	PADE PA B e	•		٠
	GOST CODE ACCOUNT BUHHART	PARE	4/3	•	

TOE U.S. BEPARINERI OF ENGNOT - BICRLARD GROES \$704.3 "COST (STINATING, AMALTIES AND EXAMPARAIZATION" DATED 3-27-05, PEONIDES GUIDELING FOR ISLIMATE CORTINGIACIES, THE GUIDELING FOR A SINOT (STIMAT) Should have an overall rake of 20 to 30%.

CONTINUENCY IS EVALUATED AT THE THIPD COST COOR LEVEL AND SUMMARIZED AT THE PAIMART AND RECORDANT COST CODE Livel of the Detailed Codi Estimate.

ta ci at l'Allas	ARO MADAGEMENT, GOE COST CODES D2D. 010, 040 BUE TO 15E DETIBUTIVE DETIGUIANE EZI DINETNA COMPTEINETION EFFORTS DETIGO CALCULATAD AS A
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31	0100.0100100	2476 BOURT BIN BT 10 MAM CREW + 248 B 2 SUPPORT LTIEBDERIS + 334	780 1) 	۵ • • • • • • • • •	•	•	•	•		• •	q	
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31	0100.0113012	LIGH FOR HUG, SUPPORT 13126 of Structures and Facer Act Pepa filters and facer Act Are up	740 1	u 44	• • • •	5 64	2996	•	1501	•		0 135 1	13394	,
31		ALLÓW FOR SIRUEIUFE VEGEN (SIZE UF SIRVETVÁCA UUKAÓVA)	760	4 404	• • • •	5 100	3823	•	- 9	•		0 1990	5817	t -
31	0108.0113185	ALLOW FOR BURNAL PACEAGING	760	v 47) »II	s 40	1531	•	1000	•		6	5327	Ł

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516200	AP 182/184 PUCSE AIR APRIEM														
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A-68	310200,15 310200,1526120	AF 102/104 INSIALL PIPING Comprise Com Swp's		¥	¢		٠	Q	¢	• •	•	a o	•	D-TWR-AGA-00 Revision 1
	310201.1526122	PROVIDE AND INSTALL FARE FARM COMPLET JUNPER W/COMM, NEADI & M/FLOW PROVENSER (ALLOWARES)	704	۲	£ 1	EÅ	48	2363	•	30040	•	0 1533	\$1894	
	314240,1524183	GPECATON SUPPORT TO SET	79 0	٧	21		32	1414	6	•	•	735	2149	
	318290.1576128	PLACE COMPRESSOR SKIW APERLINE COMPOSE FIELD EWAL & MRAP SEE IPREF	700 700 700	Ū.	140	F L	24 13 20	12#2 64 1048	:	ō		64/ 333 191	1949 976 1673	
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	ALOWRECE FOR VLV COPTEOLLES ALOWRECE FOR ALS RECULATORS	740 760		11	:	527 527		• 1444 • 1444	;	0	222 222		
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	SALIS FAN D.84 2 WARIDOWSING 24.96 3 WHAP IGR WAALUPE GALFF							11	I	•		178 423	
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APPENDIX B

SAMPLING SYSTEM ALTERNATIVE GENERATION AND ANALYSIS

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APPENDIX B

SAMPLING SYSTEM ALTERNATIVE GENERATION AND ANALYSIS

BI.0 DECISION ANALYSIS SUMMARY

This alternative generation and analysis (AGA) report provides information for the Low-Level Waste Feed Staging Plan (Certa 1996) This AGA evaluates what infrastructure upgrades to the intermediate waste feed staging tanks (IWFSTs) are necessary to support the sampling system Tanks 241-AP-102 and 241-AP-104 have been designated as the IWFSTs (Galbranth et al 1996a)

Section B10 includes a description of the options evaluated and discusses the comparison of the options to the decision criteria. Section B20 details the problem statement, and Section B3 0 discusses the constraints and assumptions for the analysis. Section B4 0 provides the detailed analysis of the options, and Section B5 0 provides the document references.

BI.1 STATEMENT OF THE PROBLEM

What type of sampling system should be used in the IWFSTs to support the staging of lowactivity waste (LAW) for Phase I privatization?

B1.2 DECISION ISSUES

B1.2.1 Open lornes

The variability in supermutant composition from riser to user is assumed to be very low (below analytical error). For this reason and because of the cost of multiple sampling locations, batch samples from each IWFST will be taken from a single riser.

The number of samples required is based on a nominal estimate of 2 percent solids for the "well-mixed" and "not-mixed" waste scenarios. This corresponds to an average of 7 and 25 samples per batch, respectively. The average number of samples at a low estimate of 1 percent solids for the "well-mixed" waste scenario also was seven. However, the average number of samples at a high estimate of 5 percent solids for the "not-mixed" waste scenario was 29

Waste feed sampling maybe required to satisfy regulatory requirements of the Resource Conservation and Recovery Act of 1976 (RCRA), the Environmental Protection Agency (EPA), and the Washington Department of Ecology Present regulations require all wastes to be sampled and analyzed with extremely low detection levels. To achieve the mandated detection lizzits, sample volumes of up to one liter in size are required. However, it has been assumed that the largest sample required from the IWFSTs will be 100 mL. If the one liter sample size is required, the results of this AGA may be inaccurate.

B1.2.2 Scope

The objective of the Phase I privatization is to deliver LAW and high-level waste (HLW) feed to the Phase I private contractors for vitrification. Sampling of the IWFSTs will be required to find out if the LAW feed batches are within a Request for Proposal (RFP) feed envelope (DOE 1995). This report addresses the sampling requirements for the IWFSTs and the upgrades required to support various sampling system options.

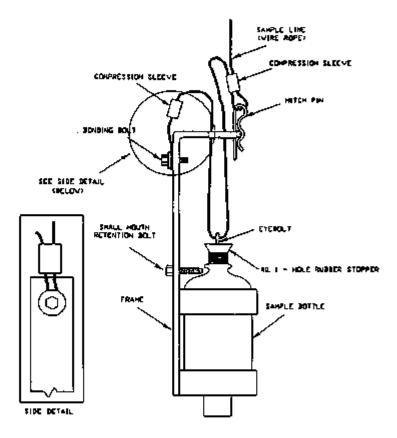
B1.3 DESCRIPTION OF OPTIONS CONSIDERED

Recent sampling analyses (see Section 3.4) have determined that a total of 585 samples would be required for the "not-mixed" waste scenario. This is based on a nominal estimate of 2 percent solids and corresponds to an average of 25 samples per batch. For the "well-mixed" waste scenario, a total of 151 samples would be required at the nominal estimate of 2 percent solids. This corresponds to an average of 7 samples per batch. In addition, the analyses showed that at a low estimate of 1 percent solids, the average number of samples per feed batch would be 7 for the "well-mixed" waste scenario. The high estimate of 5 percent solids corresponded to an average of 29 samples per batch. In addition, the analyses showed that at a low estimate of 1 percent solids, the average number of 5 percent solids corresponded to an average of 29 samples per batch for the "aot-mixed" waste scenario. The sample size is assumed to be no larger than 100 mL. Three sampling options will be investigated to determine their adequacy in meeting the sampling requirements stated.

B1.3.1 Option i - Grab Sampler or "Bottle-on-a-String"

The current method of sampling supernatant in the DSTs is the grab sampler or "Bottle-ona-String" method. Grab sampling is the easiest method of obtaining samples from the DSTs. The system comprises a bottle, stopper, weight and wire rope. Two types of bottles are used: (1) a wide mouth (125 mL) bottle for sampling low viscosity sludges and (2) a narrow mouth (120 mL) bottle for liquids (WHC 1996c). The sample bottle assembly is shown in Figure B1-1. Preparation for obtaining a sample involves prestringing the bottle and its rubber stopper with the appropriate lengths of wire rope. This sampling method can obtain samples within 13 cm (5 ia.) of the bottom of the tank. A glove bag or other containment structure is place over the designated sample riser on the tank. The sample pig (Carlstrom 1995) is placed inside the confines of the glove bag.





To obtain the sample, the cover is removed from the nser. The sample bottle in the sampler carner is lowered to the appropriate depth and held for several seconds. Then the rubber stopper is removed by jerking on its wire rope. The bottle is allowed sufficient time to fill, and then is pulled back to the upper portion of the riser. The bottle is raised to grade level, but not removed from the riser. The rubber stopper is removed and haposed of appropriately. After surveying the sample to determine extremitly dose rates and contact radiation readings, the sample bottle is capped with the screw-on lid. It is then lowered a short distance down in the riser radiation as possible. The sample bottle is then transferted into a plastic bag and placed in the sample pig. After putting the is done the pig and installing the locking pin, the dose rate is checked to caster adjunistive control limits associated with handling and transporting the pig are not exceeded. The riser cover is then normal operational conclusion.

Part of the sampler induced bias for the grab sampler are as follows

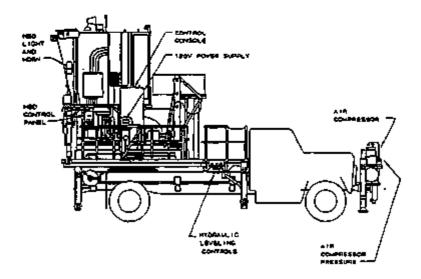
- Material collected in the bottle may be contaminated by material from adjacent elevations due to the movement of the sampler when the stopper or cork is removed.
- Samples collected are not currently (emperature controlled (except freeze protection) after removal from the tank

B1.3.2 Option 2 - Cere Sampler

A specially designed and equipped core sampling truck is currently used to obtain samples of waste in the DSTs. This sampler is mainly used in tanks that contain sludges and salt cake, but can also be used for liquid sampling. The core sampling equipment is mounted on a rotating platform on the core sampling truck. The core sampling truck is shown in Figure B1-2. The truck moves from tank to tank and is positioned over a tank riser for sampling. For the IWFSTs the sampler could be mounted on a skill or a complete core sampling truck could be bought. This analysis will identify the cost of a new sampling truck separate from the cost to perform the feed batch samples.

The maximum volume for this sampler is 300 mL for liquids and samples can be obtained within 7.5 cm (3 m) of the bottom of the tank. The core sampling track is equipped with many systems and equipment to perform the sampling operation. Details of the sampling procedure can be found in *Tank Farm Plant Operating Procedure*, TO-080-503 (WHC 1996d). To sample a tank, the track must be positioned for the drill and the sampler to be lowered into the tank penetration. A sampler is inserted into the drill string core barrel and the drill string is attached to the core barrel. The drill string is lowered into the tank and additional sections of drill string are anached until the sampler is just above the waste surface. The drill string is pushed into the waste to obtain the sample





The drill string is detached from the drill unit after the core sample is obtained. The shielded receiver is then placed over the drill string and the sample is raised into the shielded receiver. From the shielded receiver the sample is transferred into a transfer cask before it is sent to a laboratory for analyses.

B1.3.3 Option 3 - Isolok Sampler

This option uses the conceptual design done for the Grout Disposal Program that locates a sampling facility within the AP Tank Farm (Carter 1989). The facility uses as Isolok-type sampler system that can obtain representative samples of the contents of any tank in the AP Tank Farm. The samplers would be within a stucked hot cell in the sampling facility. A piping plan showing the location of the sampling facility is shown in Figure \$1.3.

The AP Tank Farm sampling facility would consist of a vestibule, clean disrobing and survey area, two airlocks, soiled laundry slorage, supply storage, soiled disrobing and survey area, maintenance area, operating area, hot cell, Padurae (radioactive transportation cask) storage, truck port, mechanical/filter room, and mechanical/electrical room

BLA DECISION CRITERIA

Decision criteria consists of information used to distinguish preference among the options considered. The list of decision criteria specified in the draft decision plan are not all needed in evaluating the sampling options. The criteria to be used are described in the following sections.

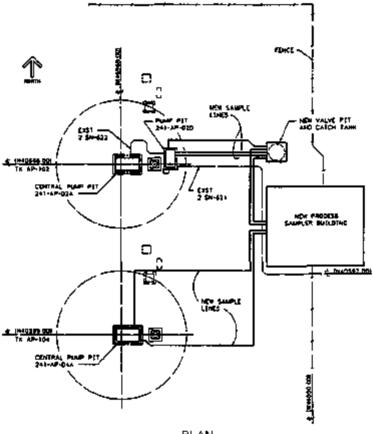
BI.4.I Cest

The systems will be evaluated with respect to developmental costs, project capital costs, operating costs, and disposal costs

B1.4.2 Schedule

The schedule impact/risk will be assessed relative to implementation of a given option. The DOE has developed a planning schedule with the start date of June 1, 2002 for the operations of Phase 1 facilities and feed staging will begin October 1, 2000 (Certa 1996).

Figure B1-3 Grout Sampling Facility



PLAN

B1.4.3 Maintainability

The maintainability of a system will be assessed by evaluating the complexity, reliability, and repairability of the associated equipment and components. Complexity will address any training requirements for operation personnel, the need for special tools or procedures, and design qualities such as features that ease repair. Reliability will address calibration and preventive maintenance procedures along with impact of failures. Repairability will address the location of the equipment, the means of repair, and the number and type of personnel required to support repairs.

B1.4.4 Technical Maturity

The technical maturity of the system will be assessed as to wether the system has been applied at the Hanford Site or commercial industry, and of the system has been tested experimentally by bench scale experiments

B1.4.5 Performance Requirements

The sampling system must be able to perform the following (Certa 1996)

- Insure that the waste composition means envelope requirements
- Satisfy regulatory requirements, if any, for delivery of feed to the private contractors
- Satisfy the operating specification document (WHC 1996a) and waste compatibility data quality objectives (Fowler 1995) for transfer and storage of waste in the IWFSTs
- Establish the official composition of the waste for assessing the private contractor's performance
- Establish the quantity of sodium delivered to the private contractor.

The time needed to obtain samples and deliver them to the laboratory should require no more than five days with a median value of two days or an equivalent distribution. In addition, the sampler shall not alter either the physical or the chemical properties of the sampled material.

B1.5 OPTION EVALUATION

This section describes how each option was evaluated across all of the decision criteria. In absence of a tangible means of comparison, engineering judgement has been used in determining how well a criterion has been met by the options. The analyses of the three sampling system options have been summarized in a tabular form in Table B1-1

The cost estimates are provided in Section B6.0. The operating costs for the grab and core sampler were based on the costs from the Analytical Services Fiscal Year 1996 Multi-Year

Program Plan (Spahr 1995) The ICF Kaiser Estimating Department developed a sampling module based on the unit rates from the program plan. The cost for a new core sampling truck was based on Fiscal Year (FY) 1994 and FY1995 cost for Trucks 2, 3, and 4 (Pickett 1996). The cost for the Isolok sampler was based on the cost from the Grout Disposal Program conceptual design report (Carter 1989) with an escalation factor of 25% for current dollars.

The Grab Sampler, Option 1, is the dominant option. Option 1 meets all of the criteria set for the sampling system. In addition, the cost of Option 1 is approximately \$7,000,000 less than the next lowest option.

		Option	
Decision criteria	Option 1 "Grab Sampler"	Option 2 "Core Sampler"	Option 3 "Isolok Sampler"
Cost ^a "Well-muxed" ("Not-muxed")	\$3,860,000 (\$9,840,000)	\$12,670,000 (\$18,540,000) Note \$5 75M of thus is for a new core sampling uwck/skid	\$12,970,000 (\$16,900,000) Note This is based on an estimate in FY 1988 with 25 percent escalation
Schedule	Option 1 would have no impact on project milestones. There are no new construction items with this option	Option 2 would have no impact on project ratilestones Procurement of a new core sampler is the only long-lead item with this option However, this should not affect the October 1, 2000 operation start date	Option 3 would have mayor impact on the project milestones. The fabrication, procurement, leating, and approval for operation would not be ready for full operation by October 1, 2000

Table B1-1 Matrix of Sampling System Options by Decision Criteria

		Option	
Decision critena	Option J "Grab Sampler"	Option 2 "Core Sampler"	Option 3 "Isolok Sampler"
Mamtamability	The grab sampler is a common sampling system on the Hanford Site. The reliability of the system is very high with equipment failure unlikely to occur. However, the success of the activity is highly dependent on the skill and experience of the personnel taking the samples.	The core sampler is also a common sampling system on the Hanford Site. The system involves complex equipment, however, the system has been shown to be very reliable. Special training for personnel in the operation of the sampler is required	Same as Option 2
Techaical insturity	Option 1 has been effectively applied at the Hanford Site	Same as Option 1	Same as Option 1
Performance requirements	Option1 has the highest radiation exposure and potential for personnel contamination in addition, Option 1 is the most susceptible to being delayed by weather conditions	Option 2 meets all of the criteria established for the sampling system. Option 2 could also have a problem meeting the sample and delivery time due to bad weather delays	Option 3 meets all of the enterna established and substantially reduces the radiation exposure. In addition, factors due to weather conditions are eliminated

Table B1-1 Mains of Samphing System Options by Decision Criteria

The costs are based on the average number of samples at the nominal estimate of 2 percent solids Table B4-1 provides the cost breakdowns for capital, operating, and analysis

B2.0 PROBLEM STATEMENT

The objective of this AOA report is to determine the best option for sampling the IWFSTs. The IWFSTs will deliver LAW feed to the privatization contractors' staging tanks. A statistical confirmation of the feed batch's chemical and physical characteristics will be needed to support the claim that the DOE and the Management and Integration (M&I) contractor have fulfilled their obligation to provide LAW feed within the prescribed RFP envelopes.

This AGA will investigate options for the sampling of the IWFSTs and determine the modifications required to install these systems. Previous analysis and work on sampling systems will be used to screen options and a preferred option will be selected. The criteria for determining the best option will be based primarily on cost and technical maturity of the sampling system.

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B3.0 CONSTRAINTS AND ASSUMPTIONS

The IWFST sampling system would be considered part of the Store Managed Tank Wastes Function 4.2.1.1 (WHC 1996) This includes the mobilization/suspension of tank waste solids, minor chemical adjustments, and in-tank blending and feed staging

The performance requirements identified in Function 4.2.1.1 that pertain to the sampling system are as follows

- Estimated TWRS Project Schedule The sampling system must support the TWRS project schedule Proof-of-concept operations will be from June 2002 through June 2007 with DOB's option to extend processing through June 2011
- Chemical Concentrations Limits The sampling system interfacing with the waste sources must be capable of handling waste with the chemical concentrations specified in OSD-T-151-00007 (WHC 1996a)
- Tank Dome Static Loading The weight of any portion of the sampling system installed on a tank riser will be limited by the static dome loading design limits specified in OSD-T-151-00007 (WHC 1996a)
- Tank Venutation System Pressure The sampling system will not over- or underpressurize the tanks based on the limits specified in OSD-T-151-00007 (WHC 1996a)
- Temperature Non-Aging Waste DST Waste The sampling system must be capable of handling waste with a miximum temperature of 82 °C (180 °F) as specified in WHC-SD-WM-OSR-016, LCO 3 2 2 (WHC 1996b)
- Shielding Cruteria The shielding design enteria in the Radiological Design Guide, Section 7.0 (WHC 1994), will be used to determine the shielding requirements for the sampling system Shielding shall be designed to limit the total whole body dose to less than 5 mSv per year

B3.1 CONSTRAINTS

Constraints are requirements imposed by an external organization. The design, operation and maintenance of the IWFST sampling system are affected by state and federal regulations, agreements, DOE Orders, and WHC requirements. In addition, there are guidelines and apecifications that set forth engineering requirements docrined necessary for safe design and construction of the sampling system. The requirements and guidelines presented in these orders,

regulations, codes, and agreements must be followed when designing and installing a sampling system. The format below establishes a hierarchy into the listed documents to be used during definitive the design stage of the IWFST upgrades.

- DOE Order 5480 28, Natural Phenomena Hazards Mitigation
- DOE Order 5820 2A, Radioactive Waste Management
- DOE Order 6430 1A, General Design Criteria
- WAC 173-303-640, Dangerous Waste Regulations Tank Systems
- WHC-IP-1043, WHC Occupational ALARA Program
- WHC-SD-GN-DGS-30011, Radiological Design Guide
- WHC-SD-TP-SARP-001, Sample Pig Transport System Safety Analysis Report for Packaging (Onsite)
- WHC-SD-WM-SARR-031, Safety Analysis for Push and Rotary Mode Core Sampling
- WHC-CM-2-14, Responsibilities and Procedures for all Hazardous Material Shipments
- WHC-CM-4-46, Safety Classification of Structures Systems and Components
- ASME B31 3, Process Popung

Other design constraints on the sampling system are as follows

- The system must be able to obtain the required samples through tank-top risers with diameters of between 10 and 30 cm (4 and 12 in nominal)
- Retrieved samples and associated hardware must fit in the existing Hanford Site bot cell facilities

B3.2 ASSUMPTIONS

The following assumptions have been made in the analysis of the IWFSTs sampling system options:

- Batch samples will be taken from a single riser on each IWFST. This is because the variability in supernatant composition is assumed to be very low.
- The number of samples required is based on a nominal estimate of 2 percent solids for the "well-mixed" and "not-mixed" waste scenarios. This corresponds to an average of 7 and 25 samples per batch, respectively. The average number of samples at a low estimate of 1 percent solids for the "well-mixed" waste scenario also was seven. However, the average number of samples at a high estimate of 5 percent solids for the "not-mixed" waste scenario was 29.
- The sample size is assumed to be no larger than 100 mL (See Section 3.4).
- It is assumed that the operating cost for sampling the waste has not changed significantly since FY 1995. This allows the use of the cost numbers from the Analytical Services Fiscal Year 1996 Multi-Year Program Plan (Spahr 1995) for the gtab and push mode sampling.
- The exposure detriment for the grab sampler is based on a total person-tem of exposure of 0.12 per sample.
- The total exposure detriment was determined using Equation (2) from the Cost/Benefit Analysis at Westinghouse Hanford Company (Brown 1992).

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B4.# ANALYSIS OF OPTIONS

This section documents the methodology used to generate the options and documents any options that were acrocated. In addition, this section determines how well an option satisfies each selection criteria.

B4.1 GENERATION OF OPTIONS

The options for the sampling system were developed by informal brainstorming and documented in meeting minutes (Galbraith 1996b). Only current sampling practices were considered. The options generated for the sampling system consist of the following: Grab Sampler, Core Sampler, and the Isolok Sampler. A description of each option is provided in Section B1.3.

B4.2 SCREENING OF OPTIONS

The options generated could be initially screened against the criteris of schedule. Option 3, the laolok Sampler, is highly unlikely to be able to meet the operational start date of October 1, 2000. However, there is a remote possibility that the operational date could be met with a very aggressive schedule. Therefore, each option is evaluated against the decision criteria and no options are screened.

B4.3 ANALYSIS OF SAMPLING OPTIONS

The analyses of the three sampling options have been summarized in a tabular form in Table B1-1. This section addresses how well each option satisfies the decision orderion. The main driver in selecting the preferred option will be based on cost. Therefore, this section provides a detailed description of the cost associated with each option.

B4.3.1 Cost

Table B4-1 shows the cost breakdowns for each option. The cost estimates are provided in Section B6.0. The costs are based on performing 7 samples per batch for the "well-mixed" waste scenario for both the nominal (2 percent solids) and low (1 percent solids) estimates. The costs for the "not-mixed" waste scenario are based on performing 25 and 29 samples per batch for both the nominal (2 percent solids) and high (5 percent solids) estimates, respectively. The current schedule is to send 12 batches to each contractor for immobilization (Certa 1996). The costs shown are for the nominal 2 percent solids estimate with the costs for the high estimate of 5 percent solids shown in parentheses.

Centa		ton 1 Samplet"		loe 2 Sempler	Option 3 "Isolok Sampler"		
	Wei⊢maxed [‡]	Not-mixed [®]	Well-maped* Not-maked*		Well-maned	Not-muxed	
Total capital	petal 50		\$3,750,000		\$11,250,000		
Operating			· · · · · · · · · · · ·				
Semplung prop	\$1,3	20,000	\$1,90	00,000	\$6	0,000	
Sampling	\$\$30,000	\$1,380,000 (\$1,560,000)	13,360,000	\$5,000,000 (\$5,360,000)	\$170,000	\$300,000 (\$350,000)	
Transportation	\$60,000	\$180,000 (\$200,000)	\$60,000	\$1,\$2,000 (\$200,000)	360.000	\$160,000 (\$200,000)	
Exposure detranse	\$\$30,800	\$1,650,000 (\$2,140,000)	\$0	\$0	50	\$0	
Total Operating	\$2,430,000	\$4,730,000 (\$5,220,000)	\$5,320,000	\$5,320,000 \$7,000(\$7,460,000)		2540,000 (2610,000)	
Andysi	· · · · · ·						
Loqued equilysis (\$4000/sample)	\$670,000	\$2,490,000 (\$2,780,000)	\$670,000	\$2,400,000 (\$2,780,000)	\$670,000	\$2,400,000 (\$2,780,000)	
Solid and begind (\$4500/sample)	\$760,000	\$2,710,000 (\$3,140,000)	\$760,000	\$2,710,000 (\$3,140,000)	\$760,000	\$2,710,000 (\$3,140,000)	
Core heading (\$1000/core)	-		\$176,000	\$600,000 (\$700,000)	•		
Total Analysis	\$1,430,000	\$5,110,000 (\$5,920,000)	\$1.600.000	\$5,710,000 (\$6,620,000)	\$1,430.000	\$3,110,000 (\$3,920,000)	
Total Cost	\$3,860,000	\$9,840,000 (\$11,140,000)	\$12,670,000	\$18,540,000 (\$19,\$30,000)	\$12,970,000	\$16,900,000 (\$17,760,000	

Table B4-1 Cost Summary of Phase I Sampling System Options

"The costs for the "weil-mixed" waste scenario are based on an average of seven samples per batch. The number of samples required is the same for both the nominal estimate of 2 percent solids and the low estimate of 1 percent solids.

"The costs for the "not-mixed" waste scenario are based on an average of 25 samples per batch for the nominal estimate of 2 percent solids. The cost values in parentheses are based on an average of 29 samples per batch for the high estimate of 5 percent solids.

"The sampling costs for the Isolok Sampler are assumed to be \$1,000/sample

⁴The exposure detriment for the grab sampler is based on a total person-rem of exposure of 0.12 per sample. Using this value in equation (2) of the *Cost/Benefit Analysis at Westinghouse Hanford Company*, WHC-SA-1533-FP, the total detriment per grab sample is \$3,080.

The operating costs for the grab and core sampler were based on the cost numbers from the Analytical Services Fiscal Year 1996 Multi-Year Program Plan (Spohr 1995) The ICF Kaiser Estimating Department developed a sampling module based on the unit rates from the program plan. The costs include prerequisites, work package preparation, planning, and sampling. The prerequisites include the costs for mutual work required prior to inspection activities for each tank, riser inspection, and job completion activities. The actual sampling costs include cost for mobilizing crew and equipment, preparing to sample, performing sampling including placing the sample in the transfer cask, transferring samples to the 222-S Laboratory, and demobilizing crew acid equipment.

Option 1 has a total cost of \$3,860,000 for the "well-maxed" waste scenario (\$9,840,000 for the "not-mixed" waste scenario) That is approximately \$160,000 (\$410,000) per batch per FWFST

Option 2 has a total cost of \$12,670.000 for the "well-mixed" waste scenario (\$18,540.000 for the "not-mixed" waste scenario). This includes the cost for a new core sampling truck of \$5,750,000 (Pickett 1996). The cost of the sampling and analysis is approximately \$290,000 (\$530,000) per batch per IWEST.

Option 3 has a total cost of \$12,970,000 for the "well-maxed" waste scenario (\$16,900,000 for the "not-mixed" waste scenario). This includes \$11,250,000 for the cost of the Grout Disposal Program sampling system with an escalation factor of 25 percent for current dollars (Carter 1989). The cost of the sampling and analysis is approximately \$70,000 (\$240,000) per batch per JWPST.

B4.3.2 Schedule

Option't does not require any construction and will have no unpact on project schedule or other milestones. Therefore, Option 1 ranks the highest against the schedule criteria

Option 2 requires procurement of a new core sampling truck or a skid mounted sampler. The procurement and operational approval of the sampler should have no impact on project schedule or other milestones. Therefore, Option 2 also ranks high against the schedule ontena

Option 3 requires the design and construction of a complex sampling facility. The facility consists of long-lead procarement ticms such as lead glass windows and remote manipulators. The implementation of this option may cause schedule delays since it is unlikely that Option 3 could be fabricated, procured, tested, approved for use, and ready for full field operation by June 1, 2002. For these reasons, Option 3 ranks poorly against the schedule criteria.

B4.3.3 Maintainability

Option 1 is a fairly simple system, but it does require a high degree of skill and experience by the operation personnel. The reliability and reparability of the system are very high with equipment failure unlikely to occur. Option 1 is the least complex to maintain and ranks the highest against the maintainability enteres.

Option 2 involves complex sampling equipment that requires specifically trained personnel to operate. The core sampling system has been reliable in other applications on the Hanford State Also, access to the equipment for repairs is readily available. However, high expertise is required by personnel to support repairs of the equipment. Option 2 does not rank as high as Option 1, but performs well against the maintainability criteria.

Option 3 performs the same as Option 2 and receives a good ranking against the maintainability criteria.

B4.3.4 Technical Maturity

All three options have been applied successfully on the Hanford Site, and, therefore, rank high against the criteria of technical maturity

B4.3.5 Performance Requirements

Option 1 can meet the performance requirements established. However, the grab sampler has some induced bias as discussed in Section 1.3.1. In addition, Option 1 has the highest radiation exposure and potential for contamination. Option 1 could have a problem meeting the sample and delivery times established due to its susceptibility to bad weather. Therefore, Option 1 receives the lowest ranking against the performance requirements criteria.

Option 2 meets all of the performance requirements established Option 2 also could have a problem meeting the sample and delivery time due to bad weather delays. This option performs better than Option 1 and receives a good ranking against the performance requirements entering

Option 3 meets all of the performance requirements established In addition, this option substantially reduces the radiation exposure and potential for personnel contamination. Also, my delays due to weather would be eliminated with this option. Therefore, Option 3 tanks the highest against the performance requirements criteria.

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B6.0 COST ESTIMATES

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TWRS CHARACTERIZATION SAMPLING MODULE

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Sampling Module General Notes and Instructions

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"Well-Mixed" Waste Scenario Estimate Summary (1 and 2 Percent Solids)

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"Well-Mixed" Waste Scenario WBS Report (1 and 2 Percent Solids)

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"Not-Mixed" Wasse Scenario Estimate Summary (2 Percent Solids)

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"Not-Mixed" Waste Scenano Work Breakdown Structure Report (2 Percent Solids)

HNF-SD-TWR-AGA-001 Revision 1

TWRS CHARACTERIZATION SAMPLING MODULE

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"Not-Mixed" Waste Scenario Estimate Summary (5 Percent Solids)

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APPENDIX C

VENTILATION ANALYSIS LETTER REPORT

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APPENDIX C

VENTILATION ANALYSIS LETTER REPORT

C1.0 INTRODUCTION

This report analyzes the existing AP Tank Farm ventilation system. In particular, the analysis determines the capability of the system to remove heat created by moter pumps that may be installed in tanks 241-AP-102 and 241-AP-104. These tasks have been designated as intermediate staging tanks for waste to be provided to a private vendor for vitrification. Knowing the permissible time of operation of the pumps that will not overheat the tanks is necessary.

C2.0 SUMMARY, CONCLUSION, AND RECOMMENDATIONS

Analysis of the existing tank farm ventilation system reveals that sufficient capacity is available to maintain waste conditions within operational safety requirements (OSR) limits with intermittent operation of mixer pumps (Heubach 1996). Limitation of the total heat load (decay heat + pimp heat) to the OSR decay heat maximum of 70,000 Btu/h will allow operation of a 300 hp mixer pump for 4 h/wk in a tank having decay heat of 50,000 Btu/h. The average bulk waste temperature would be approximately 106°F under these conditions. If the bulk temperature is allowed to reach the OSR lamit of 180°F the pump may be operated for 75 h/wk

The maximum rate of temperature use calculated for operation of the mixer pump for 75 h/wk is 3.7°F/day. This maximum will occur during initial pump operation in waste at low temperature. This result agrees with analysis performed by the W-211 project (Risck 1995), considering differences in pump power and waste characteristics.

If intermittent operation of mixer pumps (as defined) is adequate to achieve the degree of mixing required, no modification to the existing ventilation system is needed. However, due to uncertainties concerning future operations and classifications of the tank farms, the existing systems limits could be exceeded. The existing primary ventilation system limits would be exceeded under the following conditions.

- The total primary artflow rate is increased by more than 25 percent.
- 2 One (or more) of the AP tanks is added to the flagonable gas watchlist.
- 3 The safety classification of the ventilation system is upgraded

If the existing system is judged onsuitable (for whatever reason), studies have been performed that address changes to the systems. For information only, two of these studies are addressed in the following paragraphs

Modification of the existing system to increase capacity by 50 percent has been recommended (ICF KH 1995). The direct cost of the modification was estimated at \$221,000.

The W-314 project has provided a conceptual design (Briggs 1996) that recommands complete redesign and replacement of the primary ventilation system, based on the need to satisfy all three system limitations listed above. In addition, provisions are made for connection of modular equipment to control animonia or other toxic air pollutants that may be released in the future. The cost was estimated at \$3,400,000, which includes procurement and installation of new primary ventilation equipment, dramage upping, new seal pot and pit, and demolition and burial of the existing system. The W-314 project Tri-Party Agreement unlestone is June 2005.

C3.0 APPROACH / EVALUATION

Analysis of the existing AP Tank Farm ventilation system was performed to determine tank temperatures with variations in thermal loading caused by the addition of mixer pumps. A computer code developed for Project W-236 was used to model the waste tank heat removal systems

input to the program included

- I Mixer pump heat
- 2 Radionuclide decay heat
- 3 Inlet air temperature and humichty
- 4 Vapor suppression factor
- 5 Tank dimensions
- 6 Annulus flow conditions

Outputs from the program included

- Waste temperature and vapor pressure
- 2 Net evaporation
- 3 Primary auflow required
- 4 Vapor space temperature and humidity
- 5 Annulus exhaust temperature
- 6 Annulus heat loss
- 7 Conduction heat less

The results were graphically presented to show the relationship between radiolytic decay best and maxer pump heat that would satisfy two separate enterna

- Total tank heat load (decay + pump) ± 70,000 Btu/h
- 2 Average bulk waste temperature ≤ 180°F.

in each case the mixer pump heat allowed in combination with various decay heat values was equated as a percentage of 300 hp, the assumed mixer pump size. In this way the percentage of time allowed in full power was determined

C4.0 UNCERTAINTIES

- I The capacity requirement of the mixer pumps is not certain. Higher power pumps will require shorter operating periods.
- 2 The existing underground single wall vertilitation piping has not been inspected to determine remaining life
- 3 It is uncertain whether one or more of the AP tanks may be placed on the flammable gas watchlist. The ventilation system design would be affected.
- 4 It is uncertain whether operation of the mixer pumps may cause release of toxic vapors not currently identified

C5.0 REFERENCES

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- Rieck, C. A., 1995, Engineering Report Initial Tank Retrieval Systems Tank 241-SY-102 Waste Cooling Evaluation Project W-211, WHC-SD-W211-ER-002, Rev. 0, Westinghouse Hanford Company, Richland, Washington

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C60 CALCULATION

AP TANK FARM HEATING, VENTILATION, AND AIR CONDITIONING THERMAL ANALYSIS

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99.0 97.0 95.0 93.0 91.0 89.0	26.2 24.6 23.2 21.8 20.5 19.2 18.1	31094, 28083, 25085, 22102, 19137, 15195, 13280,	6429. 7862. 7297. 6733. 6173. 5617. 5070.	7.53 10.05 12.55 15.04 17.53 20.03	0.022 0.020 pp 0.019 0.017 0.016 0.014 0.013	119.78 162.09 261.64 365.59 505.65 702.40	97.2 95.0 92.8 90.7 88.5 86.4	56.9 55.3 55.5 54.7 53.6	96.8 94.6 92.9 91.0 89.2 87.3 85.4
97.0 95.0 93.0 91.0 89.0 87.0	26.2 24.6 23.2 21.8 20.5 19.2	31094, 28083, 25085, 22102, 19137, 15195, 13280,	6429. 7862. 7297. 6733. 6173. 5617. 5070.	7.53 10.05 12.55 15.04 17.53 20.03 22.56	0.022 0.020 µm 0.019 0.017 0.016 0.014 0.013 0.012	119.78 162.09 261.64 365.59 505.65 702.40 995.49	97.2 95.0 92.8 90.7 88.5 86.4 84.4	56.9 55.5 55.5 54.7 53.6 52.4 51.0	96.8 94.8 92.9 91.0 89.2 87.3

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70,000 STU/h Total

Inlet / Suppres ALC Flo Tank D' Tank Th	Air Teap stion Fa ny Rate lamater tickness	0000 8tu/ - 77 f ctor - 0 scf - 75 ft - 1 in - 1.25	Rela 45 Inle Anny Tank Soil	onuclide tive Humi t Air Tem lus Flow Height - Depth - tide Air T	dity = p at An Rate = 35 ft 10.5 fi	1433 scf A t	77 F	- 30	in .
Soln	Saln	Anna Tas	Conduct	Net	Exit	Regula	ed Ya	Exit	Ann. Ex.
Temp.	٧p	Loss	Loss	EVED	, Hum, R				Тевр
F	na H g	′Btu∕h	Btu/h)6H2O/h)pe/10	da scfm	F /	XRH	F
130.0	35.2	47817.	11327.	8.01	0.031	76.78	307.7	58.3	107.4
108.0	34.2	44760.	10762.	10.60	0.029	112.41	105.5	57.9	105.4
106.0	32.3	41710.	10196.	13,16	0.027	ps154.99	103.3	57.4	103.5
104.0	30.4	38666.	9629.	15.67	0.025	206.29	101.1	55.9	- 101.6
102.0	28.7	35630.	9062.	18.15	0.023	268.77	98.9	56.4	99,6
100.0	Ź7.O	- 32604.	B495.	20.50	0.021	345.89	96.8	55,7	97.7
98.0	25.4	29587.	7929.	Z3.0Z	0.019	442.71	94.6	55.0	95.6
96.0	23.9	26583.	7364.	25.42	0.018	566.90	92.4	54.2	93.9
94.0	22.5	23592.	680L.	27.80	0.016	730.67	90.3	53.2	92.0
\$2.D	21.1	20517.	6241.	30.18	0.015	954.69	85.1	52.0	90.1
90.0	19.8	17663.		32.55	0.014	1276.81	86.0	50.7	68.2
68.D	38.6	14733.	5141.	34.92	0.012	1773.81	84.0	49.0	86.4
86.0	17.5	11835.	4411.	37.24	0.011	2025.32	82.1	47.2	84.5

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390,00 BTU/h Total

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Inlet Suppre ALC F1 Temk D		 D scfm 75 ft 1 in 	Rela (S Inle Anny Tank Soil	lonuclide Itive Humi It Air Tem Ilus Flow Haight - Depth -	dity = 4 p at Annu Rate = 1 35 ft 10.5 ft	1433 scfm An	7 F	- 30 1	n
Concre	te Depth	1 = 1.25 f	ft Outs	ide Air 1	(emp - 7)	7 F			
Soln	Soln	Annolus	Conduct	Net	Exit	Regulare	d Vi (xit A	wn. Ex.
Temp.	¥р	Loss	Loss	Evap	Hu m Ra	Flow	Cor	1đ	Temp
F	ma Hg	8tu/h	8tu/h	16H2O/h	lbw/lbd:	scfill	- F /	YAH 👘	F
190.D	213.5	156554.	29343.	185,15	0.224 14	a 90.75	171.5	62.5	176.4
178.0	204.2	153424.	28775.	JB8.48	0.209		169.3	62.6	174.5
176.0	195.3	150295.	28208	190.74	0.195	224.22	167.1	62.6	172.5
174.0	186.7	147167.	27638.	192.95	0.183		164.9	62.7	170.5
172.0	178.4	344040.	27067.	195.12	0.172	263.17	162.7	52.7	166.5
170.0	170.4	· 140913.	26495.	197.23	0.161		160.5	62.8	166.5
168.0	162.7	137787.	Z59Z1.	199.29	0.151	308.64	158.2	62.8	164.5
166.0	155.3	134663.	25346.	201.29	0.141	334.23	156.0	62.9	162.5
164.0	148.2	131539.	Z4770.	203.23		361.98	153.7	62.9	160.6
162.0	141.3	128416.	24192.	205.12	0.124		151.5	6Z.9	158.6
160.0	134.6	125293.	23613.	206.94	0.116		149.2	62.9	156.6
156.0	128.5	122173.	23033.	206.70	0.108		146.9	62.9	154.6
156.0	122.4	119053.	2245].	210.40			144.7	62.9	152.6
154.0	115.6	115934.	Z1668.	Z12.04	0.094		142.4	62.0	150.6
152.0	111.0	112817.	21283.	213.60	0.068		140.1	62.0	148.7
150.0	105.7	109700.	20697.	215.10	0.062		137.7	62.7	146.1
148.0	100.6)06586.	20110.	216.52	0.077		135.4	62.5	144.T
146.0	95.7	103472.	19521.	217.87	0.071		133.1	62.4	142.7
144.0	91.0	100360.	18930.	Z19.14			130.7	62.2	140.7
142.0	B6.4	97250.	1833B.	220.34	0.062		128.4	62.0	138.8
140.0	82.1	9414].	17744.	221.44	0.057		126.0	61.7	136.8
138.0	78.0	91035.	17149.	222.46			123.6	61.4	134.8
136.0	74.0	87930.	16552.	223.38			121.2	61.0	132.9
134.0	70.3	84827.	15953.	224.21			118.8	60.6	130.9
132.0	66.5	81726.	15352.	224.92 225.53			116.4	60.1	178.9
130.0	63.2	78628.	14750.	223.93	0.036 1	636.60	114.0	59.5	126.9

390,000 BTU/h Total

Jnlet Suppre ALC Fi Tank D Tank T	Pump Heat = 320000 Btu/h Radionuclide Heat = 70000 Btu/h Inlet Air Temp = 77 F Relative Humidity = 40 % Suppression Factor = .45 Inlet Air Temp at Annulus = 77 F ALC Flow Rate = 0 scfm Annulus Flow Rate = 1433 scfm Tank Diameter = 75 ft Tank Height = 35 ft Ann Gap = 30 in Tank Thickness = 1 in Soil Ompth = 10.5 ft Concrute Cepth = 1.25 ft Outside Air Temp = 77 F										
Soln	Soln	Annulus	Conduct	Net	Exit	Regula	ed Kal	Exit A	nn. Ex.		
Temp.	٧Đ	Loss	Loss	Evap	Hum Ra		Ca		Temp		
·	📻 Hg	Btu/h	8tu/h	16H2O/h	164/164			S AH	i F T		
•			++- / -				• •	414.	•		
180.0_	213.5	156554.	29343.	186.16	0.224 2	190.75	121.5	62.5 62.5	176.4		
178.0	204.2	153424.	28776.	188.48	0.209	205.65	169.3	62.6	174.5		
)76.0	195.3	150295.	28208.	190.74	0.196	224.22	167.1	62.6	172.5		
274.0	186.7	147167.	27638.	192.95	0.183	242.95	164.9	62.7	170.5		
172.0)78.4	144040.	27067.	195.12	0.17Z	263.17	162.7	62.7	168.5		
170.0	170.4	· 140913.	26495.	197.23	0.161	295.01	160.5	62.8	166.5		
168.D	162.7	137787.	2592].	199.29	0.151	308.64	158.2	6Z.8	164.5		
166.0	155.3	134663.	25346.	201.29	0.141	334.23	156.0	62.9	162.5		
164.0	148.2	131539.	24770.	203.23	0.132	361,98	153.7	62.9	160.6		
362.0	141.3	128416.	24192.	205.12	6.124	392.12	151.5	62.9	158.6		
160.0	134.8	125293.	23613.	206.94	0.116	424.90	49.2	62.9	156.6		
358.0	128.5	122173.	23033.	208.70	0.108	460.53	146.9	62.9	154.6		
156.0	122.4	119053.	22451.	230.40	0, 101	499.63	144.7	62.9	152.6		
154.0	116.6	115934.	21868.	232.04	0.094	\$42.29	142.4	52.8	150.6		
152.0	111.0	112817.	21283.	213.60	0.088	569.09	140.1	62.0	148.7		
150.0	105.7	109700.	20697.	215.10	0.082	640.53	137.7	62.7	145.7		
148.D	100.6	106586.	20130.	216.52	0.077	697.25	135.4	62.5	144.7		
146.0	95.7	103472.	19521.	217.67	0.071	759.99	133.1	62.4	142.7		
144.0	91.0	100360.	18930.	219.14	0.055	829.61	130.7	6Z.2	140.7		
142.0	86.4	97250.	18338.	220.34	0.062	907.18	128.4	62.0	138.8		
140.0	82.1	94141.	17744.	221.44	0.057	993.97	126.0	61.7	136.8		
138.0	78.0	91035.	17149.	222.46		1091.55	123.6	61.4	134.5		
136.0	74.0	87930.	16552.	223.38		1201.83	121.2	61.0	132.9		
134.0	70.3	84827.	15953.	224.21		1327.26	118.8	60.6	130.9		
132.0	65.6	81726.	15352.	224.92		1470.87	116.4	60.1	128.9		
130.0	63.Z	78628.	14750.	225.53		1636.60	114.0	59.5	126.9		

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APPENDIX D

WASTE TRANSFER SYSTEM ENGINEERING REPORT

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APPENDIX D

WASTE TRANSFER SYSTEM ENGINEERING REPORT

D1.0 INTRODUCTION

DL1 BACKGROUND

Cleanup of the 177 underground hazardous waste storage tanks is part of the current Hanford Site mission. The U.S. Department of Energy (DOE) is changing the way that business is being performed at the Hanford Site. The DOE's new strategy for treatment of the Hanford Site tank wastes encompasses the use of privatization contractors (Grumbly 1996)]. Under this concept, the DOE would privatize the treatment of the Hanford Site tank wastes, including the design, paranitting, construction, operation, decontamination, and decommissioning of equipment and facilities.

The privatization contractors will receive payment for low-activity waste (LAW) treatment services based upon the quantity of sodium incorporated into the immobilized LAW, consistent with the provisions of the Request For Proposal (RFP) (DDE-RL 1996). To determine accurately the quantity of sodium transferred to the Privatization Contractors for the treatment and to comply with the transfer conditions established in the RFP, tanks 241-AP-102 and 241-AP-104 will be used as intermediate waste feed staging tanks (IWFSTs) Certa et al. (1996).

The disposal program assumes that one Privatization Contractor will process all of the high-level waste (HLW) oxides from tanks 241-AZ-101, 241-AZ-102, and 241-AY-102 (that will be a mix of 241-AY-102 and 241-C-106 tank contents). The washed sludges will be transferred from these three aging waste tanks to the privatization contractor's High-Level Processing Facility. The privatization contractor will provide a tank for receipt of the washed sludger; an existing double-shelled tank (DST) will not be used for this function.

D1.2 ASSUMPTIONS

The following assumptions have been made in the analysis of the LWPSTs waste transfer system options:

- Tanks 241-AP-106 and 241-AP-108 will be used by the privatization contractors for receipt and lag storage of LAW feed solution (DOE-R2, 1996).
- Tanks 241-AP-102 and 241-AP-104 will be used as the [WFSTs (Certa et al. 1996).
- The waste feed solution will be transferred via the modified SN-650 transfer line.

- The HLW transfer line will drain from the SN-650 to the privatization contractor's High-Level Processing Facility. The tre-in point with the contractor will be determined upon completion of contract negotiations.
- * The piping design temperature is $93^{\circ}C$ (200 °F) and the piping design pressure is 2.8 MPa (400 psig)
- The shielding requirements will be satisfied with 0.9 m (3.6) of soil and 0.6 m (2.6) thek cover blocks
- Phase I privatization will be finished June 2011.
- The HLW will not be stored in tanks 241-AP-102 or 241-AP-104

D2.0 SUMMARY

The objective of this report was to compare options for transferring LAW via the SN-650 line to tank 241-AP-102 or 241-AP-104 Tank and transferring HLW via the SN-650 line directly to the privatization contractor's High-Level Processing Facility

Option 1 installed a new valve pit north of tank 241-AP-102 with a jumper arrangement to provide the required routing capabilities. Option 2 looked at using the existing 241-AP-02D pump pit to provide the necessary jumper arrangement. Finally, Option 3 looked at installing a new process pit on tank 241-AP-104 similar to the 241-AP-02D pump pit.

The analyses of the three options have been summarized in a tabular form in Table D2-1. The enteriou for determining the best option was based primarily on cost and whether the option met the topography requirements in Certa et al. (1996).

Decision entena	Option 1 New valve pit	Option 2 241-AP-02D pump pit	Option 3 New pit on 241-AP-104	
Total cost	\$2,800,000	000,000,12	\$2,750,000	
Leak detection	eak detection element (LDE) for high- level waste (HLW) line and the transfer pumps in tanks 241-AP-102 and 241-AP-104		Separate LDE for HLW line and the transfer pumps in tanks 241-AP-102 and 241-AP-104	
Meets alternative K topography requirements	Yes	No	Yes	
Mainteinability	Easy access	Tight access	Easy access	
Mosts required hydraulic charactenstics	Yes	Yes	Yes	

Table D2-1 Matrix of Transfer System Options by Decision Criteria

Options 1 and 3 are almost identical in each of the decision criteria used. All of the requirements of the transfer system, including the topography are met; and the costs are similar However, Option 3 is the preferred option because the new pit on tank 241-AP-104 would allow access to a 30 5-cn (12-in) riser. This pit could be used in the future for m-tank equipment where as the pit in Option 1 could only be used for the scope of Phase 1 privalization.

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D3.0 PURPOSE

The purpose of this report is to define the design requirements for implementing upgrades to the SN-650 transfer line (Galbrauh et al. 1996). This includes the requirements for theing into an existing line, installing a new valve pit, treing roto an existing DST riser, and routing new waste transfer and drain lines.

Three options were considered for transferring LAW via the SN-650 line to the tanks 241-AP-102 or 241-AP-104 and transferring HLW via the SN-650 line directly to the privanzation contractor's High-Level Processing Facility. These options are presented to allow the best choice for the final design. Option 1 is the original requested method, while Options 2 and 3 were considered for possible cost savings. This engineering report shows piping plans, jumper arrangements, piping and instrument diagrams (P&ID), and hydraulic diagrams for the system options. In addition, cost estimates for the three different options are included.

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D4.0 DESCRIPTION

D4.1 TRANSFER LINE FUNCTIONS AND REQUIREMENTS

D4.1.1 Safety Function

The transfer line shall be capable of confiring tank waste during transfers. The design, construction, and operation of the transfer lines shall establish multiple barners that protect public and facility personnel from hazards associated with the use of radioactive and other hazardous materials. Releases of hazardous materials postulated to occur from design basis accidents (DBAs) shall be limited by designing the transfer lines so at least one confinement system remains fully functional following any credible DBA (i.e., unfiltered/minutgated releases of hazardous levels of such materials shall not be allowed following such accidents). The transfer line design shall provide attenuation features for postulated accidents (up to and ancluding DBAs) that preclude offsite releases that would cause doese more than the DOE 5400 series limits for public exposure. In addition, to the extent practical, such releases shall be maintained as low as reasonably achievable (ALARA). Protection shall be provided for normal operation and for those ascidents that can be anticipated as occurring during the facility lifetime such as radioactive material spills.

D4.1.2 Operational Practico

Gravity drained piping shall be installed with a slope that results in a inquid velocity of at least 0.6 m/s (2 ft/s) at the average rate of flow (WHC 1994). The transfer lines shall have sufficient carrying capacity and be configured to meet the flow and hydrawhe requirements. The piping shall be sized to handle 150 percent of the maximum design liquid waste flow rate (WHC 1994).

The waste pumpsiolity rule requires that the Reynolds number be greater than 20,000 with volume percent less than 30 percent solids for non-routine transfers (Fowler 1995b). For the waste properties evaluated in Galbrauth et al. (1996) this would require a minimum velocity of 1.7 m/s (5.6 ft/s) in a 7.6-cm (3-in.) transfer line and around 2.6 m/s (5.5 ft/s) in a 5.08-cm (2-in.) transfer line.

Pollowing a waste transfer through a transfer pipeline, the waste generator shall flush the transfer pipeline with a volume of water that is equal to the transfer pipeline volume (Galbrath et al 1996)

The specific gravity of the solution must be less than 1.41 SpG. If the specific gravity is greater than 1.41, then a detailed technical evaluation of the potential for flammable gas accumulation in the commingled waste shall be performed (Galbraith et al. 1995 and Fowler 1995a).

D4.3.3 Physical Characteristics

The transfer lines shall be underground double-walled pipe (i.e., primary pipe within an encasement pipe). The transfer lines shall be supported and protected against physical damage and excessive stress due to settlement, vibration, expansion or contraction. The transfer lines shall terminate at nozzles in the new transfer valve pit.

D4.1.4 Reliability

The design life of the transfer lines shall be 25 years (Fowler 1995a) The system design shall provide for redundancy or diversity of components to most reliability requirements Specifically, the transfer lines shall be designed such that at least one confinement system remains fully functional following any credible DBA

D4.1.5 Maintainabulity

The design shall provide for routine maintenance and repur or replacement of equipment subject to failure. The transfer lines shall be designed to allow inspection, maintenance, and testing to ensure their continued functioning and readiness for operation. The design of equipment that must be located within confinement systems shall allow for in-place maintenance or replacement. The capability shall be provided for the maintenance of contaminated equipment that cannot be repaired in place. This capability shall include the necessary provisions for confinement, ventilation, and waste control. The design of process equipment shall include features to reduce self-contamination of equipment, piping, and confinement areas

D4.2 PIPING CONSTRAINTS

D4.2.1 Design Requirements

Priping outside of facilities shall be located beneath all other piping and electrical cables (Fowler 1995a) Encasement (secondary containment) piping shall have connections to introduce dry at or nitrogen for piterimatic pressure tests (Fowler 1995a). The transfer lines shall be of fully welded construction. Taps for instrumentation, test connections, and similar small diameter pipe shall be made on top of the pipe (Fowler 1995a). All components of the transfer line expected to be in contact with strong acids or caustics should be conosion resistant (c g , fined with suitable synthetic resin materials or made of stanless steel that is not reactive with the wastes). The use of traps in radioactive liquid waste lines should be avoided and the piping should be designed to minimize entrapment and buildup of solids in the system (Fowler 1995a).

D4.2.2 Design Loads

The encasement pipe shall be designed to withstand system pressure of 2.8 MPa (400 psig) The secondary pipe shall be evaluated for the design temperature of the primary pipe unless lower temperatures are justified by thermal analysis. The primary and secondary pipes shall be designed for dead loads associated with the self-weight of the pipes and the soil overburden as applicable. The transfer lines shall be designed for an American Association of State Highway Transportation Officials (AASHTO) H20-44 wheel loading, and American Railway Engineers Association (AREA) Cooper E80 rail loading at rail crossings, and a 100,000 lb crane loading in the tank farm area (Wagenblast 1995). Primary and secondary pipes shall be designed for the interaction and transfer of loads between the primary and secondary pipes at the reaction support points of the primary pipes

The transfer lines shall be designed for the applicable response spectra of GCLOAD-01 The 5 percent damping response spectrum shall be used when dynamic evaluations are performed. Pipes exposed to soil shall be designed for sensitiv induced stresses resulting from sensitiv waves. Peak ground velocity shall be calculated to GCLOAD-01. Sensitiv wave velocities for the determination of sensitiv shall not be less than 610 m/s (2,000 ft/s). The effect of the sensitiv and permanent settlements of the structure to which these pipes are anchored shall be considered. The potential for ground-failure phenomena such as soil inquefaction, and stides, gross surface softlement, collapse of voids, and instability of soil slopes shall be considered in the design of underground process pipes.

D4.2.3 Burnet

Buried piping must be provided with a backfill material that is a noncorrosive, porous, homogeneous substance that is carefully installed so that the backfill is placed completely around the piping and compacted to ensure that the piping is fully and uniformly supported

D4.2.4 Cothodie Protection

The dasign of cathodic protection for the new transfer lines shall use the practices described in NACE Standard RP-02-85 as guidelines in providing corrosion protection. The cathodic protection system shall be installed at the same time as the piping system. Connections at joints shall ensure electrical continuity except where insulating joints are installed. Instituting joints shall be used to electrically isolate protected sections from non-protected sections and from neighboring metallic structures. Test stations shall be provided at sufficient intervals along the piping system to evaluate the performance of the cathodic protection system after installation. Test leads shall be terminated in test blocks housed in aboveground cast metal boxes with removable covers. These test stations shall be located in areas not exposed to traffic or grass mowers and properly identified.

D4.3 VALVE PIT FUNCTIONS AND REQUIREMENTS

D4.3.1 Valve Pit

The valve pit shall be constructed of reinforced concrete and designed in accordance with ACI-349. The valve pit shall be painted with a protective coating or lined with 304L stainless steel. The liner shall be designed to confine contamination in accordance with WAC-173-303-640.

D4.3.2 Valve Pit Coatings

Valve pits shall have coatings to ensure the integrity of containment and ease of decontamination. Access penetrations shall be scaled to provide containment. The protective coating is specified as to installation location, corrosion resistance, substrate cleaning and preparation, method of application, and other parameters. This is in direct compliance with DOE Order 6430.1A that states that where radioactive materials are hundled and contamination can occur, washable or strippable finishes shall be used on walls and floors. The primary functional interface for the pit coatings is to protect the valve pit that establishes a secondary containment required (or the transfer lines and connections. The coatings enable the secondary containment due to physical contact with the waste (40 CFR Part 265 and 40 CFR Part 280).

The protective costing shall have the following physical characteristics:

- Continuous. The layer of protective coating shall not contain any holes, seams or defects. Application of the coating shall be done without any breaks in the application process that would lead to a seam between set and uncured material. Continuity requirements shall include coating which is applied to items penetrating into the pit.
- Application Height. Protective costing shall be applied to a level equal to or above where the pozzles enter the pit.
- Corrosion Resistance. The protective coating shall be resistant to the standard decontamination solutions listed in ASTM D-3912, Figure 1. Chemical resistance testing shall be in accordance with ASTM D-3912 or an equivalent standard. Test samples shall be prepared in accordance with ASTM D-5139. Exposure of the coating to the service conditions shall not result in pitting, soughing, peeling, or any other damage.

 Decontamination A principal criterion of any coating is the relative case with which radioactive contamination can be removed, typically measured by the decontamination factor (DF) A costing that demonstrates a minimum DF of 50 as detarmined by ASTM D-4256. Method A The DF after an initial wash with 120 to 160 pts chemical agent sprays should be around 20

D4.3.3 Valve Pit Leak Detection

Valve pit sumps shall have installed leak detectors. Leak detection instrumentation is required to detect leaks and display leak detection status information (WAC-173-303, 40 CFR 265, DOE 5820 2A). Leak detection systems that will be used to alert operators of leaks or to activate automatic shut-off or alarm systems shall be capable of detecting a minimum leak of 3 gallons per hour at 10 pounds per square unch (psig) line pressure within one bour (WAC-173-303, 30).

The leak detection system shall be capable of detecting the failure of the primary containment structure or the presence of any release of dangerous waste or accumulated liquid in the accordary system within 24 hours, or at earliest practical time if the cousting detection technology or site characteristics will not allow detection of a release within 24 hours (WAC-173, Section 640, 4 and 40 CFR 265)

The leak detection system shall be capable of detecting the leak rate with a probability of detection of 0.95 and a probability of false alarms of 0.05. The systems shall be designed to allow for periodic calibration and ease of access for repair and replacement of components (WHC 1996). The design of equipment shall incorporate the objectives of efficient maintainability. The surveillance, testing, and maintenance of a system and its restoration to operational effectiveness shall be achieved at minimum life-cycle cost with a minimum level of support services. UCRL 15673 shall be considered for system design (DOE 6430 1A 1300-12 4 10). The system shall provide capability for remote maintenance and other appropriate techniques to maintain personnel radiation exposure ALARA (DOE 5820 2A Chapter 1, 3 $\alpha(2)(g)$).

D4.3.4 Valve Pit Cover Blocks

The pit cover blocks shall form part of the secondary confinement barner to the valve pit and are required to confine any potential release of hazardous material from the primary confinement (DOE 6430 1A). They shall provide protection from an ingress of foreign matter into the pit enclosure. The pit cover blocks shall be designed as an integral part of the pit structure to gain access to equipment within the pit for operational of maintenance purposes (DOE 6430 1A). They shall be designed to shield operators/maintainers from radiation sources within the pit (DOE 6430 1A). The integrity of the accordary confinement shall be maintainable through all normal operations, anticipated operational occurrences and for the DBAs they are

required to withstand (DOE 6430 1A) The cover blocks shall be equipped with penetizations to facilitate operation and/or maintenance of valves. They shall be equipped with legends to indicate routing options and valve positions. The cover blocks shall be equipped with lifting bails to facilitate removal of the block by crane. The cover blocks shall have a special protective costing to prevent the migration of contamination and improve the ease of decontamination.

D4.4 PROCESS PIPING MODIFICATIONS

Several decision enterta were used to evaluate the three different options to transfer waste. The cost of the modifications, upgrades, and installations was estimated based on current costs. Maintainability was based on ease of access and spare room in the pit. The ability of the lines to drain by gravity to the tank for LAW or to the private contractor for HLW was a condition of design acceptance. The ability to perform simultaneous transfers of LAW from tanks 241-AP-102 or 241-AP-104 and HLW from SN-650 to the private contractor was designed as a part of the physical characteristics. Leak detectors are required for each pit, however, for two options the leak detectors are shared with another system in the pit.

Excavation costs are based on using the guzzler to dig the trenches in the 241-AP Tank Farm These costs for using the guzzler are estimated from those ancurred by Project W-151 The estimate for the HLW transfer line is based on terminating the line 10 feet outside the 241-AP Tank Farm fence. It is assumed that the rest of the line will be the responsibility of the HLW privatization contractor. The proposed routing of the HLW transfer line from the valve pit to the privatization contractor is shown in Section 7.0, Figure D7-17

D4.4.1 Option One

Oppon 1 would locate a new valve pri on the SN-650 line prior to it feeding into tank. 241-AP-102 Tank A plan view and a P&ID for Option 1 are shown in Section 7.0, Figures D7-1 and D7-2, respectively. The new valve pit would be located on the northeast edge of tank 241-AP-102 near riser 24 (10 2-cm (4-in] riser) In addition, a new 7 6-cm (3-in) transfer bite would be routed from the new valve pit to stack 241-AP-104 A second new 7.6-cm (3-in.). transfer line would be routed from the new valve pit to the HLW privatization contractor Also, a new 5 1-cm (2-m) drain line from the valve pit floor drain would be routed to a spare riser on tank 241-AP-102 The number arrangement in the new valve pit would allow LAW to be sent to either tank 241-AP-102 or 241-AP-104 and allow HLW to be could directly to the HLW privatization contractor. The jumper arrangement for Option 1 is shown in Section 7.9, Figure D7-3, while hydraulic diagrams are shown in Figures D7-4 through D7-5. Option 1 is identical to Alternative K as presented in Certa et al. (1995). One of the key design features and process requirements with Alternative K is that HLW can be transferred to the privatization contractor's RLW Processing Facility at the same time that LAW is being transferred from the [WPSTs to either tank 241-AP-106 or 241-AP-108 This simultaneous transfer is possible since the two transfer routes do not abare any common leak detectors and, therefore, the routes can be

isolated in regards to the master pump shutdown system. The total construction cost for the work included in Option 1 is approximately \$2,800,000. This includes an estimated cost of excavation of \$432,000 using the Guzzler and a fabrication cost for the new valve pit of \$350,000.

D4.4.2 Option Two

Option 2 would use the existing 241-AP-02D pump plt and alleviate the need to build a new valve pit. A plan view and a P&ID for Option 2 are shown in Section 7.0. Figures D7-7 and D7-8, respectively. The existing nozzles in the pump pit are all 2 in. and, therefore, all the iumpers would need to be 2 in, and the new transfer lines would need to be reduced before entering the pit. This would create additional head losses compared with that calculated in Galbraith et al. (1996). In addition, to provide all of the routing requirements, the jumper arrangement would be very congested and several connections would need to be fitting-to-fitting. This would not be a desirable arrangement when design tolerances of ±1/32 of an inch are required. The jumper arrangement for Option 2 is shown in Figure D7-9, while hydraulic diagrams are shown in Figures D7-10 and D7-11. Finally, Option 2 does not meet the topography requirements of Alternative K. The transfer pump for tank 241-AP-102 would share a leak detector with the HLW routing. This would cause the master pump shutdown system to stop both transfers if the leak detector was alarmed. The cost estimate for this option includes returning riser 24 on tank 241-AP-102 to a spare riser condition. This riser was where the existing SN-650 transfer line entered the tank. This is the least expensive of the three options with a total construction cost of approximately \$1,900,000. This includes an estimated cost of excavation of \$354,000 using the Guzzler.

D4.4.3 Option Three

Option 3 would locate a new process pit on tank 241-AP-104 similar to the 241-AP-02D pump pit. A plan view and a P&ID for Option 3 are shown in Section 7.0, Figures D7-12 and D7-13, respectively. Since this would be a new process pit, all of the problems mentioned in Option 2 would be eliminated. Primarily, the new pit would have a wall that would separate the 12-in, riser for a transfer pamp from the valve arrangement to support the Phase 1 cansfer of LAW and HLW. Each section of the pit would have a separate leak detector to meet the requirements of Alternative K and allow simultaneous transfers. The jumper arrangement for Option 3 is shown in Figure D7-16, while hydraulic diagrams are shown in Figures D7-15 and D7-16. The total construction cost for the work included in Option 3 is approximately 22,750,000. The attached cost estimate was based on fabricating a pit similar in size to the 241-AP-02D pump pit. However, this cost was increased by a rough estimate of \$526,000 to fabricate a larger process pit with a separation wall.

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D5.0 CONCLUSIONS AND RECOMMENDATIONS

Option 1 has the benefit of adequate room in which to install new equipment. This also translates into room for maintenance and repair work within the pit in the future. Also, the value pit would be new and uncontaminated. However, this option would add a new structure within the 6 1-m (20-ft) exclusion zone of the tank. In addition, the only purpose of the new value pit would be to support Phase I privatization. This option meets the topography requirements to allow for simultaneous transfers as discussed in Certa et al. (1996). The total construction cost of Option, 1 is approximately \$2,800,000.

Option 2 would require a scan of the pit walls before core drilling to find the rebar and other possible obstructions. It will allow less flexibility for design modifications. In addition, the 7.6-cm (3-in) transfer lines would have to be reduced to 5.1 cm (2-in). Also, the fabrication and installation of the required jumper arrangement would be very difficult as it is fitting-to-fitting, to fit in the pit. The pump pit will require decontamination before construction work inside the pit can start. In addition, the jumper arrangement would make the pump pit very congested, making maintenance and repair work more challenging. Finally, having the tank 241-AP-102 transfer pump and the HLW rowing in the same pit would mean that they use the same leak detection system. Therefore, this option does not meet the topography requirements to allow for simultaneous transfers. The total construction cost of Option 2 is approximately \$1,900,000.

Option 3 is the preferred choice. This is based on the need to build a pump pit for tank 241-AP-104 (see Appendix A), the pit could easily be ealarged to accommodate the transfer line valves and jumpers. By combining tasks, construction costs could be reduced over building a new valve pit (Option 1). It addition, adequate room for maintenance and repair work can be accorporated into the design of the new pump pit instead of using a crowded existing pump pit (Option 2). It also provides a cleaner routing of the transfer lines. A wall separating the HLW routing and the transfer pump meets the topography requirements of Alternative K. Finally, the new pit in Option 3 could be used in the future for in-tank equipment after the completion of Phase I privatization. The total construction cost of Option 3 is approximately \$2,750,000.

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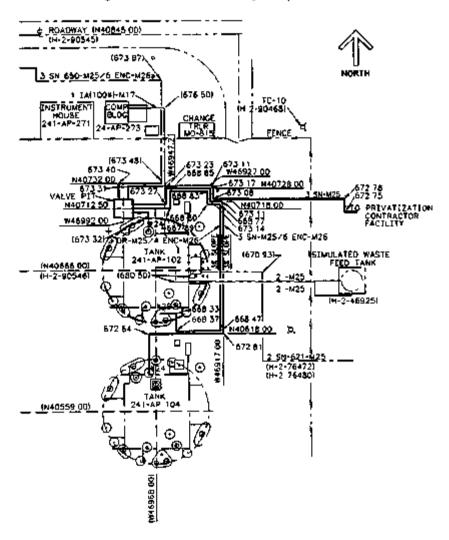
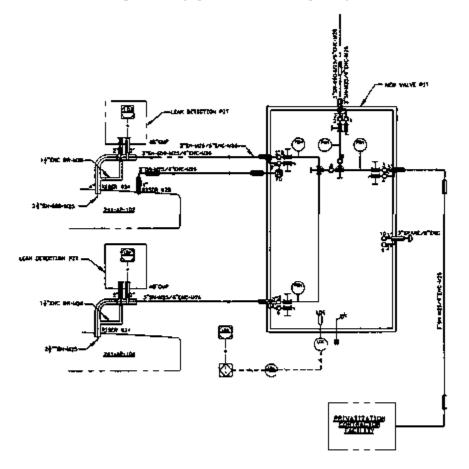
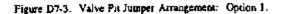
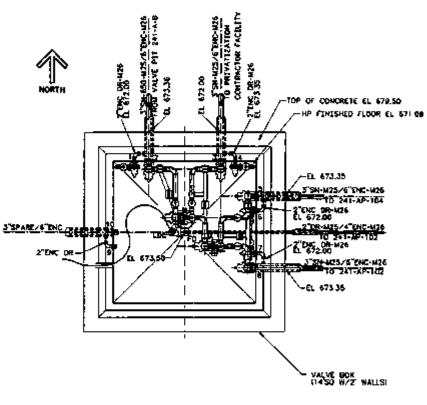


Figure D7-1 AP Tank Farm Site Layout Option 1

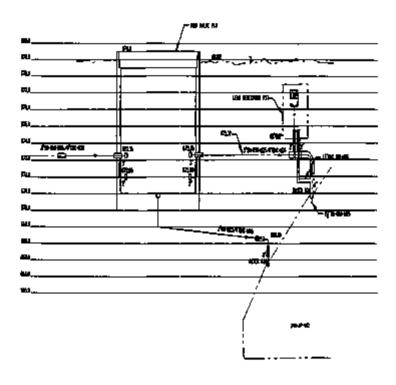


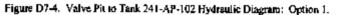






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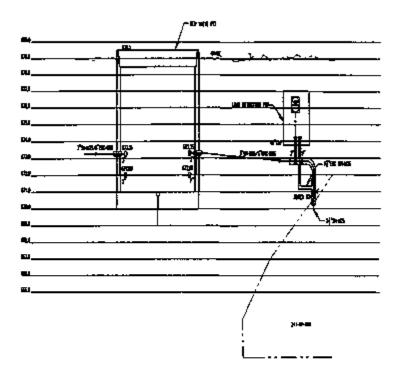
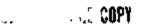


Figure D7-5. Valve Pit to Tank 241-AP-104 Hydraulic Diagram: Option 1.



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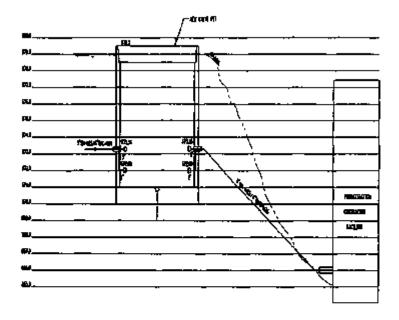


Figure D7-6. High-Level Waste Transfer Line Hydraulic Diagram: Option 1.

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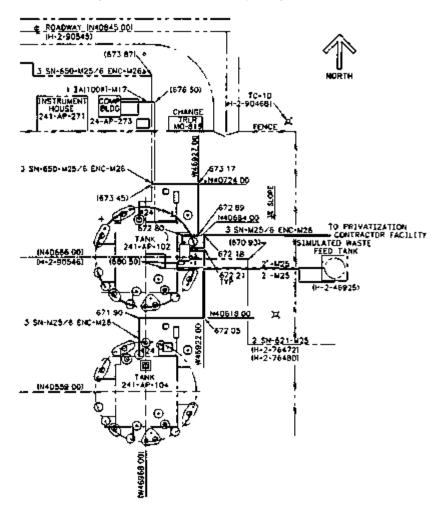
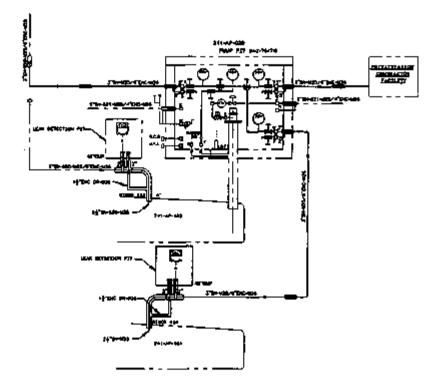
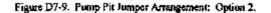
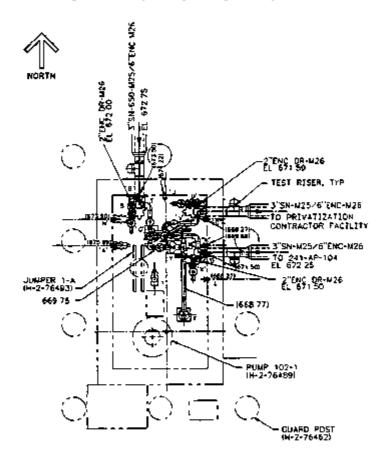


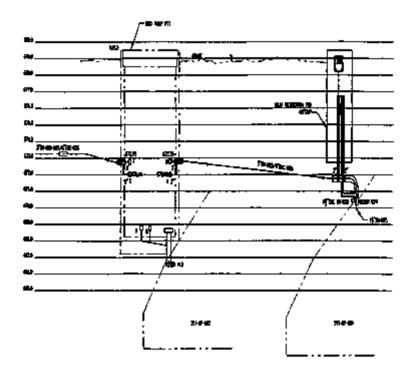
Figure D7-7 AP Tank Farm Site Layout Option 2

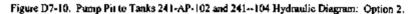




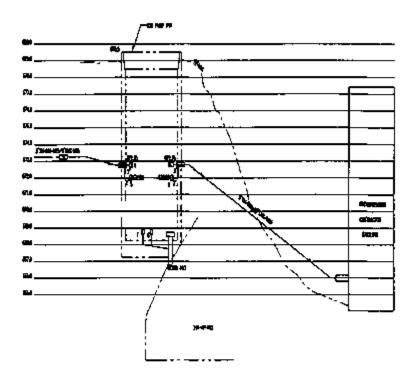








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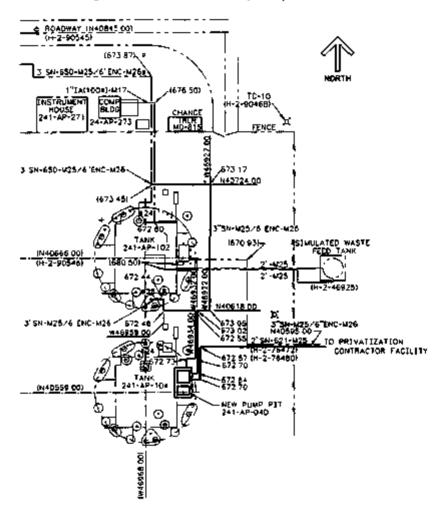
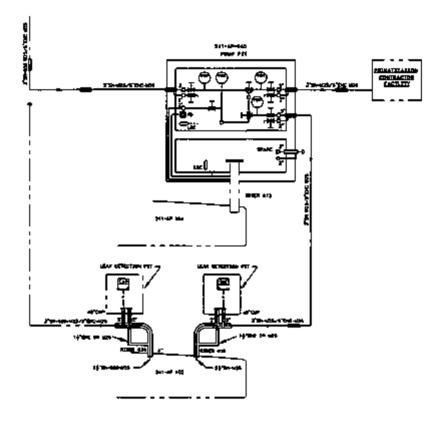


Figure D7-12 AP Tank Farm Site Layout: Option 3.





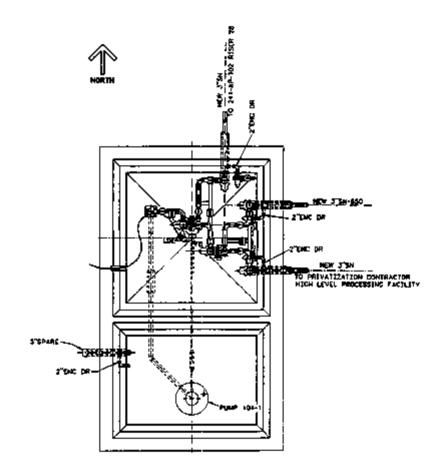


Figure D7-14. New Process Pit Jumper Arrangement: Option 3.

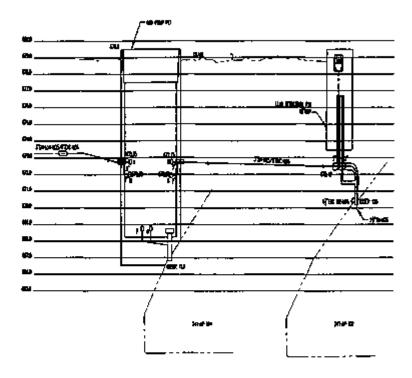


Figure D7-15. New Process Pit to Tanks 241-AP-102 and 241-AP-104 Hydraulis Diagram: Option 3.

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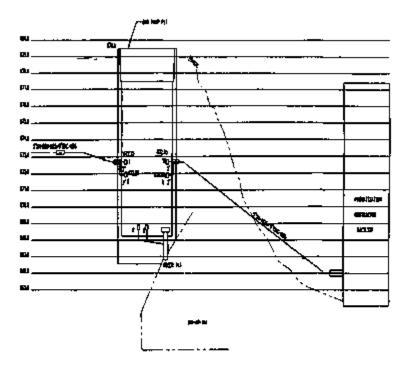
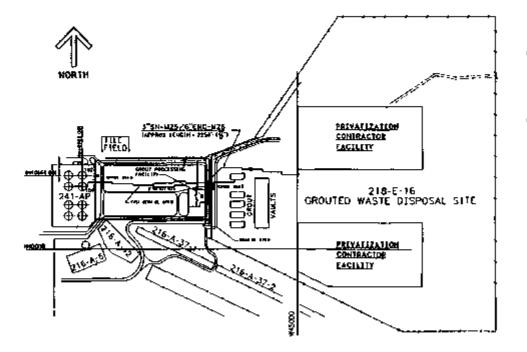


Figure D7-16. High-Level Waste Transfer Line Hydraulic Diagram: Option 3.

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D9.1 OPTION 1 COST ESTIMATE



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	CLOSEL PROJECT MONT & COLORATION	5640e	•	36080	4.46		54840	29	11200	47188
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HNF-SD-TWR-AGA-001 Revision 1

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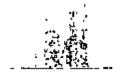
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ICT EATSER DADFORD VESTINGEOUSE DADFOED CONFACT 108 NO. 247487 FLLE 10. 24135403

** IEST · JUTERREFITE ESCIENCIES ** PRAIE I PEIVATIZATION ALTERMATIVES APTEZ & 184 BARRANES ALT #2 STUDY ESTIMATE POL_RUS - CONTINUERER ARALTEDE BASIN POLET

PARE 7 OF 4 BATE 48/72/96 ...

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CEPERENCE :	EFTIMATE BABIN SOULT	state 3 st 8
	COLL COPE ACCOUNT SUMMARY	Plat 3 of A

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BEALER & HANJGERERT

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INTE THE PEOPLET MARAGEMENT A 205 CONTINUER WAT APPLIED TO MUE PAGARET MANT IT ALLOW FOR ADDED FUEL DWE ADDITIONAL WER CLEDEL DECOMENTATION REQUISED TO SUPPORT THIS WEGADE ON ART DECAID IN RESEDUCE.

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APERAGE CONSTRUCTION COPIEDRES 395



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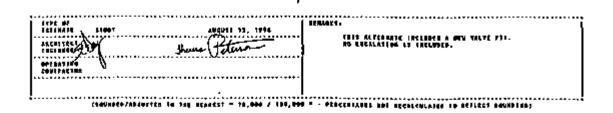
D8.2 OPTION 2 COST ESTIMATE

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HNF-SD-TWR-AGA-001 Revision 1

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SCT EAI3GE MAMFURD Weitingnung gaurube Company Jom M., Párgát File 40. 25135683	** 1857 - INTERCOINESS NATION ** Prais I Privalization Rivernations for the Wreader of the source of the top National Statistics (Sumany					P4CE 2 08 4 hare 46/93/96 93,93:93 h1 thr/Lab/Lab/pex						
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HNF-SD-TWR-AGA-001 Revision 1

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ICC CALSER RARGED WETTINGS WEST RESPOND CONTACT 100 00. PAPADT CILE NO. 16181045

** JEST · INTERACTIVE ESTIMATION ** PRASE I PRIVATIONALINE ACCEMBATINES APORt & 196 ETROT BETIMATE

**** 3 ** 8 AA12 84/13/96 Shf /Las/ball ġТ.

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1. BOCONGERS AND DERMINES

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2, MATERIAL PRICES ----

UNIT COSTS ACPECTEDI CURTENT PRICES POR APLEITICO MATERIAL.

3. LABON MATCH

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- A.) (CF-EN ADURLY MALES ARE DADED ON THE 1995 FISCAL LEAR DURDET LIGUIDATION BATCH AS 1550ED BY ERO FINANCE (CEPTELITYE 43-80-94), SEE ALSA THE FE 1996 PLANNING NATES * (NEGOTA BAREZONZ), 4.) WE BOWLLT NATEE ANG DASED UPOD THE FT 1996 PLANNING NATES * (NEGOTA BAREZONT).

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- C.) MASE CALTI BATES ARE AS LIQUED BT REM FINDBER (CFFECTIVE 10-01-75). BATES INCLUDE FALMARE BEBEFLIS, LANDR INFUMAMEE, TATES AND INAVEL WHER APPELEGABLE, PER MADROMM AITH SINGLUZATION MANDEMENT, RPSARLE A (CFFECTIVE 40-04). ALTON ANTI A C LEE MANFAND REFT ACCOLLING AND AND AND AND AND AND AND COLLING ANTICAL A (CFFECTIVE 40-04). AT 1944 PLANTING ANTICL.

I. GENERAL REQUIREMENTE/TECHDICAL SERVICES/AVER BRADE

- A.) OWNIE CONTINUETION FONCES REATEAL PERSONNERTS, ISCANICAS DERVICES AND COLFT OVERHEAS CASES AND INCLUDED AS A Contribute proceeding of the second of the \$1)68 (3 \$47,55,55 (8 145 "PROF/061" COLUMN OF 185 \$31,0474 \$614.
- 5. ESCALATION
 - ******** ESCALATION WAT BUT INCLUDED.
- s. neudette

U.L. DEPARTMENT OF SUSENT - BOE ONDER SIGG. PAGE 1-32 SUSPARASHAPA (B), REQUISES BOUNDIES OF ALL SERENAL PLANT PRANECTS (CPP-0) AND LINE ITER (LI) EPHT EITERATEL, ECFENENCE, DOL STOD.4, FIGURE 1-11, BATER 10-31-84,

- 7. REMARCE
 - A.) BO EFCALATION TH INCLUDED IN THIS OFFICATE.
 - B.] ALL MORE BY ECFFER CONSTRUCTION FORCES (CF).



ICP KASTER HARTOND WESTERDARDERE HARTOND COMPARY JOE NO. PAPEOR Fill DO. 24750443 ** (163 - (UFEPACT3YE ETTAATIBE ** Phase 3 Phiras)(Actom Alternatives Api02 & 184 Updebbg: Alt 3) Diver Bystaatb Geb_003 - Guilaste Dasid Suger

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P444 4 40 8 DATE 08/13/44 D1 SHF/160/140/DER

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B.) JUMPETS: Ing JUMPETS WILL ALL OF CAREDON STEEL CARINTERS, FUMP JUMPETS INTER ALL OF CAREDON STEEL CARINERS IN SUPPERSIDE ALL PARTIES IN STEEL PARTIES. ADD - SHET WILL AT FINILAR IN STEEL E WORKED.

- 2.) EXCAVAILOD: PICAVATION WARNOUS ALE ALEE OF CUSELES PROVALION INTIDE INT FADM (5.5 MBX /57), NE VILL TENEE ENISTING EXCAVATED BIRL (NON'T EPECIAL DOAY LI).
- D-55
 - 7.5 PIEGS PROTEINS OPADE INSIDE THE AP FILE IS 679. THE NEW TRAVE PIE WILL MATE A TO BE PLOOM. FIRISH FLOOM'ELEVATION WILL BE 471. 33 WILL BE LIKE WITH 12 UNKER FUT.
 - I.) SAGIATION CORPETIONS: NO NATE REMOVED IN PIS CACEPI CON EMERGILLING, NO NUMBOR, Untils acquired for uncaverion in the fair. Mass for its jum to and control exception for the for. Emisting exception for and the secure - not durited.
 - 4.) DO EVANTI ON ACTUCINIÓN JUNPÓNI NUE INCLUDED IN INTE ESISTATE. DIRECTORIS PÓN J. PÉTÉRIDE & W. LICCUME.
 - 1.) STILLTE DOES BUT INCLUDE OFCONTAMINATION OF READDING AND RESTING FIRE ON ANDRUGH IN PILE.

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1.) COLTS THE BUTINET DEFENS, CONTINUECTION AND NOT PROVED HANAGEMENT AND DANGE ON A PERCENTAGE OF BIASEST CONSTRUCTION, - 20% Pag an

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ICF KAISCU RANFORD Misisborddie Baafond Corpaot Joh No. 76f607 Filt DD. 24356833	** 1847 - IBIERARI'IYE (SIRBAIIBO ** PRABE 1 PRIVATIZALIGO ALLERARIYYE ADIQE 1 IPL UPDRABES DPF of 1 DIVOR'EDIRAR DØE_004 - CBII CODE LEEGDRY SDWWART					Páde 5 ól 8 8316 40/13/96 13:13:53 87 60//140/140/989				
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556 ofmin sydnefutte										
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HNF-SD-TWR-AGA-001 Revision 1

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ICT ELISER VANGAGO Wentingender Kangago Tompany Jog do. Pagady File Bg. 24958449	4' IEGI - IBGERACTIVE REGIMEIGUN ** Porte i frivatization algebraigun afiaz a 164 VPERFORE OPI of Stove Registande Gue_obi - Eftigate Dunnaat ut een olvistan					8434 8 97 8 8434 88/33/94 43:13:54 87 887/487/487/88				
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SCT TAISCE PARTMED RESIDERPRE AARTMED CONFART Jun JD, Pérédi Filu Re, 26136843 ** LEGT - LATARNETING ASTIMATING ** PARE I PALYARIZATION RETEMBATING APLUZ & INC WYGANDUB RET AT 3700 KSTEMATE POL_ADA - CHARTAGUET ANALIZET AJAS UNDER #462 7 #7 8 #410 84/13/96 #4 ###/18#/L##/#K#

BE FE BENGE -	EDTIMATE DAGIS SAUTT		1444		
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PUEJON & HANADENEDI 134 FFFC6 11

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	A 29% CONTINUESET MAY APPLIED ID WER PROJECT BORL TO ALLOW FOR ADDIE COAT GOE ADDIEGOLD
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356 erner situstätten

totál 558 – PERER RICUCTURES

766 SPECIAL COULP/PPOCESS STITERS

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\$19097	JURPERS (FAG & (BETALL)	24	CANTINGUECT ADDED -LACEING DETAIL, A CRANEL IN MATERIAL DE PESSON IS PEDDABLE
	ELLEFRICAL	25	CONFINENCE AND TO ANALISITY AND THE COULD CHANGE AD DETAILS BUT AVAILABLE
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TOTAL TOP SPECIAL COULD/PADCENE LESTER 34

ATEAAAA COVETEDCTION CONTINUEDCT 343

ATERALC PROJECT CORTINEERCT 203



ICT EAISEN BANT an o Urttineboue bantano company Joo No. Papadi File No. Existan3		** 1267 - 16 PRAEE 1 - 16144412441 UPURAUE UPT OUT_ETT - UUSITE	AN ALTERIA	THE RELEMANCE		PIGE V OF B Gate GB/13/96 13:13:55 87 474/LGB/LDB/DX8			
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D8.3 OPTION 3 COST ESTIMATE



ECT KATEER HANFORD Westinggovie Radjung Company Job ND. Potadj File V. Luistaes AF 1237 - INVERSION DEVINITION ** PMLSE I DAIVALIZALTON REJENTALIVES REIGE IDS UPGARES OFF 83 AUDOV EETAMATE DSELVA - PROJECT COST SUMTRAL PARE 1 07 7 PARE 06/13/PP 13:53:13 07 587/140/LN0/000

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INTAL C		1,500,100		148,100	t, 109, 101
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ICT TAIDEE BARTORN WEDILGAROUET ANNFORD COMPANY Job Bo. Papady file Bo. Zaissac)

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APPENDIX E

PULSAIR VENTILATION ANALYSIS LETTER REPORT

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APPENDIX E

PULSAIR VENTILATION ANALYSIS LETTER REPORT

E1.9 INTRODUCTION

This report analyzes the effect of a proposed tank waste maxing strategy known as Pulsair on the 241-AP Tank Farm exhaust ventilation system

The Pulsair maxing system is similar to the air lift circulator (ALC) system currently used to agitate waste in the 241-AY and 241-AZ tanks. The primary difference in operation is that the ALC system introduces a commous flow of air evenly distributed throughout the waste whereas the Pulsair system depends on relatively violent local sparging at one or two sites within the tank. Air is admitted at a frequency of from 5 to 12 pulses/mjn.

It is necessary to know the effect of Pulsair on the following

- Waste tank thermodynamics
- Tak head space pressure variations
- Arosol generation and exhaust HEPA filter (ife.

E2.0 SUMMARY, CONCLUSION, AND RECOMMENDATIONS

Calculations have been performed to analyze the effect of the Pulsair system on temperature, pressure, and serosol generation within the 241-AP tanks

Tank waste solution temperatures will not be increased due to operation of the Pulsar mixing system. This is in contrast to the elevated waste temperature created by use of mixer pamps

Tank head space pressure will vary less than 4 percent as a direct result of Pulsair operation

Aerosol generation within the tank head space is expected to increase slightly due to Pulsar operation. Under these conditions, HEPA filter life in the ventilation exhaust system has been calculated as 2.6 years or more – installation of a protreatment device upstream of the HEPA filters may be warranted if extended filter changeout intervals are wanted. For comparison, the

existing HEPA filters have shown less than 0.25-in we pressure differential increase per year of operation.

A cost estimate has been prepared for installation of a fluidic vortex scrubber to extend HEPA filter life. Performance and operating principles of the scrubber are described in the referenced journal article (AEA 1993). The efficiency of the fluidic scrubber is nearly 99 percent for 1 μ m particulate. Liquid mist carryover is reportedly nonexistent, which implies that the deentrainer in the tank farm ventilation system could be eliminated if a fluidic scrubber with full system capacity (34 m³/min [1,200 ft³/min) were installed. The estimated total project cost of a 11.3 m³/min (400 ft³/min) scrubber (to treat exhaust from Pulsair tanks only) is \$4,000,000 (see Section E7.0). The cost estimate includes a concrete enclosure (missile and radiation shielding) around the scrubber, and a large amount of "burnout" expense to perform hot tie-ins to the existing ventilation piping.

The increased frequency of filter changeout, due to Pulsair operation without a ventilation system pretreatment device, will increase tank farm maintenance costs. The life-cycle cost for ten years of annual filter replacement amounts to only \$49,000. Installation of the vortex scrubber for the sole purpose of extending filter life is, therefore, not cost effective. However, if the complete exhaust system were to be replaced (as recommended by Project W-314), installation of the scrubber may be cost effective, and should be given serious consideration in light of its unique capabilities.

E3.4 APPROACH / EVALUATION

A thermal analysis of the 241-AP tanks was performed to determine the effect of using the Pulsair mixing system. A computer code developed for project W-236 was used to model the waste tank heat removal systems. The Pulsair system was modeled using the provision in the code to analyze the effect of ALCs.

input to the program included the following:

- Radionuclide decay heat
- Inlet air temperature and humidity.
- ALC flow rate
- Vapor suppression factor
- Annulus flow conditions
- Tank dimensions.

Output from the program included the following:

- Waste temperature and vapor pressure.
- Net evaporation
- Supply air required.
- Vapor space temperature and humidity.
- Convection and conduction heat losses.

Pressure variations in the tank head space caused by discrete pulsed air additions to the waste were calculated. Ideal gas law relationships were used conservatively to estimate the change in pressure assuming the volume and temperature to be fixed, with a variable gas mass.

Acrosol generation due to Pulsair operation was assumed to be equivalent to the effect of ALCs in existing aging waste tanks. Acrosol measurements have been made in the ventilation systems for the aging waste tanks and for the AP Tank Farm (Ligotke et al. 1994). Calculations were made to determine the projected HEPA filter life in AP Tank Farm assuming filter change out at a particulate load of 2,000 g in a 28.3 m³/min (1,000 fi³/min) HEPA filter.

The additional cost for a pretreatment device to extend filter life was compared with the filter changeout costs that would be incurred without the device. Filter changeout and disposal costs used (from personal communication with J. T. Ross) were as follows:

- \$2,660 per cubic meter (\$3,500 per cubic yard) burial cost.
- Five HEPA filters in a 0.91 m x 0.91 m x 1.8 m (3 fl x 3 fl x 6 fl) burial box.
- 60 worker-hours at \$50 per worker-hour for greenhouse.
- Each HEPA filter cost \$250.

Assuming only two filters are changed out for each greenhouse set up, the average cost of replacement is approximately \$3,150 each. Changeout of two filters per year (considered excessive, based on the calculated life of 2.8 years) would incur an annual expense of \$6,300. The present value cost of 10 years of annual filter changeouts is equal to \$49,000 (\$6,300 times 7.76) (Petersen 1996).

E4.4 UNCERTAINTIES

It has not been verified that the Pulsair system will adequately mix the tank contents using the given air quantities.

E5.0 REFERENCES

- AEA Technology Engineering Services, "Solvent Recovery: Try Power Fluidics," The Chemical Engineer, December 9, 1993, Huntsville, North Carolina.
- Ligotke, M. W., et al., 1994, Aerosol and Vapor Source Term Produced During Double-Shell Tank Waste Mobilization and Restrieval: Literature Review and Recommendations, Letter Report, Pacific Northwest National Laboratory, Richland, Washington.
- Petersen, S. R., 1996, Emergy Price Indices and Discount Factors for Life-Cycle Cost Analysis 1996, NISTIR 85-3273-10, U.S. Department of Commerce, Washington D.C.

E6.0 CALCULATION

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HNF-SD-TWR-AGA-001 Revision 1 Call: No <u>1-0</u>2 KAISER ENGINEERS Revuelon C Rege No 3 of S DESIGN ANALYSIS Com WHC WOIND No <u>E23360</u> Data <u>B)2/96</u> Dr <u>PD Rice</u> Sugar Pulse - Any Institution Checked SITAGE BY & Dalogon Location 2004 241- AP Arused 60 Findmas and Corclassions .)) The results of the Tonk Thernal analysis show That use of Pulse-Air in a tenk having to, no bright Radiolytic heat Load will be notheably affect Solution Temperature, exhaust Tempenature, or were evaporation rate. The columnation _ Balvion Temperature is log of 2) The result of the Tonk Maps Space Pressure Derivation and we is that the Warner on Should be less than 0.04 Mince, which is considered negligeable. 3) The result of the devosal generation analysis - Records a Harr filter Life nime exceeding - 2. 8 years. TO CALCULATION S The Wasta Tank Exhaust Thermodymenics PULSE VOLUME = 1 123 @ BO PSIG \$ 60 F . TPUENET ; Vo = PV @ T= Const. $V_{2} = \left(\frac{80 + 14.7}{14.7}\right) + 6.4 \neq Z^{2}$ Edge frequency = 5-12 pulses/min. average flow @ Max. fuequercy = (12)(6.4) = 77 sam Thereffect of operation with \$ w/o Pulse air is Shown on the computer print out (pas 445) :

\$4-4300-037 KEN 0037 OD 406.021

Operation without pulse air 4/8

Inlet / Suppres	net - C Lir Temp Esion fo pu Aute	ttor 0 scfm	45 [n]e Anne		dity p 1t An Rate	1433 scfi	77 F			^
	ameter			Bepth -			on Gap	- 30	10	
		- 1 in - 1.25		Ide Air T						
		· • • • • •								
5018	So)n	Anay] us	Conduct	Mat	Exit	Require	ad Va	Exit	Ann. Ex.	
Тепр.	Vp	Lors	Loss	Eves	Huan R				Тапр	
F	en Hg	Stu/h	Stv/h	15 H2O /h	10#/16	da sofia	- F /	뒤바	F.	
110.0	36.2	47817.	11327.	8.0L	0.031	75.78	107.7	58.3	107.4	
109.5	35.7	47052	11105.	8.66	0,030	85.12	107.1	58.2	106.9	
109.0	36.2	46288.	11045.	9.31	0.030	93.8Z	105.6	58.1	106.4	
100.5	34.7	45524.	10904.	9.96	0.029	L02.9)	106.0	58.0	105.9	
100.0	34.2	44760.	10762.	10.60	0.029	112.41	105.5	\$7.9	105.4	
107.5	33.7	43597.	10623.	11.25	0.028	122-34	104.9	57.8 57.7	104.9	
107.0	33.2	43234. 42472.	10479.	11.69 12.52	0.028 0.027	132.73	104.4	57.6	104.5	
105.5 195.0	32.7 32.3	41710.	10196.	13.16	0.027	154.99	103.3	57.4	103.5	
105.5	31.8	40946.	0055.	13,79	0.026	166.91	102.8	57.3	103.0	
105.0	31.3	40187.	9913.	14.42	0.026	179.41	102.2	57.2	102.5	
104.5	30.9	39426.	9771	15.05	0.025	192.52	101.7	57.1	102.0	145 c/m
104.0	30.4	41566.	9629.	15.67	0.025	205.29	101.1	56.9	103.6	
162.5	20.0	37906. 37147.	9488. 9345.	16.30 16.92	0.024 0.024	220.74 235.94	109.6	56.8 56.7	10J.L 100.6	
103.0 102.5	29.1	36388.	9204.	17.54	0.023	251.93	99.5	56.5	100.1	
102.0	28.7	35630.	9062.	18.15	0.023	268.77	98.9	55.4	99.6	
101.5	28.2	34873.	89ZQ.	18.15 18.77	0.022	286.51	55.4	56.2	59.2	
101.0	27.8	34336.	8779.	19.38	0.022	305.23	97.9	56.1	98.7	
100.5	27.4	33359.	D037.	19.99	0.02Z	325.00	97.3	\$\$.9	98.Z	
100.0	27.0	32604.	8495. 8363	20.60	0.021	345.89	96.8	55.7	97.7	
99.5 ° 99.0	26.5 26.2	31849. 31 094 .	8353. 8212.	21.21 21.62	0.021 0.020	368.0D 391.44	96.Z 95.7	55.6 55.4	97.2 96.8	
98.5	25.8	30340	8070.	22.42	0.020	416.30	95.L	55.2	96.1	
98.0	25.4	29587.	7929.	23.02	0.019	442.71	94.6	\$\$.0	95.8	
97.5	25.0	28835.	7767.	23.63	0.019	470.61	94.0	\$4.6	95.3	
97.D	24.6	28083.	7646.	24.23	0.019	500.76	93.5	54.6	94.8	
98.5 96.0	24.3	27332. 26583.	7505. 7364.	24.82	0.0)B 0.016	532.72	92.9	\$4.4	94.4 93.9	
95.5	23.9 23.5	25833.	7223	25.42 26.02	0.017	566.90 603.51	92.4 91.9	54.2 53.9	97.4	
95.0	23.2	25085.	7082.	26.61	0.017	642.BJ	91.3	\$3.7	92.9	
94.5	22.6	24336.	6941.	27.21	0.017	586,05	90.8	53.4	92.5	
94.0	22.5	23592.	6501.	27.60	0.016	730.67	90.3	53.2	92.0	
93.5	27.1	22847.	6560. CÉRN	28.40	0.016	779.94	89.7	52.9	91.5	
91.D 92.5	21.8 21.5	22102. 21359.	6520. 6380.	28.99 29.58	0.016 0.015	833.34 891.39	89.2 88.6	52.6 52.3	91.0 90.5	
92.0	21.1	20617.		30.18	0.015	954.69	88.1	52.D	PO.1	
91.5	20.8	19877.	6102.	30.77	0.035	1023.56	87.6	52.D 51.7	89.6	
91.0	20.5	19137.	6963	33.36	0.014	1100.02	87.L	51.4	89.2	
90.5	20.2	28400.	5626.	31.96	0.014	1183.91	85.5	\$1.0	88.7	
90.0 89.5	19.8 19.5	17663. 16928.	5687. 5549	32.55 33.14	0.014 0.013	1276.81 1380.23	86.0 85.5	50.7 50.3	88.2 87.8	
69.0	19.3 19.2	16195.	5413.	33.73	0.013	1495.96	65.0	49.9	87.3	
68.5	18.9	15463.	5177.	34.32	0.013	1628.21	\$4.5	49.5	66.8	
88.0	19.6	14733.		34.92	0.012	1773.81	84.0	49.0	86.4	

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HNF-SD-TWR-AGA-001 Revision 1 Operation with pulse air 5/8

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	at - f			onuci ide			v/k			· -
inlet /	Alt lend	• 77 F	Reia	tive Humi	1011.y	10 %	17 F			
Suppres	510A PI	ctor -	45 1RIG	it Air Ta						
		• 77 sef		itus Flor				- 20.6		
		- 75 ft		i Height -			bu esb	- 30 i		
		- 1 în	301	Depth -	10.5 11					
LONCTO	te Depth	- 1.25	11 0015	lde Air T	ieap = 1					
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Sola	Soln	Andri i î î	Conduct	Net	Exit	Reguin			wn. Ex.	
Teop.	VID.	Loss	Loss	Evap	item Re			nd .	Ттар	
F'	He He	Btu/ħ	Bto/h	16H207h	New/16d	ia sofu		sin	F	
109.0	35.2	45288.	11177.	9.17	0.030	14.56	107.5	56.9	106.4	
108.5	з.т	45524.		9.62	0.030	23.18	106.9	57.0	105.9	
108.0	34.2	44760.		10.48	0.029	32.14	106.3	\$7.1	105.4	
107.5	33.7	43997.		11.14	0.029	41,44	105.8	57.3	104.9	
107.0	33.2	43234.		11.80	0.028	SI 11	105.2	57.4	104.5	
106.5	32.7	42472.		12,49	0.028	60.05	104.6	57.9	104.0	
106.0	32.3	41710.		13.1Z	0.028	71.03	104.1	\$7.8	103.5	
105.5	31.B	40948.		13.76	0.027	82.54	101.5	57.7	103.0	
105.0	31.3	40]87.	10020.	14.39	0.026	54.60	103.0	\$7.6	102.5	
104.5	30.9	39426.	9876.	15.02	0.026	107.26	102.4	57.4	102.0	
104.0	30.4	38556.	9737	15.65	0.025	120.52	101.8	57.3		11B Cfm
103.5	30.0	37906.		16.28	0.025	114.45	101.3	57.2	101.1	
103.0	29.5	37147.		16.90	0.024	149.30	100.7	57.0	300.6	
102.5	29.) 26.7	36388. 35630.	9300.	17.52	0.024	164.51 180.73	100.2 99.6	56.9 56.8	100.1 99.6	
102.0	28.2	34873	9156. 9012.	18.14 18.76	0.023 0.023	197.82	59.0	56.6	99, Z	
101.0	27.8	34116.	8868.	19.39	0.023	215.65	98.5	56.5	98.7	
100.5	27.4	33259.	8724.	19.99	0.022	234.87	97.9	56.3	99.2	
100.0	27.0	32604.	8561.	20.60	0.022	254.98	97.3	56,1	97.7	
99.5	25.6	31649.	8437.	21.22	0.021	276.25	96.8	55.0	97.2	
99.0	26.2	32094.	8293.	21.82	0.021	298.78	96.2	55.B	96.8	
98.5	25.B	30340.	8149.	22.43	0.028	322.68	96.2 95.7	\$5.6	96.3	
98.0	25.4	29587.	8006.	23.04	0.020	348.05	95.1	55.4	P5.8	
97.5	25.0	28835.	7862.	23.54	0.019	376.04	94.6	55.2	95.3	
97.0	24.6	28063.		24.25	0.019	103.77	94.D	55.0	54,8	
96.5	24.3	27332.	7576.	24.85	0.019	434.43	93.4	\$4.8	54.4	
96.0	23.9	26583.	7433.	25.45		467.19	92.9	54,6	93.9	
95,5	23.5 23.2	25633.	7290.	26.05	0.018	502.25	92.3	54.4	93.4	
95.0 94.5	22.8	25085.	7147.	26.65	0.017	539.87	91.8	54.1	92.9 92.5	
\$4.0	22.5	24338. 23592.	7904. 6862.	27.25 27.85	0.817 0.027	580.29 523.85	91.2 90.7	53.9 53.6	92.0	
53.5	22. L	22647	6720.	28.45	0.016	570.89	90.1	53.4	91.5	
93.0	21.6	22102	6578.	29.04	0.016	721.82	89.6	53. i	91.0	
92.5	21.5	21359	6436.	29.64	0.016	177.13	89.0	52.8	90.6	
92.0	21.1	20617.	6295.	30.24	0.015	837.36	88.5	57.5	90.1	
91.5	8,05	19877.	6154.	30.84	0.025	903.18	88.0	52.Z	89.6	
91.0	20.5	19137.		31.44	0.015	975.37	87.4	51.9	89.2	
90.5	20.Z	18408.	5971.	32.03	0.014	1054.85	66.9	51.5	88.7	
90.0Q	19,Ē	17563.	\$733.	32.63	0,014	1142.74	26.1	51.1	88.2	
85.5	19.5 · 19.2	15928.	5594.	33.23 33.83		1240.39	86.8	50.B	87.8	
69.0		16195.	5456.			1349.45	85.3	SQ. 4	87.3	
44.5	19.9	16462.		34.0		1473.94	\$4.5	50.0	\$6.8	
89.0	28.6	14733.	5)81.	35.07	0.012	1610.41	84.3	49.5	86.4	

HNF-SD-TWR-AGA-001 Develop I

Revision 1
KAISER ENGINEERS Edde. No. H-02
HANFORD RAVERA C
DESIGN ANALYSIS Page No. 6 . 01 8
Cham WHE WOLLOO NO. E23380
Chana WHE WOLLOG No. E23380 Subject PILLE - AIN VIENTILATION Data 8/5/06 by Poul Rice
Cracese 6/9/44 51 51 22 221710 -8
Location 200 5 24/-AP Revised by
· · · · · · · · · · · · · · · · · · ·
Calculations (cont)
7.2 Tank Headspace Pressure Variations
THE MOST CONSERVED A DOWNER IS TO DESIGNE
The most conservative approach is to assume The Tank headspece is a sealed volume When The air pulse is added. To a full touch.
When The RIT pulse 15 adad. To a full tout.
PV=NRT.; = n= @ CONST. T + V
Here Whente . Total Tank Whene - Woste Volume
Total Volume of DST =1198,215 ft3
Volume of 1,000,000 got = 133,610 ft.
Change in n due to I pulse = 6.4 pt & & STP.
$\frac{n}{n} = \frac{(64,536+6.4)}{(64,535)} = 1.000093$
······································
CrAP = Ps-P, = 0.0014 ps/ = 0.039 M.WC.
The maximum Vorietion in Tone head pressure.
The maximum Variation in Tonk head pressure. Will occur at minimum Tenk negative ~ 1 "bic.
Variation % = 0.039 bit = 4 % (negligentie)
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\$1-4300-037 KD+0037 00 (05/92)

KAISER ENGINEERS			5	alc. No	4-02
	DESIGN	ANALYSIS	F P	avision 🔜	_ * <u>A</u> _
Chem WHC Subject PRESE - Dry Martil		WO/Job No. 22	2.555	6	
		Orection 4 9/72	-6 ₽ γ β	201.2	2.47
Location 200 E 24/-A	>	Asvided	₽y		v –
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Calculagions (Co	(דמכ				
1.7.3 HEPH XILTE	2 Life				
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all your to	ALE A	ana da	15%	Smile	47.
-+++The pulse -	ary filo	w '10Te	غمريته	and-	
Pulse's	air fros	M TONES ,	APios	4104	
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(117a	34-1).				<u>-</u> -
Ref 3 also,	ADTES.	That Con	denser	S .in 7	hel 1-12
Appracimenta	System	have a	parta	10 D,	εöγ.
I fee the appoint	CONT P	article C	MCANT	TION	IN THE
LICENT HEADE	4 MEAY 2017 MA	* THE TON	e cur	2.4.7	<i>UIT</i> -
(16.5 Alg/m/3)	Concert	ser v= = s)	/ =	83,44,1	M-
Measurements Reasurements Reary Geros	Sox R	ef 3). Vere	als Th	وم تم	Tille.
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OF THE DATA OF STITUTE OF Fould Chall	Deros Baser 7	CL CORLON No. Invel av	habet	ng 77kg Gaine	F F QUIL
is aerosol La				w. 74	<i>₩</i> =
1/70 /2 (83 /4	<u>m²</u> _	2735 JUS,	/mm.		
	<u> </u>				-
	-				

54-4300-037 K06-0037.00 (09/93)

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HNF-SD-TWR-AGA-001 Revision L KAISER ENGINEERS Cale No. <u>H-02</u> HANFORD Revision 🖉 DEBIGN ANALYSIS Page No. R of A Chan NHC WO/Job No. 5.23380 Open BISIAL Whe - Ary VENTHOTION W PD Rice Checked BITHE BY GTRLIPPA Location 200 241-A1 Revised Calculations (CONT.) Fipical HEAR fitter POTTILLATE Load at changeout 🛎 2000 gm. . Time to accumulate 2000 gm in HEA filter . (assume HEA Jelter Takes all particulate) <u>2000 9M</u> = 731,400 min = 508 days 2735 X10 ¹⁰ 9m / min Roc ref A), Frequerers will approximately double. - 1+ 14 fuller hife expected = (508) 2) = 1016 days 2.8 YYS This should be considered Conservative as no credit was given yor the effect of the Deentrainer in the system in remaining Particulate that would be enceosured in. Liquid MIST Liquid would be Present in The Sistem IN Conduction hear losses from The Single Wall Vent Diping (under ground) Cooled The air flow from The Tank Whor spoce Condition of 102° F @ 57% By To below 80° F

54-4300 017 KB+ 8037 80 404/121

E7.0 COST ESTIMATE

VORTEX SCRUBBER



167 CALSER BARRORD CONTAGE MEDTINGOUNE BARRORD CONTAGE JAB OD. 2-414 File BD. Feldaar2

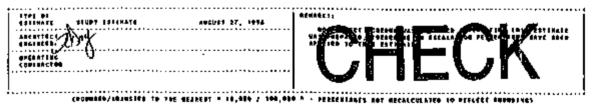
7" :437 - LPTERACI)TE COTIANTON ** AP-102/106 -404.00 Alb 975704 - Vorica Bervoore Hayr Armot Citymite 606.004 - Projec Cost Indust

PARE I DI LA MATE 40737794 89154149 87 818

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CBE I		BEGALATER		1802957	1974L	
2 0 92	**************************************	TOTAL COPI		T#T44	********	
625	111LE 11 BE1104	250,000	25	40,010	749, 198	
655 648	111LE FAL E/S BURSHE CONSTANCISM PROJEEF MANAGEMERT	111-111	27		224,000	
Far	(ADJU11E0 10 MEET DOG 5100.4)	130,000	•	- 54 . 484		
	4W TAA HINYELMENI	508,848	34	1+4,494	***,***	
550		20,000	44 32	10,000	14,444	
740	(PRARTIES IN WELL SOE JUDGED	2,200,000 -20,000	32	799,499	-14,000	
IØIBL CON	I BUCT I GB	2,286,668	34	700,000	7, 444, 844	
101AL 6010	APIES CONTINUETION CODES ("ECC)	2,740,000	38	646,064	3,300,000	
	61428 PE032E1 CON15	L48.844	25	100.010	508,004	
	(ABJUS1ED FO MEEL DOE 5198.4)	•		•	•	
	107 CASTE (IPC)	3,148,044	34	941,410	4,988,948	

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	461 021C010100	USIIWLTĖ Eubtoiau	•#\$112 10414211	TUŘ TOTAL	•	LETICE IDÍAL	TW& TWFAL	L	FOIRE	1474L PMLL423	
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	SUBFUTAL I ENGINEERING	\$49234	•	30774	4.45	•	345224	23	86387	43 (93 5	
	ZALDIB VOPTEN CC+URBET JUIERNLP Zaldeb vorden CC+URBET JUIERNLP	3 94764 74134	:	549766 74136	:::	:	5847# 4 71956	28 25	179941 18934	71746 <i>7</i> 77460	
	\$U\$10745 2 PROCUNEMENT	473868	٠	673848	0.00	•	473840	77	138475	812311	z
E-19	318008 CENERAL GEOWIRENENIS 319018 ECRUBRER INSTE II ROWEING ERGUEINGE 31920 YERT I DORID CINE DOJALL/FRE II 31950 Electrical Evetra Jitoša Burndov	\$78854 28727 261528 48582 1848948		172056 23727 261528 60502 1960790	8_00 4.00 4.00 4.00 4.00	:	174856 32727 361936 68982 1968788	****	60021 9991 69561 12179 619563	240879 31896 341991 52757 1648671	ğ
	SWATGING 31 CONSTRUCTION FORCES	1523841	•	1525001	4.48	•	1525891	17	\$76935	2495434	
	130406 BUATAL COSIE Juutbial 33 - Apérating Cuitancian	14 88\$ 14 88\$:	14 803 14 803	4,41 1,41	:	14885	23 25	5721 1721	18464	
	100101AL 3 CONSTRUCTION	1540546		1514484	4.44	•	1544666	31	525294	2714663	
	CODED BY PROJECT MANAGEMENT	148384		169594	1. N	•	+1+344	25	37599	164195	
	INFINE C PROVICE MERICEMENT	3 147594	٠	164546	4.94	•	748544	23	37394	186775	
	Sadend Atmin Presdert costs	5+5424	•	391829	4.44	•	795824	23	49995	4+2775	
	PROJECT TOTAL	3, 185, 144	•	3,103,168	1. +1	•	3,145,144	39	934,692	£,014, 46 8	

HNF-SD-TWR-AGA-001 Revision 1



icf estate states WESTINGASE ANDFORM COMPANY 344 80. 2-414 CILE 10. 24141422

** LEST - INTERACTING RETIRETING ** AP-192/104 PULSE ATA LTUIEN - VOLTUN SCHUDDER THUT Siter during the DOG BOJ - COVERANT BASID SOFET

PAGE 1 OF 10 **FLE**

I. ROCKNERIS ADD DELVIDES

DOCUMENTS: TEMPOR LETTER FROM ALA IECHTOLAGY ENGLAGY ENGLIERAING STRVIERS, INC. TO JOHN & BALURALIP, BATTO AUG 4. 1996.

CEMALL, EXABLING ATSWAPTIONS FOR VEGISLASION UPITRATE (PULBAIR) FOOD SOMA D VALURAITA, BATCH, AND 15, 1970

GRAUIDER- AF FAME FACH SKETCH OF WHDIRGROUD WEILLITERS, AF GRAVIAL PORTE.

BALLAINI PRICES

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ment cours supereners coursel forces for affecting matching. This is information was added and following preven VOELER ICANDERS

3. LJOOR RUTES

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 - 4.5 ICS RE BOURLE MATES ALL BARES OF LOS 1996 FINICAL NEAD ANDART LIBBIDATION BAREM AN INCLUDE BY FEN FINANCE igredebive I de taj net alig the fi lebe planetes enfes + (adente bungtoit).
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APPENDIX F

SAMPLING SYSTEM ANALYSIS

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APPENDIX F

SAMPLING SYSTEM ANALYSIS

This appendix provides sampling assumptions and analysis used in determining requirements for the subsystems of the Intermediate Waste Feed Staging System (IWFST).

F1.0 PROJECTED FEED BATCHES

FI.1 PROJECTED FEED BATCH SUPERNATANT COMPOSITIONS

The feed batch supernatant compositional masses (as they will exist in the intermediate waste feed staging tapks) are based on Shelton (1996) and were calculated for, although not published in Certa et al. (1996). Tables F-1 and F-2 show the compositional masses (as projected in 2002) for each batch for Contractors 1 and 2, respectively. The chemical components are listed in metric tons (MT) and the radionuclides are listed in becquerels (Bq). The value for the total transurances (TRU) is the sum of neptunium, plutonium, and americium isotopes.

Tables F-3 and F-4 show the projected WFST feed batch supernatant compositions' for Contractors 1 and 2, respectively. The concentrations, shown in molarity (M), for each component in the supernatant (C_i^{l}), except the radionuclides, were calculated with the following equation:

$$C_{r}^{L} = \frac{M_{1}}{MW_{r} + V_{\mu}} \left(10^{4} \frac{r}{MT}\right)$$
 Eqn.1

where:

M, = Mass of component i (excluding radionuclides) in the batch (MT)

MW, ~ Molecular weight of component / (g/mole)

Va = Volume of the Batch (L).

^{&#}x27;This is the projected composition of the feed batches as they will exist in the staging tanks, not as they will exists in the contractors' tanks.

For this calculation, the molecular weight of the total organic carbon (TOC) was assumed to be 12 g/mole. The concentrations of the radionuclides (in Bq/L) in the supermatant (C_r^4) were calculated with the following equation:

$$C_r^+ = \frac{M_r}{V_o}$$
 Eqn 2

where:

M, = Activity of radioanclide r in the batch (Bq).

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Table F-1 Projected Feed Batch Supernatarit Masses for Contractor 1 (Tank 241-AP-102)

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HO;	4.000.+#E	4728+482	1.000 +940	4 WE+62	1.000 + 812	7278444	1215+02	1.001+02	100.402	4.802.462	4478+68	1.16
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Table F-2 Projected Feed Batch Supernatant Masses for Contractor 2 (Tank 241-AP-104)

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Table F-3 Projected Feed Batch Supernatant Compositions for Contractor 1 (Tank 241-AP-102)

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6°		1.857-64	4.9594	6.996-0-	1.005-00	1381-44	1346-45	434 - H	4 MG-44	1318-44	7.8RE-84	4.000-00
oer 🛛	245-47	2.00L-07	1.27 1 - 22	1.84É - 10	1.000	6.485-88		\$.99	7.88t-88	8-145-ET	7.586-12	2.000-00
0404,	1 1 1 1	228-44	7,00804	\$3 68 - 00	7.001-00	- 200 - 10	3.002-40	1008-00	1.85-10	100-06	1.00	
	1.000-00	7.899-44	1 100-04	105-0			1476-68	1.05-0	1.005-14	144-3	144.44	1.538-44
		4.000 - Bb	1.000-11	8 788-18	\$122-88	1.17 9 -18	1.000-00	1.00	Last-D	7.000-10	1.14 6 -14	\$ 99 - 12
E	1.000-00	1.002-00	- 200 - 01	1206-01	2012-4-	1742-68	4 10 - 10	4188-68	1.00°-07	1.62-0	Lini-M	teni-m
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He-+	1445-44	6.0K - H	1.75.0	1.005-04	1945-04	145-61	6.88T-89	135-00	3.68-00		(391-64	1446-16
~	4.212-8 7	1.01	3466-40	Mart-44	1.000-04	1.385-46	1718-68	1116-60	100-00	222-62	144-00	1782-8
U U	100 - 57	(176-18	17 4 -0	1.5564	1760	1.446-44	0.040 - DA		144-W.		76-08	3778-00
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r i		3,675-01	1.205-02	4.000-04	tenE-az	and-w	202-0	umi-m	Mail-R	5781-BE	1.000,-401	4999-99
20 , 1	4418-88	4.41548	186-B	ME-41	784E-10	2105-07	Late-+1	148-61	11 2-8	122-22	1005-02	278-10
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ian .	1.002 - 02	1.00C+10		NALÉ - ME	1772+80	7.8NQ 8N	7.000-01	7415+8+	1.000-04	L	5.84 7 -84	646 - 91
992 - 11-	uht-m	214E-01	138-4-	1448-47	1002-01	1001-01	Last-m	1.00 × 10	100.00	1.002.00	£20(+2)	128-0
-11-	101.00	-	LENE+B	LUB-R	1221-0	i.	1981-68	1.16.1	170.00	178.08	1.010+88	1.345+30
	3444-04	1.006 a Ma	178-0	3.000-00	140f + 19	- 200 - 00	e entren	1.441.44	LINE+R	1.002.00	(ard set	1.001.107
	LANS;+10	ş vet v m	1.mt-w	1.848 4 16	1007+10	4.005+10	1.947-040	4.945+14	100T-00	10.00	***	4.34E+14
1994 - C	127E+p	1966 - DA	1.221-00	175-98	i gel - et	34 12 -m	1.04Logr	LIFE	tal est	LORILO DE		
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	1766+04	1.000-044	\$7M+#	1,075+04	136-44	7 136+04	1106-00	1124.+00	2468 + 22	6.48 8 + 24	1.842+44	7284+65
-1-	¥78+14	104+0	3 HB + H -		4905-44	C. 106 + 75	1915-07	100.00	1.005 - 30	4.845-94	-	778-00

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Table F-4	Projected Feed Batch Supernatant Compositions for Contractor 2
	(Tank 241-AP-104)

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64 ⁴⁴	100-17	L65-77	L141-40	7.487 - 10	1.000-11	334 -47	1000-00	1.200-1499	425-10	175-77	4.00 -##	1000-01
la.≁	184-0	148-44	7.882-64	1000-04	1466-49	146-44	10-2-41	844 - M	1745-00	1445-44	7212-01	2116-64
or I	1448-77	2488-07	136-00	110 - 14		1.46-64	1386-47	200-47	748-44	6 ME-77	4366-47	4.85-##
a.cot,	7 481-10		744 - 14	1012-44	1.000-00	1.000-00	2.000-00		1.202-0+	1245-00	1 101-01	125-04
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⊷	1.000 +14	4.931-53	1.002-00	0.000-01	1.000-04	1,002-00	110-00	1116-00		1343-44	1405-47	7.042+47
u i	111E-17	1.010-00	14E-07	4-36-14	1765-04	2005-00	0.04E-04	884E-84	2442-44	1.000-00	122-66	1868-##
00,-00	246-41	3.386-41	1.705-01	(7.94 1 - 171	1001-01	6.995-dri	6.00E-01	1465-41	496-01	4888-01	194-41
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#0,*	1.00	3.MI-8	176-40	1996-08	436.49	2346-AU	4946-40	4386-60	114-01	128 - 17	1316-44	3 78 8 - 6 4
DH	1365-+#A	2.156.146	2 Mil - Mil	3.04K - 488	\$ 775 APP	1315-01	7446-41	7446-04	****	1.000 - Ini	****	100- 4 1
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F1.2 POTENTIAL FOR INSOLUBLE SOLIDS ENTRAINMENT

In order to assess the potential effects of entraining insoluble solids from compacted sludge layers in source tanks during retrieval and the subsequent effect on the percent actiled solids in the staged feed batches in the staging tank, the following assumptions are made

- The maximum permissible percentage of the settled solids layer volume to the feed batch volume (R_g^{max}) as 5 percent
- The percentage of the actual solids volume to the total volume in the compacted sludge layer (R_{AC}) in the source tank is 70 percent (30 percent void space in the source tank sludge layer)
- The percentage of the actual solids volume to the total volume in the settled solids layer (R_{A/S}) in the staging tank is 50 percent (50 percent void space in the staging tank settled solids)
- The ratio of the staged feed volume to the original volume of the waste before retineval is the dilution factor (D) and is described in Certa et al. (1996) for each source tank waste retineved.

Table F-5 below lists the low-level waste (LLW) Phase I privatization source tanks which contain a sludge layer excluded from the planned retrieved waste by Certa et al. (1996). Table F-5 also chaplays other information from Table 2-23 in Certa et al. (1996) including the volume of retrieved waste, the dilution factor, and the total shudge that is thought to be layered at the bottom of the source tank. The maximum permissible volume ratio of compacted sludge fayer entrained to retrieved waste (R_0^{erm}) was calculated using the following equation

$$R_{x}^{\text{mail}} = R_{y}^{\text{mail}} \frac{R_{AS}}{R_{AC}} \phi \qquad \text{Eqn 3}$$

where

- Ryme Maximum permissible ratio of settled solids layer volume to feed batch vol%
- R_{ACC} = Percentage of actual solids volume to total volume in the compacted sludge layer (percent)
- R_{A.5} = Percentage of actual solids volume to total volume in the settled solids layer (percent)
- D = Delation factor, ratio of staged feed batch volume to retrieved waste volume.

Assuming that solids (i.e., sludges) are entrained equally for each batch of waste retrieved from a source tank, the maximum volume of source tank sludge layer (V_{ex} ^{-w}) that can be entrained from each source tank can be calculated by the following equation

$$V_{ESL}^{\text{quer}} = V_R \frac{\hat{R}_R^{\text{max}}}{100\%}$$
 Eqn 4

where

 $V_n = -Volume of waste estricted from the source tank (ML)$

Table F-5 shows that enough sludge exists at the bottom of tanks 241-AN-102, 241-AN-104, 241-AN-107, 241-AY-101, and 241-AW-101 to exceed that volume percent settled solids limit. The exception is tank 241-AN-106 which does not contain enough solids to exceed this limit.

Source Tanks	Batch # for Contractors 1 & 2 ⁴ (1 2)	Waste vohame retrieved (V _R)	Onlwaton ratio* (D)	Maxemum entrainment allowed (Rs ^{tar})	Mexumum cntrained sludge layer (V _{est} =*)	Total sludge in source tank"
AN-104	33	3 02 ML	1 71	6 10%	0 18 M/L	1 00 ML
AW-101	44	3 94 ML	1 43	511%	0 20 ML	0 32 ML
AY-101	6,12 6	4 16 ML	1 00	3 57%	015 ML	0 31 ML
AN-307	7.8 7,8	3 68 ML	1 31	4 68%	017 ML	051 ML
AN-102	99	3 84 ML	1 62	\$ 78%	0 22 ML	0 34 ML
AN-106	10 10	4 00 ML	, 231	6 25%	0 33 ML	0 05 ML

Table P-5 Estimated Solids/Sludges Entranzoent

"Data from the Certa et al. (1996).

FL3 PROJECTED FEED BATCH ENTRAINED SOLIDS COMPOSITIONS

The following is an enabling assumption used to estimate the composition of the solids entrained in the feed batch during retrieval and transfer.

 The entrained solids have the same composition as the settled solids (i.e., studges) in the source tank.

Not all of the of the source tanks have had solids characterization completed. The currently available solids data were collected for, although not published in, Shelton (1996) and the Certa et al. (1996), and are shown in Tables F-6 and F-7.

Table F-6. Projected Feed Batch Entrained Solids Compositions for Contractor 1 (Tank 241-AP-102).

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Table F-7. Projected Feed Batch Entrained Solids Compositions for Contractor 2 (Tank 241-AP-104).

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F1.4 PROJECTED COMBINED FEED BATCH COMPOSITIONS

The following enabling assumptions were used in calculating the feed batch compositions as a sum of the projected supernatant and entrained solids compositions.

- The modified Request for Proposal (RFP) feed envelope criteria refer to the total
 composition of the feed batch including the entrained solids.
- The ratio of the actual solids volume to total volume in the settled solids layer is assumed to be \$0 percent.
- The volume of the supernatant displaced by solids is negligible.
- Where no solids composition data is available, the solids composition is assumed to have no effect on the feed batch composistion.

The compositions (in M or Bq/L) for the supernatant and the entrained solids were combined to calculate the total feed batch compositions (C, 7). These were calculated with the following equation:

where:

- $C_i^L =$ Total concentration of component *i* in the combined supermatant and entrained solids phases (*M* or Bq/L)
- C⁸ = Concentration of component *i* in the entrained solids phase (*M* or Bq/L)
- R_e = Ratio of settled solids layer volume to the total feed batch vol%.
- R_{Ad} Ratio of the actual solids volume to total volume in the settled solids layer (percent).

Tables F-8 through F-13 show the projected total feed batch compositions for Contractors 1 and 2 for the zero, two, and five percent settled solids cases.

Table F-8	Projected Feed Batch Combined Compositions 0 Percent Settled Solids, Contractor 1
	(Tank 241-AP-102)

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NQ-	1,898.000	1418-041	1.620+00	1366.444	1.34E +#0	- 345 - 40	2105-00	178-00	2-15+40	10000-000	177-44	1.00
=, j	1318+60	1335+40	122+40	1445+44	1 - HE HO	1.885++++	1078-01	7478-01	1885.+44	112.000	1782+440	1.848 +++4
HQ. 1			176-44									
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			2022-00									
9e			276.44									
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	1744-445	194	3786+84	4375+64	1.000 +04	7 1.38 +03	1106-00	- 135-440	1006-00			734 44
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Table F-9	Projected Feed Batch Combined Compositions 0 Percent Settled Solids, Contractor 2
	(Tank 241-AP-104)

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ы сы ,	7.497-49	119 1 -84	2.002-00	634 8 -64	1.000-00		Last-m		Last-H	Loni-m	1 788-84	178
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I		مد - ایجنه	7.000-11	6738 - C	378-04	3478-00	1.000-07	1000-07	1245-91	2.000-70	2.00E-11	1.
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Revision 1 RMF-SD-CWR-AGA-001

Table F-10 Projected Food Batch Combured Compositions 2 Percent Settled Soluda, Contractor 1 (Tark 241-AP-102)

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Table F-11 Projected Feed Batch Combined Compositions 2 Percent Settled Solids, Contractor 2 (Tank 241-AP-104)

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Table F-12. Projected Feed Batch Combined Compositions 5 Percent Settled Solids. Contractor 1 (Tank 241-AP-102).

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Table F-13 Projected Feed Batch Combuned Compositions 5 Percent Settled Solids, Contractor 2 (Timk 241-AP-104)

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전국 "[11] 전 전체 - 12	ku-		1.84 - 44	1.259-47	4465-00	1 1 1 1 1 1	1.000-040	1466-67	1.485-07	1.005-44	1.146-10	1.005-04	1.000-01
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FL5 PROJECTED FEED BATCH RATIOS

Since the feed envelope lists the concentration limits as ratios of the component concentration to the sodium concentration. The component concentrations were converted to sodium ratios (R_i) with the following equation:

where:

- R_i = Sodium Ratio: Ratio of the component i concentration to the sodium concentration (moles i /moles Na or Bg r / moles Na)
- C_{Aa} = Total concentration of sodium in the combined supernatant and entrained solids phases (*M*).

Tables F-14 through F-19 show the projected total feed batch sodium ratios for Contractors 1 and 2 for the zero, two, and five percent settled solids cases. The value listed for sodium is the sodium concentration in moles/L.

Table F-14	Projected Feed Batch Sodium Ratios 0 Percent Settled Solids, Contractor 1
	(Tank 241-AP-102)

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Table F-15	Projected Feed Batch Sodium Ratios 0 Percent Settled Solids, Contractor 2
	(Tank 243-AP-104)
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Q F	1446-18	3700-00	1.000-000	44000-11	aver - ex	1 8800	3.000 -PR	agel-ea	1.000-00	7.899-499	-	4-185-44
0404. j	125-44	4.000 -00	1,000-007	9.34 <u>9</u> -44	1.981-02	L 100 +85		4.675 -64	4745-04	1466-444	10-764	1012-01
Rrf -	1271-#	1.346-444	1.56-44	67E-P	4415-44	1.895-08	2295-40	1306-00	1.482-04	4188-86	1.000-04	
He ^{re}		070E-11	1,007-12	LEDE-14	1.199-44	4 06- 10	1.005-00	1.000-00	1.00	146-10	245-12	1.02-10
r l	1.000-00	1.24E-82	1.000-00		1445-42		f 446L-43	1.005-44	4.346-83	2002-00	3 21 - C	
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U	1.22 - 14	2.22 - H	+ 22 - PR	i int-st	1.000-04	124-64	7 Mil-84	7 108-04	1.000-04	100-07	1.00-00	****
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e	LINT-42	2002-02	1008-04	101-01	100-10	1.000-04	1.64	1.000-00	1.005-000	£200-0H		****
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	£406-41	2408-01	1.00	3-06-61	7.698-41	1.005-41	1111 - F7	1000-01	1112-01	2.841-01	1005-01	1.000-01
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Table F-16 Projected Feed Batch Sodium Ratios 2 Percent Settled Solids, Contractor 1 (Tank 241-AP-102)

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Table F-17 Projected Feed Batch Sodium Ratios 2 Percent Settled Solids, Contractor 2 (Tank 241-AP-104)

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р. В	174-02	40004	14 6 -01	9326-00	1108-04	1871-18	1.011-04	107L-01	-18 - 00	194-D	1.22E-94	1000.00
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Table F-18	Projected Feed Batch Sodium Ratios 5 Percent Settled Solids, Contractor 1
	(Tank 241-AP-102)

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orden, i	1.08-00	-Hi-Hi	1.00-03		1142-04	7415-41	4.72 -0-	+725-04	5. Mill-44	148-14	1.000-00	-
M7	1.005-06	1 465-44	1.00	6.748-47	6.07 1 -01	t-st-se	2.000 - PR	201-0	1.000	a rist-an	7766-P5	1.005-4
₩		5441E-11	2.04 1 - 12	\$ 38E-14	1.12-14	4.3-6-07	1798-00	1768-04		1 100-10	3.899-11	125-1
r	1001-01	7.005-00	1.000-000	1.000-01	1.00 1- 11	1.145-64	175-00	uni-e		2.942-04	1.006-447	100-0
		1.00	100-00	145-10	1000-11	104-10	10-5-44	1.84 - 44	1765-44	1745-11	4	init-e
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	178-66	194	ŝ	-	1710-1P	4.000-0-	****	1	****	198-18 1971 - 1972 - 19	148-65	484.4
~ 1	414-64	1,007-00	4.00 1 -16	1.485-04	1.000-44	1201-04	1.000-01	1006-01	486-66	+ 182 - ED	100.00	1.788-0
u	175-00	1.01 -++	105-00	LINE-04	145-14	7.005-44	1	145-64	e.me	1314-42	1.000-000	- 100
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• ·	100-01	2000-00	1246-02	1406-01	1005-00	2.000-00	a 705-00	176-00	*78-68	1.00 -04	104-04	7.000-0
r	:	14H-P	1005-00	unt-a	1005-01	UN\$ 49	Last-M	145-44	F188-40	1495-00	4.244 -444	1000-00
H2.1	1771-01	104-44	116-44	1.001-00	110(-41	- 100 - 40	100-00	144-67	1.201-02	7.000-00	t.ml-e	unt-n
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ni,	1.721-41	1000	1.00	1.00	1	3.02-01	1	104-01	100	1.000-01		
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Table F-19	Projected Feed Batch Sodium Ratios 5 Percent Settled Solids, Contractor 2
	(Tank 241-AP-104)

Personal State		A Made of C		Burlins -	Charles and	Burling A	and a		4000	da Way —	de Triev	a more
innen Ten	M- 14			1997 - 1941	÷	#≈-#*L	44.10	*			AF-147	
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	and-re		1100-01									486-41
.	53E-H	1 146-48	3.000-04	107E-10	1.856-13	\$308-94	1.04	1.005-00	1441-44	146-44	840 - 67	till -
64°	244-19	1.16-14	1.011-04	7.876-44		2.368-49	1.38-65	1205-69	1.100-00	105-11	1.84	1.000-04
6 -	1445-44	1.000-00		4495-11	1.00	1105-00		3.08.86	4.782-044	7.945-44	\$1 2 -0	8 CE-64
0(04),	1.001-44	-	1.461-69	1286-44	1106-03	7.000-00	a 738 - 44	- 105-44	6 2 4 4 4 4	148-44	1.000-00	tint-H
**	1471-66	1.965-66	1.002-00	1786-477	148 - H	1.482-92	6.04 - PR	2.001-00	N	4 102-00	1.00 - H	LEEL-H
h-r		8 20 - 11	2 28 -10	1226-14	1.326-44	6.inE-#7	178-00	1 105-00	L#6-14	1 196-10	208-0	1366-13
K I	1.385-32	1	1.005-00	L005-01	2 2 2 - 2	1742-42	184 - CD	1.005-00	8.00E-02	4.3HE -44	خو- انتخذ	1200-00
64 ⁴⁴			178.46									
	1 1 4 + + + + + + + + + +		1.446-440	÷ ÷	144(-44		7 105 + 10	7 1 2 4 2 4	7.000.000		1.00	-1 THE-80
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u			9.202-94									
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ά.	2018-00	LOL-M	1.002-14	1 emi-ce	1.041-62	1.001-451	1745-44	a 705-60	4 748-44	2005-44	4.000-04	
F	4678-44	Mil-In	1.005-05	+ 762 - PE	3.000-02-	1012-01	****	8-48E-04	+ - 5 - 40	1.000-00	1.8%-40	19 1 -41
40;*	400 - FI	enal-m	n tab-mi	1228-00	t ret-ex	1.002-02	1.0 01-0 2	und-44	1.300-44	2.000 -++	4492-40	e.cel -ce
10, I	245-01	L486-41	196-41	248-01	1448-01	LTTE-IT	3468-01	3005-91	2446-41	1447-41	L##6-#1	£499 - 01
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PQ.*	1716-49	4.007-01	144-40	1.000 - PR	P108-64	1.002-00	8 76E-44	+ 122-44	4 20- 102 -	-105-01		4466-41
6 4	2010-01	Naid-ar	1.48 0 -01	1.001-01	4.9 0 0-44	1.046-01	1408-01	1.071-01	1.001-07	a 760 - en ;		1.781-82
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ł	9.000 - 1 14	1.01+0	L##E ##7	Ê	a and wor	t t	2042.00	3 86) - W	h	A	1.222.484	1.000
7 0		2.432.484	1.072-04	1.000 + 14	-241-62	1.005 -++0	1 101-00	1.100	1210-00	2.002.004	3 	
*0•	1345+00		125.44	1.000-00	1.002-00	1308+40	1348-44	1001-00		n.305-47	1306-04	1.32E+64
			2.42.444									
{		0+ HEA	14.5.44	5+38-+E	3445447	\$ 4 8 4 9	1.005+40	444	\$ #\$ 1 +\$ \$	6.305-H	3.4H -04	1.5
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-	1 792 - H	1.011+04	L781-04	1.000 + 10	5.000 - 444	3 196 + 88	1.001+10	1.001-00	2786-08	5 CE - 61	7 28.	LER
	a national	e e al - 121	1	162-10	- 062 - 941	10141	1998-01	1002-07	rest-end	4 199 - 100	1491-01	and sets

- -

FL6 PROJECTED FEED BATCH DENSITIES

Densities (ρ) or specific gravities (SpG) for the projected feed batches (in grams per milliliter) were estimated based on the supernatant composition. The densities were calculated using the following equation:

$$p = 1 + 0.2 (a[A1]^3 + b[A1] + a[Na]^3 + d[Na] + a[Na_2]^2 + Eqn 7$$

$$f[Na_2] + g[Na_3]^2 + h[Na_3] + i[OH]^2 + f[OH])$$

(Agnew and Watkin 1994) where the components in brackets are feed batch concentrations of that component in molarity. The coefficients in this equation are as follows:

*	-	-0.0955	f	-	0.373
b	-	0.383	8	=	0.00046
c	-	-0.0054	h	-	0.201
đ	-	0.1096	il	-	0.0197
e	-	-0.073)	٠	0.0077

The projected feed batch densities can be found in Tables F-8 and F-19.

F2.0 SAMPLING NUMBER CALCULATIONS

F2.1 WASTE VARIABILITY AND SAMPLING LOCATIONS

The intention of sampling is to obtain a set of samples that are representative of the entire feed batch. Therefore, samples should be taken in such a way as to account for the compositional variability between supermatant phases.

Lateral Variability. The lateral variability is the variability in the composition of samples taken at the same waste height but different lateral locations in the tank (i.e., at different risers). For supernatures the following is assumed

- Different phases in the waste occur because of different densities (assumably ansing from different compositions)
- Each phase has a single source and is homogeneous.
- Each phase is level throughout the tank.

From this, the following is concluded

The lateral variability for supernatants is very low (below analytical error).

Therefore, the following requirement on sampling is derived.

All the batch samples will be taken from a single riser on each staging tank.

Vertical Variability. Vertical variability is the variability in the composition of samples taken at the same lateral location (i.e., nser) but at different waste depths. If liquids with different densities (and assumably different compositions) are added together in a feed batch, stratified supermatant phases may form unless there is adequate mixing. Potential sources of stratified phases comes from

- Adding a new batch to the beel from a previous batch.
- Combining wastes from different source tanks.
- Sequentially removing different phases of waste from a single source tank.
- Adding chemicals to adjust a feed batch composition.

Because it is quite probable that stratified supernatants will appear without adequate mixing vertical variability is considered to be the most probable source of sample variability. Therefore, the following requirement is derived:

Samples will be taken at several different heights in the waste.

F2.2 ESTIMATED SAMPLING AND ANALYSIS VARIABILITY

In calculating the number of samples required to validate that a feed batch meets the feed envelope criteria, an estimate of the analytical error and sampling variability is needed. The calculations in this study use relative standard deviation (RSD) values that combine the analytical error and sampling variabilities. These RSDs were determined from the mean concentration, the variance of the mean, and the number of sample locations reported in previous sampling and analysis reports for supersstant characterization (Simpson 1994a, Welsh 1994a, Simpson 1994b, Welsh 1994b). These values are applicable to the supernatant. When solids are added to the feed batch composition, the following is assumed:

 The RSD values for the supernatants are valid for the total feed batch composition, which includes the composition of eptmined solids (i.e., studges).

The RSDs were calculated with the following equation:

$$RSD_{i} = \frac{V_{OP}(\vec{y}_{i}) + l}{\vec{y}_{i}} + 100\% \qquad \text{Eqn 8}$$

where:

RSD, = Relative standard deviation for the concentration of component i (percent)

Var(9,) - Variance of the mean concentration of component / (M or Bq/L)

1 = Number of sample locations

 $\bar{y}_i = Mean concentration of component i (M or Bq/L).$

The RSD values used represent two different scenarios in the staging tanks, "well-mixed" and "not-mixed," and are shown in Table F-20.

Component	Well-Mixe	d Scenario	Not-Mixe	d Scenario I
	ASD	RRSD	RSD	RRSD
	from 2AP	ratio	from 5AP	ratio
	RSD (%)	RSD (%)	RSD (%)	RSD (%)
AI(OH),	5.00	5.49	10.88	13.72
Ba*a	22.93	23.04	43.68	44.48
Ca ⁺²	10.00	10.25	20.00	21.68
Cd ⁺²	6. 6 9	7.06	7.38	11.16
Cr(OH),*	3.40	4.09	10.11	13.12
Fe ⁺³	28.20	28.29	21.88	23.42
Hg ⁺²	8,30	8,60	15.00	17,17
K*	3,60	4,43	7.21	11.04
La ⁺³	10.00	10.25	20.00	21,68
Na ⁺	2.27		8.36	<i>.</i>
Ni ⁺³	8.00	3.76	8.83	12,16
P5 ⁺⁴	4.10	4.69	16.24	18.27
υ	10.00	10.25	17.50	19.39
∞ <u>,</u> .	6.66	7.23	22.96	24.43
a- 1	5.83	6.07	24.18	25.58
F ⁻	6.10	6.51	15.00	17,17
\$0, ⁻²	7.72	8.05	41.71	42.54
NO,"	5.66	6.10	14.99	17.16
NO,-	5,49	5.94	10.62	13.52
PO - 3	7.02	7.38	24.23	25.63
OH-	2.00	3.03	2.50	8.73
Tộc	3.65	4.47	10.04	13.06
-Sr	8,10	8.41	13.44	15.83
■Tc	8.60	8.89	12.39	14.85
¹³⁷ Ce	5.10	5.58	9.66	12.78
TRU	<u>`</u>			
^{aar} Np	17,90	18.04	20.00	21.68
ΣΦρυ	10.00	10.25	20.00	21.68
200 Pu	10.00	10.25	12.23	14,81
эноры	10.00	10.25	20.00	21.68
⁹⁴¹ Pu	10.00	10.25	20.00	21.68
P ^{en} Am	19.38	18.52	44.10	44,89

Table P-20. Relative Standard Deviations.

The "not-mixed" scenario assumes that the staging tanks are not upgraded with an active mixing system. In this situation it is possible for stratified layers of liquids having different densities and chemical concentrations to exist in the tank. For this scenario, the component RSD values used were these values determined for the sampling and analysis of tank 241-AP-105 (Simpson 1994b and Welsh 1994b). This tank was determined to have two or more layers in the supermatant phase and its RSD values give a good indication of expected variabilities for unmixed tanks.

The "well-mixed" scenario assumes the staging tanks are upgraded with active mixing systems capable of mixing stratified liquid layers into a homogenous mixture. For this scenario, the RSD values used were those values determined for the sampling and analysis of tank 241-AP-102 Simpson 1994a and Welsh 1994a). This tank was determined to have a homogeneous supernatant phase and its RSD values give a good indication of the expected variabilities for well-mixed tanks.

Because the feed envelopes are based on component concentrations ratioed to the sodium concentration, the component RSDs are converted to component ratio relative standard deviations (RRSD) using the following equation:

$$RASD_{1}^{A} \rightarrow \left[\left(\frac{RSD_{1}^{A}}{100} \right)^{2} \rightarrow \left(\frac{RSD_{Re}^{A}}{100} \right)^{2} \right]^{6} + 100\%$$
 Eqs. 9

where:

 $RSD_i^{\alpha} = -Relative standard deviation of the component$ *i*concentration for the x scenario.

RRSD³ = Ratio of the component *i* to sodium concentration RSDs.

x = Either the "not-mixed" or "well-mixed" scenario.

These values are shown in Table F-20 for both the "well-mixed" and "not-mixed" scenarios.

Using the following equation, component standard deviations (d,) were calculated for each set of batch, contractor, mixing scenario (well-mixed or not-mixed), and volume of settled solids.

where:

R_e = Sodium Ratio: Ratio of the component *i* concentration to the sodium concentration (moles *i* /moles Na or Bq r / moles Na)

The feed envelope criteria for sodium is a concentration rather than a ratio, so the standard deviation for sodium is calculated with the following equation:

$$\sigma_{y_n} = C_{y_n} \frac{RSD_{y_n}}{100}$$
 Equ (1)

where:

 $\sigma_{sis} = -$ Standard deviation in the sampling and analysis for sodium (M)

 $C_{M_{n}} = -Concentration of sodium (M)$

RSD₃₆' = Relative standard deviation of the sodium concentration for the x scenario (percent)

The standard deviation for each transuranic radionuclide (t) can be calculated with the following equation:

where:

C_t = Concentration of transumatic radionuclide t (Bq/L)

RSD^{*} = Relative standard deviation of the transuranic radionuclide *i* for the x scenario (percent)

 σ_{m} = Standard deviation in the sampling and analysis for sodium (M).

The feed envelopes limit the total amount of transuranics rather than each transuranic radionuclide individually. The standard deviation of the combined transuranic composition (q_{rm}) is calculated with the following equation:

$$\sigma_{TRU} = R_{TRU} \cdot \left[\frac{\sum (a_i^2)}{(C_{TRU})^2} + \left(\frac{RSD_{R_0}}{100} \right)^2 \right]^{\frac{1}{2}}$$
 Eqn 13

where:

R_{my} = Ratio of the TRU concentration to the sodium concentration (Bq TRU/mole Na)

 σ_i = Standard deviation in the sampling and analysis for the transurantic radionuclide t

 C_{rav} = Total concentration of the transaranic radionuclides (Bq/L).

The calculated standard deviations can be found in Tables F-?AF through F-?BC in Section 5.0 for the zero, two, and five percent settled solids cases.

F1.3 CONFIDENCE LEVELS

There are two types of error, Type I (α) and Type II (β). When sampling the staging tanks, the hypothesis is that the feed batch meets the feed envelope orderia. An α error occurs when the feed batch is within the feed envelope limits but sampling and analysis indicate that it is not (i.e., false negative). The β error occurs when the feed batch is not within the feed envelope limits but sampling and analysis indicate that it is (i.e., false positive). To enabling further calculations, the following is assumed:

 Ninety five percent confidence intervals are needed for both types of error (i.e., false positive and false negative) to validate that a feed batch meets the feed envelope criteria.

The following is also assumed:

The component concentrations are nonpally distributed around the mean.

The sodium concentration is evaluated against both upper and lower limits and the twosided t-critical value of 1.959964 (which corresponds to a 95 percent confidence interval) is used in the sodium calculations for both error types. Because all of the other components are evaluated against concentration ratio maximums, a single-sided t-critical value corresponding to the 95 percent confidence interval is used. This value is 1.644854.

F2.4 SAMPLING NUMBER

The number of samples required to validate a specific feed batch (sampling number) for component *i* was calculated with the following equation.

$$S_{i} = \frac{(r_{x} + r_{p})^{2} \cdot \sigma_{i}^{2}}{(R_{i} - E_{i})^{2}} + 0.5 \cdot (r_{p})^{2}$$
 Eqn 14

where:

S_i = Sampling number for component I

- t_ = t critical value for the Type I (a) error
- $t_{\rm s} = 1$ critical value for the Type II (β) error
- E, = Feed envelope concentration limit for component i.

This component sampling number is always rounded to the nearest whole number. Additionally, the component sampling number is increased by one if the component stat ratio is equal to or greater than 6.5. The component stat ratio is a measure of the component ratio's proximity to the first envelope limit and is determined by the following equation:

$$sR_{i} = \frac{|E_{i} - R_{i}|}{\sigma_{i}}$$
 Eqn 15

where:

SR, = Stat ratio for component I.

The sampling number for the feed batch is then the largest of the component sampling numbers.

Tables *P-1AP* through *F-1BC* in Section 5.0 show the sodium ratio, the σ_i (Sigma), the maximum and minimum feed envelope criteria, and the number of samples required to validate the feed batch for each component for the zero, two, and five percent settled solids cases. In the top lefthand corner of these tables is an indication of the conditions the calculations were preformed for including which contractor (CNTR 1 or CNTR 2), the mixing scenario (well-mixed or not mixed), and the percent settled solids (V_E). Also indicated in the top lefthand corner of these tables is the assumed ratio of actual solids volume to total volume in the settled solids layer in the staging tasks (V_S) and the confidence interval used (C1). The ratio and sigma values for sodium are in moles per liter and those for the transmiss (isotopes of Np, Pu, and Am) are given in becquerels per liter. An up or down arrow in the "# of Samples" column indicates a component that has exceeded its feed envelope limit.

Table P-7 through P-7 summarize the number of samples required for each feed batch validation for Contractors 1 and 2 for the zero, one, two, three, four, and five percent settled solids cases.

Scenario	Weil-	Mixed	Not-	Mixed
Contractor	,	2	1	5
Saton	Sam	0 ee io	Ser	ples
1	- 3	3	7	7
[2*]	8	5,	47	34
3 1	3	3	7	7
1 4 1	3	3	- 4	- 4
5.	3	3	5	5
6	3	3	9	9
7	18	19	89	89
8	19	19	89	89
9	3	3	10	10
10 •	3	3	4	- 4
11 *	3	3	5	4.
12 ⁵	4	3	15	4
Sub~ToteF	74 1	70	291	266
Total	144		557	

Table F-21. Summary of Phase I Privatization Intermediate Waste Feed Staging Tank Samples with 0 Parcent Settled Solids.

* No solids data available for these batches.

^b No solide date available for Cntr 2's Betch 12.

^c Assumed that each feed batch currently in the feed staging plan that would fail, is replaced by a batch that meets the envelope. Assume 3 samples for each new feed batch.

NAMES OF BRIDE

Scenario	Wel-	Mixed _	Not-	Mond
Contractor	1 1	2	1	2
Batch	í Sam	ples	San	voles
14	3	3	7	7
2*	8	5	47	34
3*	3	3	7	7
4*	3	3	4	- 4
5*	3	3	5	5
6	Failed .	Failed	Failed	Falled
7	20	20	- 95	95
8	20	20	P5	95
9	3	3,	10	10
10*	3	3	- 4	4
11 *	3	3	5	4
12 6	Feiled	3	Failed	41
Sub-Totaf	75	72	285	272
Totaf	147		557	

Table F-22. Summary of Phase J Privatization Intermediate Waste Feed Staging Tank Samples with 1 Percent Settled Solids.

* No solids data available for these batches.

⁶ No ealids data available for Ontr 2's Batch 12.

⁶ Assumed that each feed batch currently in the feed staging plan that would fail, is replaced by a batch that meets the envelope. Assume 3 samples for each new feed batch.

N 7 **N**

Scanaho	Weil-	Moxect	Not-	Muxed
Contractor	1	2	1	2
Batch	Şam	olea :	. Ser	pies
1.	3	3	7	7
21	8	5	47	34
3*	3	3	7	7
4 *	3	3	- 4	- 4
54	3	3	5	5
6	Failed	Failed	Failed	Failed
7	21	21	102,	102
8	21	21	102	102
8	3	3	10	101
10 *	3	3	4	4
11 *	3	3	5	4
12 ^b	Feiled	3	Failed	4
Sub-TotaF	77	74 (299	286
Tota	151		585	

Table F-23 Summary of Phase J Privatization Intermediate Waste Feed Staging Tank Samples with 2 Percent Settled Solids

* No solids data available for these batches.

^b No solids data available for Cntr 2's Batch 12.

⁵ Assumed that each feed batch currently in the feed staging plan that would fail, is replaced by a batch that meets the envelope. Assume 3 samples for each new feed batch

Scenario	Well-	Mixed	Not-	Minord
Contractor	1	2	1	2
Betch	Sam	plés	Ser	iples –
	3	3	7	7
2*	8	5	47	34
8*	3	3	7	7
4 4	3	3	4	- 4
5 •	3 -	3	5	5
6	Failed	Failed	Failed	Failed
7	22	22	110	110
8	22	22	110	t 1Q
9	3	3	9	9
10 *	3	3	4	4
11 *	3	3	5	4
12 °	Falled	3	Failed	4
Sub-Total [®]	79	76	314	- 30í
Total	155		615	

Table F-24. Summary of Phase I Privatization Intermediate Waste Feed Staging Tank Samples with 3 Percent Settled Solids.

* No solids data available for these batches.

^b No solids data available for Cntr 2's Batch 12.

⁵ Assumed that each teed batch currently in the feed staging plen that would fail, is replaced by a batch that meets the envelope. Assume 3 samples for each new feed batch.

Program Spring

Scenario	Well-	Moted	Not-	Mixed
Contractor	ĩ	2	1	2
Batch	Sam:	oles -	San	vples
	<u> </u>	3	7	7
2*	8	5	47	34
3"	3	3	7	7,
4*	3	3	- 4	4
5*	3	3	5	5
6	Failed	Falled	Failed	Failed
7	24	24	118	118
8	24	24	118	118
) 9	3	3	9	9
10.	3	3	4	4
1 11 1	3	3;	5	4
12*	Failed	3	Failed	- 4
Sub-Totaf	.83	6 0	330	317
Totaf	163		847	

Table F-25. Summary of Phase I Privatization Intermediate Waste Feed Staging Tank Samples with 4 Percent Settled Solids.

* No solids data available for these batches.

* No solids data available for Cntr 2's Batch 12.

⁹ Assumed that each feed batch currently in the feed staging plan that would fail, is replaced by a batch that meets the envelope. Assume 3 samples for each new feed batch.

Scenario	W∎⊫-	Mixed	Not-	Mixed
Contractor	1	2	1 7	2
Batch	Sam	pies	San	iples .
1	3	3	7	7
2*	8	5	47	34
3.	31	3	7	7
4*	3	3	4	- 4
6°	3	3	5	5
6	Failed	Failed	Failed	Failed
7	26	26	128	128
8	26	26 (128	128
9	- 4	- 4	9	9
10 *	3	3	- 4	4
11*	3	3	51	4
12 ^b	Failed	3	Failed .	4
Sub-Totaf	8 8	ŝ	350	337
Total	173		687	

Table F-26. Summary of Phase J Privatization Intermediate Waste Feed Staging Tank Samples with 5 Percent Settled Solids.

* No solids data available for these batches.

^b No solids data available for Cnir 2's Batch 12.

⁵ Assumed that each feed batch currently in the feed staging plan that would hell, is replaced by a batch that meets the envelope. Assume 3 samples for each new feed batch.

F3.9 EFFECTS OF SOLIDS ON THE SAMPLING NUMBER

F3.1 EFFECTS OF SOLIDS ENTRAINMENT

Table F-27 shows the effect solids entrainment has on the sampling number for the cases of zero to six percent settled solids. The "Total Samples" column lists the total ("life-cycle") number of samples required for Phase I. This includes the samples for all twelve batches for both contractors. The right column lists the currently planned feed batches listed in Certa et al. (1996) that will not meet the modified RFP feed envelopes (i.e., failed batches) if the specified amount of solids/shudges are entrained. In calculating the total samples, it is assumed that the potential of these failed batches would be anticipated and Certa et al. (1996) would be revised to replace them with batches that meet the feed envelope criteria and only require three samples for validation.

Description of California	Tetal Complex	Batches Exceeding I	feed Envelope Criteria
Percent Settled Solids	Total Samples	Contractor 1	Contractor 2
	Well Mix	ed Scenario	
0%	144		•
1 %	147	12,6	6
2 %	151	12,6	6
3%	155	12,6	6
4 %	163	12,6	6
5%	173	12,6	6
6%	183	12,6	6
	Not Mix	ed Scenario	
0 %	557	[
1 %	557	12,6	6
2 %	585	12,6	6
3 %	615	12,6	6
4 %	647	12,6	6
5%	687	12,6	6
6 %	740	12,6	6

Table F-27. Sampling Number and the Effects of Entrained Solids.

Solids data was only available for Batches 6, 7, 8, & 9, and Contractor 1's Batch 12.

F3.2 EFFECTS OF THE TRANSURANIC LIMIT

Table F-28 lists the total (life-cycle) number of samples that would be required in the Feed Envelope C TRU limit was measured for solid entrainment scenarios between zero and 5 percent The current TRU limit is 3,000,000 Becquerels for TRU per mole of sodium. Figures F-29 and F-30 show the percent reduction in the sampling number as a function of the percent increase in the Feed Envelope C TRU Limit for the well-mixed and not-mixed scenarios, respectively

Erwelope C		N	umber	of Sem	olet A		i for Al	Pruss	Fee	1 Danieł		<u> </u>
TRU Lunat		Ŵ	ججزلا لأ	Ó Scen				No	Notes	Scent	110	
Bo/Mol Na	0%	15	2.5	3%	4%	55	0%	1%	24	31	4%	5%
3,000,000	144	147	1\$1.	155	169	173	667	- 657	586	615,	- 647	647
3,100,000	120	119	123	123	127	131	429	417	429	443	459	475
3,200,000	108	107	107	111	111	111	361	341	349	355	369	371
3,300,000	100	99	89	99	103	103	821	301	305	307	311	319
3,400,000	10	P\$	85	96	95	¢\$	305	261	रग	276	279	283
3,500,000	\$2	81	91	91	Q1	91				271	267	263
3,000,000	- 349	67	67	67	67							
8,700,000	30											
3,800,000	- 34											

Table P-28 Sampling Number as a Function of the Transuranic Limit with Respect to Mixing Scenario and Percent Settled Solids

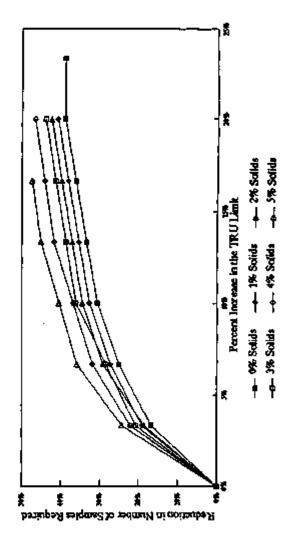
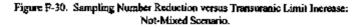
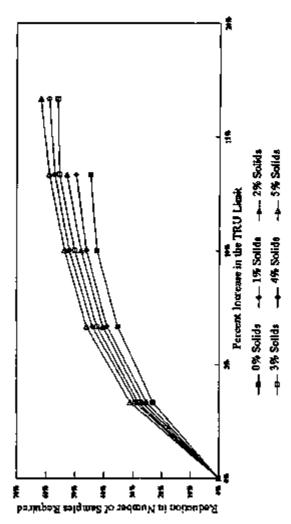


Figure F-29. Sampling Number Reduction versus Transmanic Limit Increase: Well-Mixed Scenario.





F4.9 SAMPLE AND ANALYSIS REQUIREMENTS AND COSTS

F4.1 ANALYTICAL REQUIREMENTS

An analysis of the staging tank samples will be needed for each of the analytics and radionuclides listed in the feed envelope enterna. Table F-31 lists the analytical method and procedure numbers for the required analysis

F4.2 SAMPLE SIZE REQUIREMENTS

Table F-31 also luts the volume of sample required for analysis. When received, the bulk samples are rested for several physical characteristics. The bulk sample is then separated into liquid and solids fractions which are tested separately. The sample volume required for the bulk and laquid fraction tests is 20 mL including duplicate analysis. If the settled solids are at or below five volume percent, a sample volume of 100 to 120 mL may be required to ensure enough solids are separated out to perform the required analysis. Also, sample volumes smaller that 100 may be too small to obtain a representative percent settled solid inessuredant.

F4.3 SAMPLE ANALYSIS COST ESTIMATES

The cost for sample analysis has been separated into (1) the cost for liquid fraction analysis, which includes the tests on the bulk samples, and (2) the cost for the solids fractions analysis. These costs also include the costs of duplicate analysis. The cost for liquid fraction analysis is \$4,000 per sample. The cost for the solids fraction analysis is \$4,500 per sample. If samples are taken with a core sampler, there is an additional \$1,000 per sample for assessed for extrusion of the sample from the core sampler (Rice 1996).

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Table F-31. Intermediate Waste Food Staging System Food Batch Sample Analysis Requirements. (Sheet 1 of 3)

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Table F-3). Internediate Waste Feed Staging System Feed Batch Sample Analysis Requirements. (Sheet 2 of 3)

Table F-31 Intermediate Waste Feed Staging System Feed Batch Sample Analysis Requirements (Sheet 3 of 3)

- ^A d-detect, 1-house description, e-acid description, w-water description
- * en-each, ampli-sample, DUP-duplicate, SPKMSD-spike and matrix spike duplicate, AG-analytical batch, PG-presention blank, NA-not applicable, onto-matrix.
- ⁴ Duplemin Jelens to a duplexité éliquet taken from the bulk sample
- ^D Estimated concentrations from
- ⁴ Usakune inik sample
- * From bulk sample liquid frection
- * Fram Squid-Inschen density
- * From ICP or IC fueron, weige, or acid digestions
- *Either send diubors of metrix spikes will be performed (when applicable)
- * Tracer or cerner may be used in place of a splite and results corrected for recovery
- * Cold Vapor Alornic Absorbtion
- * May not need to be performed depending on the definition of immittings weble
- * Flearineiry
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F5.0 TABLES

This section contains the tables used to calculate the minimum number of samples required to validate that the feed batches most the food envelopes.

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Table F-32 Sample Number Calculations for Contractor 1, Well-Mixed, 0 Percent Scaled Solids (Sheet 1 of 3)

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 Table F-32
 Sample Number Calculations for Contractor 1, Well-Mixed, 0 Percent Settled Solids (Sheet 2 of 3)

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 Table F-32
 Sample Number Calculations for Contractor I, Well-Mixed, 0 Percent Settled Solids (Sheet 3 of 3)

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Table F-33 Sample Number Calculations for Contractor 1, Not-Mixed, 0 Percent Senied Solids (Sheet 1 of 3)

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Table F-33 Sample Number Calculations for Contractor 1, Not-Mixed, 0 Percent Senied Solids (Sheet 2 of 3)

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 Table F-34
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Table F-36. Sample Number Calculations for. Contractor 1, Well-Mixed, 2 Percent Settled Solids (Sheet 2 of 3)

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Table F-37 Sample Number Calculations for Contractor 1, Not-Mixed, 2 Percent Settled Solids (Sheet 1 of 3)

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Table F-38 Sample Number Calculations for Contractor 2, Well-Mixed, 2 Percent Settled Solids (Sheet 3 of 3)

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Table F-39 Sample Number Calculations for Contractor 2, Not-Mixed, 2 Percent Settled Solids (Sheet 1 of 3)

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Table F-41 Sample Number Calculations for Contractor 1, Not-Mixed, 5 Percent Settled Solids (Sheet 1 of 3)

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Table F-41 Sample Number Calculations for Contractor 1, Not-Mixed, 5 Percent Settled Solids (Sheet 3 of 3)

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Table F-42 Sample Number Calculations for Contractor 2, Well-Mixed, Percent Settled Solids (Sheet 2 of 3)

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Table F-43 Sample Number Calculations for Contractor 2, Not-Mexed, 5 Percent Settled Solids (Sheet 1 of 3)

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Table F-43 Sample Number Calculations for Contractor 2, Not-Mixed, 5 Percent Settled Solids (Sheet 3 of 3)

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F6.0 NOMENCLATURE

C/	Concentration of component I in the γ phase M
C/ C/	Total concentration of component I in the combined supernatant and entrained
	solids phases M or Bq/L
C,º	Concentration of component / in the supernatant phase M
C,*	Concentration of component / in the entrained solids phase M or Bq/L
C, ^s C, ^s C, ^z C, _x , D	Concentration of indionuclide r in the supernatant phase Bq/L
C _{xe}	Concentration of sodium M
	Dilution factor, ratio of staged feed batch volume to retrieved - waste volume.
E,	Feed envelope concentration of component I moles I/moles Na
I I	Number of sample locations -
Μ,	Mass of component I in the batch MT
м,	Mass of radiomuclide r in the batch Bq
MW,	Molecular weight of component I g/mole
Rac	Ratio of the actual solids volume to the total volume in the percent (L actual
	salids/compacted sludge layer in the source tank L sludge layer)
R _{AS} or V ₅	Ratio of the actual solids volume to the total volume in the percent (L actual
	solids/settled solids layer in the IWFST L settled solids)
R,	Ratio of the component I concentration to the sodium moles I/moles Na or
5 80	concentration. Bq r/moles Na
R	Maximum permissible ratio of the settled solids layer volume percent (L settled - solids to the field batch solitons). Finally
R or V	solids/to the feed batch volume L. Feed) Ratio of the settled solids layer volume to the feed batch percent (L. settled
R _F or Vg	solids/volume L Feed)
R.	Maximum permissible volume of compacted sludge layer percent {L sludge
	(aver/entrained in the retrieved waste L retrieved waste)
RRSD.	Ratio of RSD, to RSD _w , percent
RSD,	Relative Standard Deviation of the I concentration for the x scenario percent
8,	Sample Number samples
SR.	Stat Ratio for component / -
V,	Volume of the Batch L Feed
V	Maximum volume of sludge layer that can be entrained ML
V _R	Volume of waste retrieved from the source tank ML
Var(ÿ,)	Variance of the mean concentration of component I
ÿ,	Mean concentration of component I M or Bq/L

Greek Letters

- α Type 1 error, single-sided test
- a' Type) error, double-sided test used for sodium
- β Type 2 error, single-sided test
- o, Standard deviation in the sampling and analysis for component I.

Subscripte

- I Component I (analyte, radionaclide, or transuranic radionuclide)
- r Radionuclidz r
- Na Sodium
- t Transuranic radionuclide t
- TRU Transuranics

Superscripts

- C Combined supernaunt and entrained solids phases.
- L Supernatant (liquid) phase.
- max Maximum
- mn Not-Mixed Scenario
- S Entrained solids phase.
- wm Well-Mixed Scenario.
- x Either the "Not-Mixed" (nm) or "Well-Mixed" (wm) scenario.

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